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RESEARCH ARTICLE

CROSS COUNTRY ANALYSIS OF GROSS DOMESTIC PRODUCT (GDP) OF BRICS NATIONS: AN ASSESSMENT AND NEW EVIDENCE

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ABSTRACT

Gross Domestic Product (GDP) value is the indicator for the economic growth of the economy. The higher growth rate in gross domestic product leads to increase economic growth of the country.The study is designed to analyze the gross domestic product movement of BRICS nations. The abbreviation BRICS stands form Brazil, Russia, India, China and South Africa. Each country has their various different factors which affect their GDP growth rate.Yearly data from 1990 to2017 is used in the following research study. The result of Granger causality test is showing causality relationship GDP value among various BRICS nations. The following research paper also indicates how these GDP are cointegrated with each other. Data of gross domestic product have been collected from the secondary sources such as from their world trade organization websites and some other sources also i.e. investing.com etc. to analyze the pattern of change in gross domestic product movement of BRICS country.

INTRODUCTION

One of the most common abbreviations used in economics (GDP) is known as Gross Domestic Product. There are various elements considered under the umbrella of GDP. The behavioral change in the growth pattern of GDP mirrors the economic growth of the country. Ricardo (1817) emphasized on the total goods and services and its impact on the economy. Therefore various economies adopted various economic policies so that they can increase their economic growth.Rati Ram (1986) studied relationship between economic growth and GDP of the country on the bases on international prices. He compared 104 countries data from 1960 to 1980. Summers and Heston (1984) also supported growth rate of gross domestic product based on domestic and international price are correlated with each other. ArvindVirmani (1999) studied emerging economics and tried economic forecast on the bases of their GDP growth in 21st century. He concluded that India will be at sixth number in the forecast in terms of GDP and per capita GDP growth.Becker and Tillman (1978) tried to find out the impact of family business on the GDP of US economy. Henderson *et al.,* (2012) analyzed economic growth and concluded that GDP play an important role as a variable for the study of economic growth of the country. Crafts (2000) doing their study focused on globalization and its various impact on various economies. The concluded that after world war various economies turned to increase their GDP growth.Barro (1991), Baker (1998) and Caballero (2007) concluded in the study that various internal and external variables are the determinant for the economic growth. Lucas (1988) and Barro (1991) find out that specialization in traditional technology and unskilled labor affect output of the country.

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Gross Domestic Product (GDP) Movement in BRICS nations (billions of US$)

Brazil

The GDP data of Brazil has achieved a total value of 475 billion US$ in 1990. It is showing an average growth rate of 1178 billion US$ during this period. There is consistently growth rate of GDP started from 2003 and till 2017 it achieved 1798 billion US$. This growth rate indicating that Brazilian economy is boosting and the economic policy are more favorable for expansion of gross domestic product. Brazil has recorded second position in the following study in term of growth of gross domestic product.

Russia

The GDP data of Brazil has achieved a total value of 992 billion US$ in 1990. It is showing an average growth rate of 939.73 billion US$ during the period of 1990 to 2016. There is consistently growth rate of GDP started from 2005 and till 2017 it achieved 1280 billion US$. This growth rate indicating that Brazilian economy was fluctuated various time during this time period. It achieved its minimum growth rate in 1992 of 91.94 billion US$ only but in the next coming year in 1993 it achieved 197.43 billion US$ which is just double from the previous year. It is showing that Russia is having capacity to boosting at a very fast rate.

Indian

The time period of 1990-91-92 was very crucial in the history of Indian economy. In 1991 Indian government adopted the policy of economic reform which affect all the sector of the economy. In 1991 the gross domestic product value was 274.84 billion US$, in 1992 it was 293.26 US$. The GDP data of India has achieved a total value of 362.61 billion US$ in 1990. It is showing an average growth rate of 949.55 billion US$ during the period of 1990 to 2016. There is consistently growth rate of GDP started from 1991 and till 2017 it achieved 2256 billion US$.

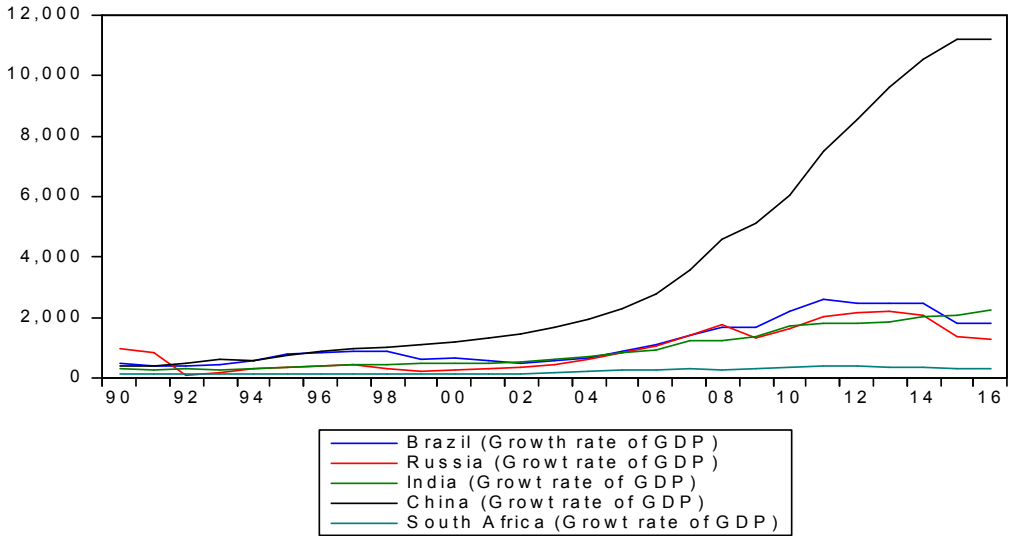
This growth rate indicating that Indian economy was also fluctuated various times during this time period. It achieved its minimum growth rate in 1991 of 274.84 billion US$ only but in the next coming year in 1992 it achieved 293.26 billion US$.

China

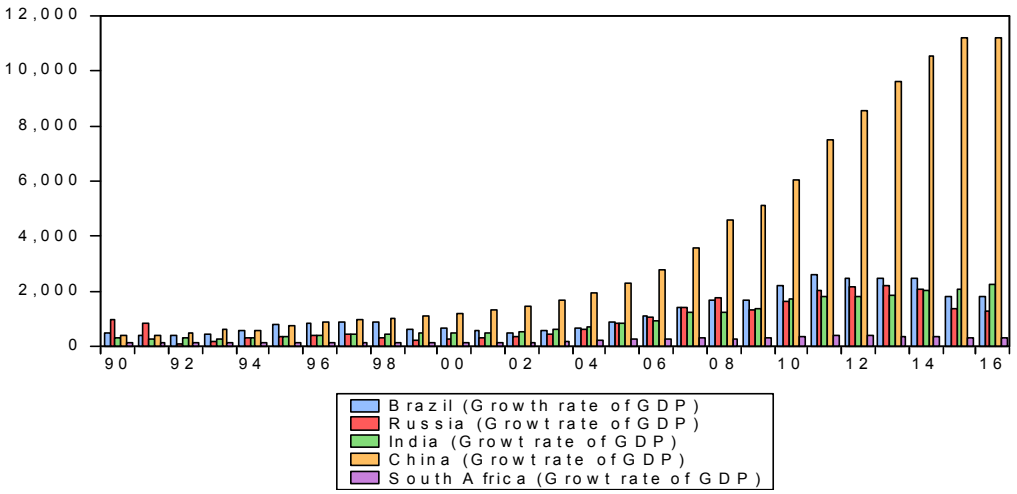
The following graph of GDP data of China is showing the pattern of GDP growth rate has achieved a total value of 398.62 billion US$ in 1990. It is showing an average growth rate of 3630.58 billion US$ during the period of 1990 to 2016. There is consistently growth rate of GDP started from 1990 and till 2017 it achieved 11218.28 billion US$. This growth rate indicating that China has much more potential to become leading economy among BRICS nations.Its growth rate of GDP showing consistent positive growth rate with some fluctuation during this time period. It achieved its minimum growth rate in 1990 of 398.62 billion US$ only but in the next coming year in 1991 it achieved 415.60 billion US$ which is just more than the previous year.

South African

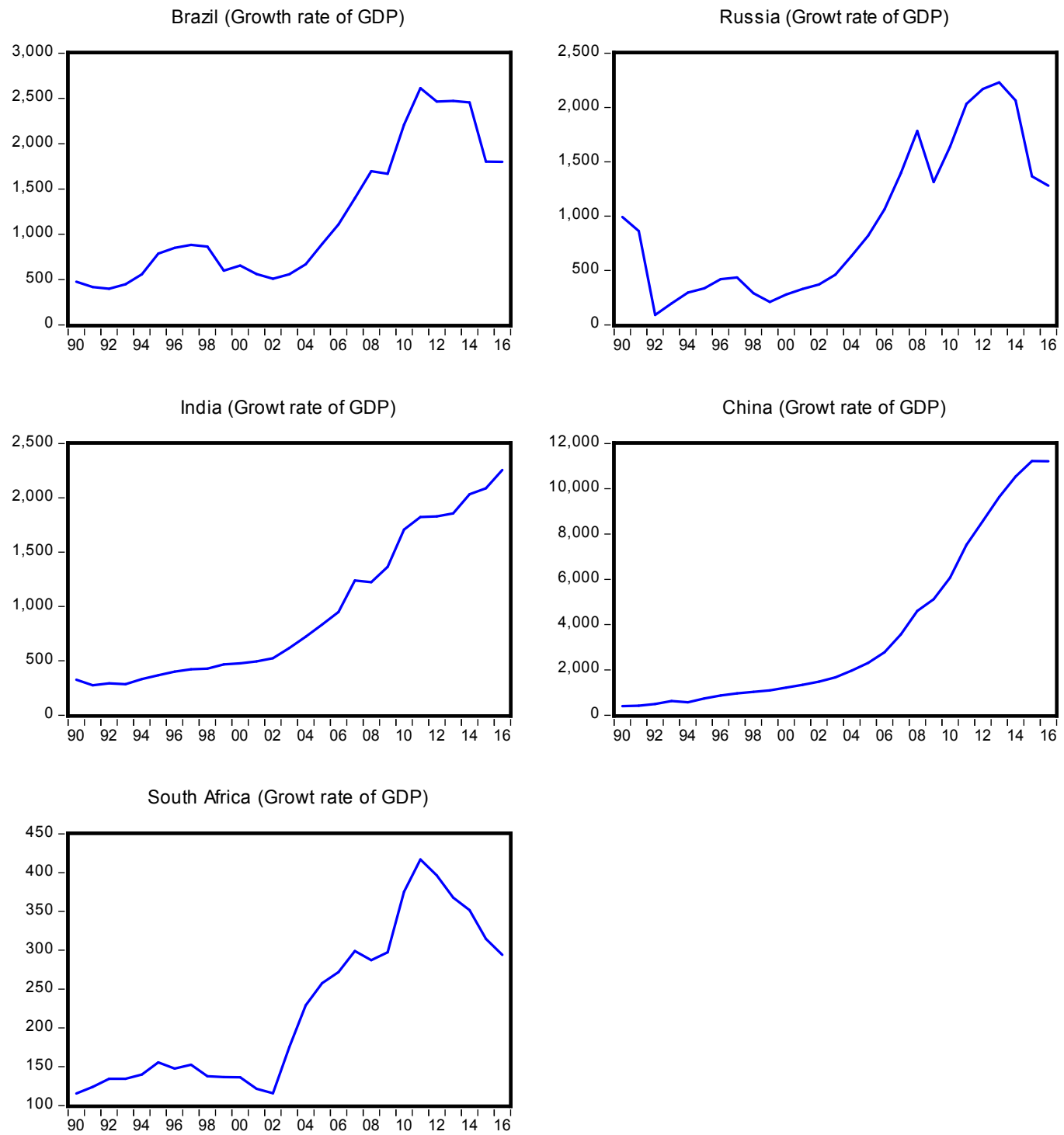
The graph showing growth rate of gross domestic product (GDP) of South Africa. South Africa having least GDP growth rate among various BRICS nation. In 1990 the real GDP of



Graph 1. Gross Domestic Product (GDP) Movement of BRICS Nations (1990-2016)



Graph 2. Gross Domestic Product (GDP) Movement of BRICS Nations (1990-2016)



Graph 3. Gross Domestic Product (GDP) Movement of BRICS Nations (1990-2016)

South Africa was only 115.53 billion US$ only and in next decade the growth rate of GDP was very low. In 2017 the GDP value was only 294.13 billion US$. The average growth rate of GDP during the time period of 1990 to 2016 was only 225.39 billion US$. South Africa needs more favorable policy and support from other BRICS nation to give boost to their economy.

Research Objective

The research object which served as a guide for the following studies are as follows:

- To analyze the performance of gross domestic product of BRICS nations.
- To find out the correlation among the value of gross domestic product of BRICS nations.
- To check the causality relationship among gross domestic product of BRICS nations.

Significance of the Study

The following study will help to various policy maker to observe the performance of gross domestic product (GDP) of particular of BRICS nations because this study is showing the

movement pattern of growth rate of gross domestic product. Apart from this, its finding is showing the causality relationship of one gross domestic product growth rate to other indices. Thus this investigation can be helpful in adding prevailing in the present literature which will help various researchers to work on this topic and they can identify regular problems various up down in GDP value of BRICS countries.

MATERIALS AND METHODS

The following study is based on growth rate Gross Domestic Product (GDP) of BRICS countries. BRICS is a group of five countries named Brazil, Russia, India, China and South Africa. It comprises around 43 per cent population of the world alone in 2015. BRICS is truly an emerging economic integrated group and it is significant in terms of development of developing countries. The following study includes the study of its gross domestic product, volatility of growth rate. This paper assumes that these BRICS nations are the leading economies in the world. The data for this study have been gathered from various government agencies, world trade organization's websites etc. The sample of the time period spans yearly from 1990 to 2016. The study applied series of various statistical and econometric techniques to test the relationship among selected variables. The test applied ranges from; Unit root test, Correlation analysis, Cointegration test and Granger causality test etc. over the sample period. Each technique is explained in both explicit and implicit term.

Unit Root Test

The very first step in time series analysis is to check the stationarity of the time series data. Unit root test helps to find out where data of particular time series is having the property of stationarity or the data is of non- stationarity nature. There are various test under Unit Root Test is used to check such property of the time series. Augmented-Dickey Fuller (ADF) test has been used in the following study which is an extended version of Dickey-Fuller (DF) Test (1979). It is an econometric test which is used to test the null hypothesis of any unit root in a time series and also used to check the property of stationarity of the data. Augmented-Dickey Fuller (ADF) test is generally used for the more complex set of time series. In ADF statistics, negative number is used in the test. The more negative value will give a strongest reason to reject the hypothesis which indicates unit root of the data at some level of confidence. In Augmented-Dickey Fuller (ADF) test data is check at level or 1st difference or 2nd difference. Augmented-Dickey Fuller (ADF) test can be expressed in following form:

$$\Delta y_t = \alpha + \beta t + \Upsilon y_{t-1} + \delta_1 \Delta y_{t-1} + \ldots\ldots\ldots + \delta_{p-1} \Delta y_{t-p-1} + \varepsilon_t,$$

Where α is used to express constant, β expressing the coefficient on a time scale and p is used to express lag order of autoregressive process. In the following expression $\alpha=0$, β =0corresponding to modeling in a random walk. ADF test includes lags of the order p which allows higher order of autoregressive process. It should be noticed that lag of the p should be determined when ADF is being used. lag of p is determined by the t-values on coefficient. An alternative approach Schwarz Info Criterion (SIC) andAlkaike information criterion (AIC) is used in the following study.

Pearson Correlation coefficient

To check the linear and symmetrical relationship among various variables, the Pearson correlation coefficients were estimated. It is mostly widely used correlation statistical tool to measure the degree of relationship among various linearly related variables. The formula of Pearson correlation coefficient can be explain as

$$r = \frac{1}{n-1} \sum \frac{(x_i - \overline{X})(y_i - \overline{Y})}{s_x s_y};$$

Where r denoting correlation coefficient.

It has its ranges from -1.0 to +1.0 where closer r is to +1 or -1, the relationship among variables can be check with this value. If the value of r is more close to 0, it indicates that there is no relationship between the selected variables whereas if the value of r is positive it show that if one variable gets larger than the other variable will also gets larger but if the value of r is negative it show that one variable getting larger while other getting smaller known as 'inverse correlation'.

Cointegration Test

After the confirmation of unit root in the time series the next step is to check the relationship among the various variable in a long run time period. Johansens (1991) used VAR based cointegration test which is used in the following study. Considering a VAR of order *p:*

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + B_{xt} + \varepsilon_t, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Here $y_t$is showing k – vector of non-stationary I (1) variables, $x_t$is used to represent d– vector of deterministic variables,$\varepsilon_t$showing vector of innovations,

We can express VAR as:

$$\Delta y_t = \Pi y_{t-1} \sum_{i=1}^{p-1} \Gamma_i \Delta y_t = \Pi y_{t-i} + BX_t + \varepsilon_t$$

Where,

$$\Pi = \sum_{i=1}^{p} A_i - I, \Gamma_i = -\sum_{j=i+1}^{p} A_j$$

According to Granger's representation theorem if the coefficient matrix Π reduced its rank $r<k$, then $k \times r$ matrices α and β each with the rank r such that $\Pi = \alpha \beta'$and $\beta' y_t$is I (0). Cointegration relationship can be shown by r number and column of β will show Cointegrating vector. There are two another statistics which is used in the Johansens cointegration. The first one is the trace test statistics and another is maximum eigenvalue test statistics.

Trace Test Statistics

Trace test statistics is used to test the rank of Matrix Π is $r_0$or not. Here the null hypothesis is that rank (Π) = r_0 and

alternative hypothesis is that $r_0 <$ rank (Π) $\leq n$, where n represent maximum number of possible Cointegrating vector. Trace test will succeed only when the null hypothesis will be rejected and the next null hypothesis is that rank (Π) = $r_0 + 1$ and alternative hypothesis is that $r_0 + 1 <$ rank (Π) $\leq n$. Thus trace statistics test null hypothesis of r Cointegrating relation against alternative of$k$ Cointegrating relation. K represents number of endogenous variables, for $r = 0, 1, \ldots\ldots k - 1$.

Trace test statistics for null hypothesis or r Cointegrating relation can be computed as:

$$LR_{tr}(r|k) = -T \sum_{i=r+1}^{k} \log(1 - \lambda_i)$$

Here λ_i represent i^{th} largest eigenvalue of matrixΠ. T represent the number of observation and LR represents likelihood ratio statistics.

Maximum Eigenvalue Test

Maximum eigenvalue statistics is used to test null hypothesis of r Cointegrating relations against alternative of $r + 1$ cointegrating relation. It examines whether the largest eigenvalue is zero relative to alternative that next largest Eigen value is zero. Firstly it test whether rank of matrix Π is zero. The null hypothesis is that rank (Π) = 0 and alternative is that rank (Π) = 1 and further it tests null hypothesis is that rank (Π) = 1, 2, … and alternative hypothesis is that rank (Π) = 2, 3,……

The test of maximum eigenvalue is a likelihood ratio test which can be expressed in a following way:

$$LR\ (r_0, r_0 + 1) = -T \ln (1 - \lambda_{r0+1})$$

Where $LR\ (r_0, r_0 + 1)$ is likelihood ratio test statistics which is used to test whether rank (Π) = r_0 versus alternate hypothesis that rank (Π) = $r_0 + 1$.

Selection of lag length is very important in Johansens cointegration test. Thus for suitable VAR model firstly selection of appropriate lag structure is very necessary. Appropriate lag structure selection is based on Akaike Information Criterion (AIC), Schwarz Criterions (SC) and Likelihood Ratio (LR).

Empirical Analysis

Descriptive Statistics

Table 1 shows the descriptive statistics of the selected emerging economies. The average growth rate are highest in China (3630.5) followed by Brazil (1178.1) and lowest in South Africa having the average growth rate is (225.3). The standard deviation represents here as a proxy of raw data and its statistic explicates that China (3709.4) is highly volatile market followed by the Brazil (750.0) and least volatile rate of GDP recorded in South Africa (101.16). The variation in the GDP was measured by Coefficient of Variation unveils that China (102.17 per cent) remained a highly varied market followed by the Russia (73.77 per cent), India (70.80 per cent), Brazil (59.24 per cent) and South Africa (44.88 per cent). The maximum value of GDP growth was found in China (11226.19) and the lowest in South Africa (115.53).

Correlation Analysis

The table 5.2 is showing linear and symmetric relationship of GDP among BRICS countries which was capture by estimating Pearson correlation coefficient mentioned above. The following table showing the result of correlation among various selected variables for the time period of 1990 to 2016. The result in the table (52) showing correlation between GDP of various countries of BRICS nations. The following table of correlation clearly showing that the growth rate of GDP of India is highly correlated with the growth rate of China followed by GDP of Brazil with the GDP of South Africa whereas growth rate of Russia is least correlated with the GDP of China.

Table 1. Results of Descriptive Statistics Analysis

	Brazil	Russia	India	China	South Africa
Mean	1178.153	939.7349	949.5527	3630.580	225.3987
Median	864.0170	820.5680	618.3690	1671.072	175.2540
Standard Deviation	750.0321	693.3053	672.3581	3709.403	101.1689
Coefficient of variation	59.4274	73.7766	70.8078	102.17108	44.8844
Minimum	399.0820	91.94100	274.8420	398.6230	115.5330
Maximum	2614.027	2230.624	2256.397	11226.19	416.8790

Sources: Computed by authors, and values are expressed in nominal terms.

Table 2. Results of Correlation Analysis

	Brazil	Russia	India	China	South Africa
Brazil	1				
Russia	0.9287651302675987	1			
India	0.9275011007856926	0.8694369200455195	1		
China	0.8942286513918694	0.8288429708541864	0.9800862109287414	1	
South Africa	0.9504273097512362	0.9188577548881104	0.9189194016423256	0.8514728722535333	1

Sources: Computed by authors, and values are expressed in nominal terms.

Unit Root Test

Time series modeling always necessitated for checking the stationary of data keeping the fact in mind, to study conducted the ADF test to check the stationarity of underlying data series. The result explained that two variables are stationary at their level whereas other three are non-stationary.

Table 3. Results of Unit Root Test - Augmented Dickey-Fuller (ADF) Test

Variable Name	Test Statistics	Critical Value	P-value	Decision	Remark
Brazil	-2.114967	At 1% - -3.769597	0.2410	Accepted	Non-Stationary
		At 5% - -3.004861			
		At 10% - -2.642242			
Russia	-4.021229*	At 1% - -3.724070	0.0050	Rejected	Stationary
		At 5% - -2.986225			
		At 10% - -2.632604			
China	-3.994598*	At 1% - -3.724070	0.0053	Rejected	Stationary
		At 5% - -2.986225			
		At 10% - -2.632604			
India	-1.560324	At 1% - -3.724070	0.4873	Accepted	Non-Stationary
		At 5% - -2.986225			
		At 10% - -2.632604			
South Africa	-2.746870	At 1% - -3.724070	0.0805	Accepted	Non-Stationary
		At 5% - -2.986225			
		At 10% - -2.632604			

Sources: Computed by authors, and values are expressed in nominal terms.
*Unit root in the first difference were rejected at 5 % level of significance.

Table 4. Results of Johansen's Cointegration Test

Hypothesized Number of Cointegrating equations	Eigen Value	Trace Statistics	Critical Value at 5 % (p-value)	Maximum Eigen statistics	Critical Value at 5 % (p-value)
None	0.945115	131.3990	69.81889 (0.0000)	72.56303	33.87687 (0.0000)
At Most 1*	0.661563	58.83597	47.85613 (0.0034)	27.08547	27.58434 (0.0578)
At Most 2*	0.496991	31.75051	29.79707 (0.0294)	17.17869	21.13162 (0.1637)
At Most 3	0.320366	14.57182	15.49471 (0.0685)	9.655018	14.26460 (0.2356)
At Most 4	0.178540	4.916799	3.841466 (0.0266)	4.916799	3.841466 (0.0266)

Sources: Computed by authors, and values are expressed in nominal terms.

Table 5. Results of Granger Causality Test

Null Hypothesis	Observation	F-Statistic	Probability	Decision	Direction
Russia does not Granger Cause Brazil	25	0.33706	0.7178	Accept	Bidirectional
Brazil does not Granger Cause Russia		1.96971	0.1656	Accept	
India does not Granger Cause Brazil	25	2.27035	0.1292	Accept	Bidirectional
Brazil does not Granger Cause India		1.48182	0.2511	Accept	
China does not Granger Cause Brazil	25	0.07739	0.9258	Accept	Unidirectional
Brazil does not Granger Cause China		4.57559	0.0231*	Reject	
South Africa does not Granger Cause Brazil	25	5.25497	0.0147*	Reject	Unidirectional
Brazil does not Granger Cause South Africa		0.37463	0.6923	Accept	
India does not Granger Cause Russia	25	7.10619	0.0047*	Reject	Unidirectional
Russia does not Granger Cause India		0.26491	0.7699	Accept	
China does not Granger Cause Russia	25	2.90005	0.0784	Accept	Bidirectional
Russia does not Granger Cause China		1.83155	0.1860	Accept	
South Africa does not Granger Cause Russia	25	20.9728	1.E-05*	Reject	Unidirectional
Russia does not Granger Cause South Africa		0.52116	0.6017	Accept	
China does not Granger Cause India	25	4.78920	0.0200*	Reject	Bidirectional
India does not Granger Cause China		13.0431	0.0002*	Reject	
South Africa does not Granger Cause India	25	0.01097	0.9891	Accept	Bidirectional
India does not Granger Cause South Africa		0.25343	0.7786	Accept	
South Africa does not Granger Cause China	25	11.4661	0.0005*	Reject	Unidirectional
China does not Granger Cause South Africa		0.47173	0.6307	Accept	

Sources: Computed by authors, and values are expressed in nominal terms.
* denotes the rejection of null hypothesis at 5 per cent level of significance.

All the null hypothesis of the underlying series for three variables is accepted at their level and hence the data are non-stationary whereas for other two variables null hypothesis is rejected. The appropriate Lag-length criterion was choosing by following AIC criterion (Appendix 1.1)

Cointegration test

The Johansens cointegration test is very sensitive to the lag length criteria. There is only one lag length is used as suggested by various lags length criteria such as Schwarz, Akaike and Hannan-Quinn information criteria. The Johansen cointegration method suggests basically two tests one is trace test and another is maximum Eigen valuetest which determine the number of cointegrating vectors.

These both tests indicate that one cointegrating equation at 5 percent significance level as first null hypothesis. In the next step, Johansen's cointegration test has been tested for the selected variables with the help of Trace and Maximum Eigen value test. The table 5.4 is showing the result of these tests. The result indicating there is two cointegration equation existing in the system which is representing by trace statistics and maximum Eigen statistics. Hence in the following equation there is twoequation is cointegrated.

Granger Causality Test

The result of granger causality test shown in table no. 5 indicating that somewhere null hypothesis is accepted where at some place it is failed to reject based on their probability value.

In the result of following table it is mentioned that the null hypothesis for Russia and Brazil granger cause for each other is accepted; null hypothesis for India and Brazil granger cause each other is accepted; null hypothesis for China and Russia granger cause each other is accepted: null hypothesis for India and China granger cause each other is accepted where as in case null hypothesis of China and Brazil is unidirectional; null hypothesis of China and South Africa is also unidirectional.

REFERENCES

ArvindPangariya, "Growth and Reforms during 1980s and 1990s", Economic and Political Weekly, Vol. XXXIX No.25, June 19-25, 2004.

Barro, R. J. and X. Sala-i-Martin 2003. *Economic Growth*. MIT Press Books, 1.

Barro, Robert J. (1991), Economic growth in a cross section of countries. *The Quarterly Journal of Economics,* Volume 106(2), pp. 407-443.

Becker, B.M. and Tillman, F.A. 1978. The family owned business. Chicago: Commerce Clearing House Inc.

Crafts, N. F. 2000. *Globalization and Growth in the Twentieth Century*. International Monetary Fund.

David Ricardo, 1817. Principles of Political Economy and Taxation, John Murray, London.

Henderson, J.V., Storeygard, A.,Weil, D.N. 2012. Measuring economic growth romouter space. *American Economic Review,* 102 (2), 994–1028.

Johansen, Søren, 1991. "Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models". *Econometrica*, 59 (6): 1551–1580.

Lucas, Robert E. 1988. On the mechanic of economic development. *Journal of Monetary Economics*, Volume 22(1), pp. 3-42.

Rati Ram, "Comparison of Rates of Growth of GDP Based on International and Domestic prices for 104 countries over the period 1960-80", *The Indian Economic Journal*, Vol.3 No.4, April-June 1986.

Summers, Robert and Heston, Alan, 1988. A new set of international comparisons of real product and price levels estimates for 130 countries, 1950-1985, *Review of Income and Wealth*, 34(1), March, 1-25.

APPENDIX

Appendix 1. Lag-Length Table

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-814.8735	NA	3.24e+23	68.32279	68.56822	68.38790
1	-677.0347	206.7581	2.82e+19	58.91956	60.39213	59.31023
2	-641.9978	37.95668*	1.67e+19	58.08315	60.78285	58.79938
3	-594.3069	31.79389	6.94e+18*	56.19224*	60.11909*	57.23404*

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