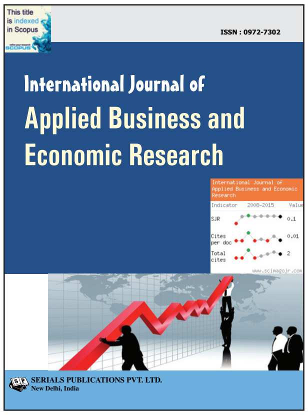

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Financial Market Development and Integration in BRICS Challenges and Opportunities

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ABSTRACT

BRICS is a group of economic integrated economies and the purpose of this research is to analyze the integration of the stock market exchanges of this BRICS nations. The oldest and largest stock market exchanges and their index has been selected for this study i.e. IBOVESPA (Brazil), RTS (Russia), SENSEX (India), SSE (China), JSE (South Africa). The monthly data from January 1998 to January 2018 is used for empirical analysis. The data has been collected from yahoo finance and from the stock exchange websites. We have converted data into stationarity form with employing augmented Dickey and Fuller unit root test. Further, Johansens cointegration technique is employed to analyse the long-run relationship among these stock exchanges. The results of Granger causality confirmed both unidirectional and bidirectional relationship among these stock exchange. The result of granger causality confirms the unidirectional causal relationship between the Russia (RTS) and Brazil (IBOVESPA); JSE and IBOVESPA, JSE and SENSEX whereas other variables showing bidirectional causal relationship. The results of the impulse response function indicating that the maximum part of impulse response of IBOVESPA is due to their own shock. The impulse response of RTS shows negative response to SENSEX, SSE and JSE. The graph of IRF also depicts that the stock market index of China and South Africa i.e. SSE and JSE have a inverse relationship whereas RTS and SENSEX have positive effect on IBOVESPA. The result of Vector error correction model suggests that there is no long run causality running from a long-run causality running from IBOVESPA, RTS, SSE and JSE to SENSEX. Thus as per the result output we can conclude that the stock market index of other BRICS countries is not causing the stock market index of India in long run.

JEL Classification: C32, F30, G11, G14, G15.

Keywords: BRICS, Johansen cointegration, Granger causality, Market Integration, Impulse response function and Vector error correction model (VECM) etc.

1. INTRODUCTION

The idea for the economic association of developing nations from all region of the world was coined by Jim O'Neill in terms of BRIC in 2001. The idea behind this newly coined term is to attract the world for new options for better economic growth. BRIC is an abbreviation used for Brazil, Russia, India and China. South Africa joined this group in 2010 and in this way, it became BRICS. BRICS is economic integrated group of fastest growing economies and it holds major participation in terms of aggregate population, economic size and land masses which cannot be neglected. The aggregate populations of the BRICS are about 40 %, and it contributes 20% in global GDP. Although the process of economic integration provides better opportunities for the development of financial market but country's own policy is very much responsible for growth of financial-market development. A healthy financial system is very much important for the growth of various financial markets. An investor expects better returns from their investment portfolio and thus it depends on the growth of financial resources. There are various components of any financial market i.e. stock market, commodity market, foreign exchange market etcA growth of financial market also depends on various organizations, institutions and individuals. There is a need for capital formation for better economic growth as well as better financial system (King & Levine 1993, Kizito 2012). In this paper we have focused on the growth of stock market of BRICS nations. There are various studies indicating the importance of international financial portfolios and stock market movements since Grubel's work (1968) followed by Granger and Morgenstern (1970), Ripley (1973), Lissard (1974), Panton, Lissies and Joy (1976) and Hillard (1979).

In last few years, Investors around the world start looking for a new hope of their better investment returns towards BRICS countries. The decision of the investors has changed due to various economic crises in last few years i.e. subprime crises in 2008. As we know, India and China is fast moving and developing economies and thus investors looks them as a potential market for better growth. In this way, this study will give an idea to the investors and policy maker to understand the cointegration of stock market of BRICS countries. There are a research studies focusing on the stock market integration of BRICS nations such as Pretorius, 2002; K.R. Chittedi, 2009; Bora et. al., 2009; Abas, 2009; Ramaprasad B. & Biljana N., 2009; Bhar and Nikolova, 2009; Singh, 2010; Sharma et. al., 2013; Mensi et. al., 2014, Visalakshmi & Lakshhmi, 2016; Kishor & Singh, 2017; Dirceu Pereira, 2018, etc. gives different empirical results. These studies based on different research methodologies to study few basic points i.e. significant relationship among stock markets exchange of BRICS nations; directional causality among these stock markets exchange and level of integration among these stock market exchange in long-run and short run.

This research study is focused on the monthly data before the formation of BRICS nations whereas there are various studies focusing on the data after the formation of BRICS nations. There are various studies confirms the dependency of one stock market on other. The volatility of the stock market fluctuation also depends on various macro-economic factors i.e. exchange rates, Government policies and Economic growth, etc. The government of BRICS countries has focused on the better financial-market development in last few years. The very purpose of this study is to analyze the growth and integration of stock market of BRICS nations. It is also an attempt to validate results based on empirical analysis with the results of previous studies. The study has following thrust areas:

1. How the shock in one stock market affects other?
2. How much one stock market are integrated with each other?
3. How does these stock market cause other stock market?

We have employed basic econometric techniques i.e. Johansson cointegration test, Correlation analysis, Impulse response function (IRF), Vector Error Correction Model (VECM) and Granger causality test to find answer of the above questions. The empirical results of this study indicating cointegration among the stock market of BRICS nations. The results also confirm that stock market of India is highly correlated with other stock market compared to other stock market which means this economic integration is very much beneficial for India.

Stock Market Movement in BRICS Nations

IBOVESPA is a stock market index of Brazilian stock exchange which was established in 1890. In 2011, IBOVESPA was in 13th position among other stock exchange of the world with the market capitalization of US$ 2.37 trillion. This stock exchange index has achieved a high growth rate during 2003 to 2008 but during subprime crises in 2008 it declined at the fastest rate. RTS is an index of Moscow Stock exchange which is one of the oldest stock exchanges in Russia established in 2001. It is clearly mentioned in the graph that it is also showing the same pattern as IBOVESPA. It starts growth from 1998 till 2007 but during subprime crises in 2008 it goes down and after that till 2017 it is showing smooth fluctuation. SENSEX is an index of Bombay Stock Exchange (BSE) which is considered to be as a first stock exchange in the Asia region established in 1875. In 2016, BSE was in 11th position in the world with the market capitalization of $ 1.43 trillion. It can be observed from the graph mentioned below that BSE is consistently achieving its growth rate. It is clearly seen in the graph that BSE except decline during 2008, BSE is showing positive growth rate. Shanghai Stock Exchange (SSE) is the world's 5th largest stock exchange established in 1990 in the city of Shanghai holds US$ 305 trillion market capitalization. It is showing highest fluctuation rate in last twenty years as shown in the graph. During 2005 to 2007, it achieved highest growth rate but the decline rate during 2008 was also very high again it achieved positive growth rate during 2013 to 2015. Johannesburg Stock Exchange (JSE) is the largest and oldest stock exchange in South Africa established in 1887 with around US$ 1 trillion market capitalization. It is clearly mentioned in the graph that the highest decline was noticed in 2001 but after this decline it is achieving smooth fluctuation in the graph. During 2008 crises there was only slightly decline in the fluctuation and it is consistently growth as mentioned in the graph.

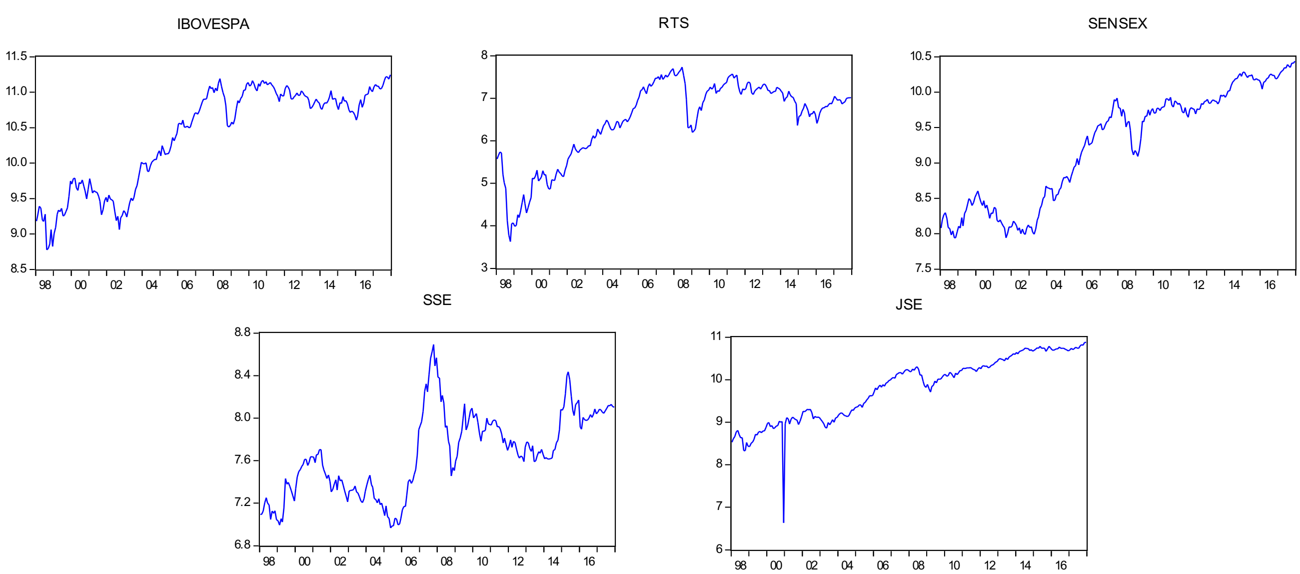

Figure 1: Stock Market Movement of BRICS Nations (1998-2017)

Objectives of the Research

The very purpose of this research study is to investigate the long-haul relationship among various stock market exchanges of developing BRICS countries. This research is an attempt to study the cointegration of various stock market indexes or indices of selected stock market exchanges of BRICS nations. This study also investigates stock market fluctuations, volatility and dependency of this selected stock market on each other. The finding of the research study will provide a basis for policy makers of BRICS countries, and it will also help to existing and new investors for getting better investment returns. It will help in rational thinking and decision making regarding investment policies and policy framework for better growth of financial markets. This study will also help to critically analyze the outcomes of the economic integration in terms of growth of financial markets.

Significance of the Research

There are various related research studies focusing on same issues but this research has their own significance in the academic domain compared to those previous findings BRICS is an association of five fast economically growing economies where India and China is in their top position in this race as suggested by empirical results of various studies but there stock markets are correlated only 75.28 %. The result also confirms that among all the stock markets of BRICS nations, the stock market of India is highly correlated with other stock markets i.e. Brazil (94.77%), Russia (79.68%) and South Africa (95.11%). The results of the correlation and integration analysis of stock market of India keep it different in nature compared to other BRICS nations; thus, the finding of this research study has greater relevance for academic experts, investors and policy makers. There are various studies based on the same methodology but only few of them focusing on stock markets of BRICS countries. This finding of this research study will help to researches for studying variations in research.

Research Methodology

The study is based on the monthly data of stock market exchange of various BRICS countries. The variable used in the following study is the stock market index of respective stock market exchanges. This data has been collected from the source of yahoofinance and stock exchanges websites. The following study includes the study of movement, volatility and performance of selected stock exchange of BRICS nations. The sample of the time period spans is monthly since January 1998 to January 2018. The study applied series of various econometric techniques to test the causal relationship among the variables. The test used for empirical analysis is a most acceptable range of econometric techniques i.e. Unit root test, Correlation analysis, Cointegration test, Vector Error Correction Model (VECM), Impulse response function (IRF) and Granger causality test, etc. over the sample period.

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 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:

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

where, a is used to express constant, β expressing the coefficient on a time scale and p is used to express lag order of the autoregressive process. In the following expression $a = 0$, $\beta = 0$ corresponding to modeling in a random walk. ADF test includes lags of the order p which allows higher order of the 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) and Alkaike 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:

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

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 where as 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:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + B_{xt} + \varepsilon_t \tag{2}$$

Here yt is showing k-vector of non-stationary I (1) variables, xt is used to represent d-vector of deterministic variables, εt showing vector of innovations, We can express VAR as:

$$\Delta y_t = \Pi y_{t-1} \sum_{i=1}^{p-1} \Gamma_i \Delta y_t = \Pi y_{t-i} + BX_t + \varepsilon_t \tag{3}$$

where,

$$\Pi = \sum_{i=1}^{p} A_i - I, \Gamma_i = - \sum_{j=i+1}^{p} A_j \tag{4}$$

According to Granger's representation theorem if the coefficient matrix Π reduced its rank $r < k$, then $k \times r$ matrices a and β each with the rank r such that $\Pi = a\,\beta'$ 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 $(\Pi) = r_0$ and alternative hypothesis is that $r_0 <$ rank $(\Pi) < n$, 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 $(\Pi) = r_0 + 1$ and alternative hypothesis is that $r_0 + 1 <$ rank $(\Pi) < n$. Thus trace statistics test null hypothesis of r Cointegrating relation against alternative of k Cointegrating relation. k represents number of endogenous variables, for $r = 0, 1, \ldots k - 1$. Trace test statistics for null hypothesis or r Cointegrating relation can be computed as:

$$\mathrm{LR}_{tr}(r|k) = -\mathrm{T}\sum_{i=r+1}^{k}\log(1-\lambda_i) \tag{5}$$

Here λ_i represent i^{th} largest eigenvalue of matrix Π. 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 eigenvalue is zero. Firstly it test whether rank of matrix Π is zero. The null hypothesis is that rank $(\Pi) = 0$ and alternative is that rank $(\Pi) = 1$ and further it tests null hypothesis is that rank (Π) 1, 2, … and alternative hypothesis is that rank $(\Pi) = 2, 3, \ldots$. The test of maximum eigenvalue is a likelihood ratio test which can be expressed in a following way:

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

where, $\mathrm{LR}(r_0, r_0 + 1)$ is likelihood ratio test statistics which is used to test whether rank $(\Pi) = r_0$ versus alternate hypothesis that rank $(\Pi) = r_0 + 1$. 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).

Vector Error Correction Model (VECM)

A Vector Error Correction (VEC) model is based on the cointegration relation of the variables. This model can be only used when at least one cointegration exist between variables. Therefor it can be said that Vector Error Correction Model (VECM) is performed to check the relationship status among variables. After the confirmation of the cointegration between any variable with the help of Johansen's Cointegration test. The next step is to construct the Error Correction mechanism to check the relationship among variables. Thus, Vector Error Correction model (VECM) involves three steps. The very first step is the selection of lag-length order based on various criterions such as Akaike information criterion (AIC), Schwarz information criterion (SC), Hannan-Quinn information criterion (HQ) etc. The decision to choose which lag-length should be based on the majority of result and lower value among that majority indicates that the model will be appropriate for the data.

The second step is to check the cointegration status where the precondition for this test is that the variable must be non-stationary at their level and stationary at their first difference. Now the final step is to perform Vector Error Correction mechanism to model dynamic relationship. The basic purpose of Vector Error Correction model (VECM) is to indicate the speed of adjustment from short run equilibrium to long-run equilibrium. The Vector Error Correction Model (VECM) is a restricted VAR designed in such a way which can be used with non-stationary series of data which are known to be cointegrated. After imposing equilibrium condition in Vector Error Correction Model (VECM) it shows result which shows that how this examined mode adjusting in each time period. As per the pre-assumption condition of Vector Error Correction Model (VECM) that the variable should be cointegrated thus deviation from short run to long run equilibrium will affect the dependent variables and it will force their movement towards long run equilibrium. Thus these cointegrated vectors will indicate independent direction where long-run equilibrium condition exists. The regression equation form for Vector Error Correction Model (VECM) can be explained in the following term:

$$\Delta Y_t = \alpha_1 + p_1 e_1 + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i} + \sum_{i=0}^{n} \gamma_i Z_{t-i} \quad (6)$$

$$\Delta X_t = \alpha_2 + p_2 e_{i-1} + \sum_{i=0}^{n} \beta_i Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-i} + \sum_{i=0}^{n} \gamma_i Z_{t-i} \quad (7)$$

In Vector Error Correction Model (VECM) cointegration rank of the output shows the number of cointegrating vector such as a rank of three indicate that three linearly independent combinations of Non-stationary variables are stationary. Error Correction Model shows coefficient; if this coefficient is negative and significant it means that in case of short run fluctuation between dependent or independent variable will raise stable long-run relationship among variables.

2. EMPIRICAL FRAMEWORK

Data Collection and Sources

The following research study is based on the secondary data where monthly data for various selected stock market indices of BRICS nations has been collected from various different sources. The index or indices of stock market represents the growth of stock exchange. We have chosen major stock exchange of each BRICS nations to study the financial market integration among these selected stock markets. The stock market of Brazil is represented by IBOVESPA; stock market of Russia by RTS; stock market of India SENSEX, stock market of China by SSE and stock market of South Africa by JSE. The data has been collected from yahoofinance and respective stock exchange websites. We have converted raw data in to natural logarithm form to avoid the problem of heteroskedasticity. This research study is an attempt to investigate cointegration and performance of selected stock markets. There are various suitable statistical and econometric techniques i.e. Unit root test, Correlation analysis, Cointegration test, Impulse Response Function (IRF), Vector Error Correction Model (VECM) Granger causality test has been employed over the sample period.

Table 1
Data Collection Sources

Various Markets	*Region*	*Name*	*Symbol*	*Frequency*	*Time period*	*Source*
Brazilian Stock Market	America	BOlsa de Valores do Estado de São PAulo	IBOVESPA	Monthly	January 1998 – January 2018	Yahoofinance
Russian Stock Market	Europe	Russia Trading System	RTS	Monthly	January 1998 – January 2018	Moscow Exchange Website
Indian Stock Market	Asia	S&P Bombay Stock Exchange Sensitive Index	S&P BSE SENSEX	Monthly	January 1998 – January 2018	Yahoofinance
China Stock Market	Asia	*Shanghai Composite Index*	SSE	Monthly	January 1998 – January 2018	Yahoofinance
South Africa Stock Market	Africa	Johannesburg Stock Exchange	JSE	Monthly	January 1998 – January 2018	Yahoofinance

Source: Author's own calculations.

Descriptive Statistics

Table 2 depicts the results of descriptive statistics of the monthly data of selected stock market indices of BRICS nations respectively. It shows an average rate 10.38 for Brazil (IBOVESPA) with the volatility of 6.76 per cent and their minimum and maximum value are 8.77 and 11.24 respectively for the selected time period. The average rate of Russian Stock market (RTS) was around 6.47 and their minimum and maximum value are 3.63 and 7.73 respectively. The average value of stock market of India (SENSEX) and China (SSE) was 9.25 and 7.66 respectively. The stock market of South Africa showing 7.64 average rate. The results of the kurtosis statistics of selected variables follow normality patterns, and their values are less than 3. The results of Skewness statistics showing all the variables are positively skewed except China.

Table 2
Results of Descriptive Statistics

	IBOVESPA	*RTS*	*SENSEX*	*SSE*	*JSE*
Mean	10.38440	6.473010	9.251395	7.660493	9.810287
Median	10.71640	6.786281	9.545470	7.649138	10.01475
Std. Dev.	0.702650	0.957817	0.797834	0.386603	0.750016
Coefficient of Variation	6.76	14.79	8.61	4.96	7.64
Minimum	8.775240	3.630721	7.941175	6.966720	6.634725
Maximum	11.24376	7.732075	10.43579	8.691947	10.87911
Skewness	–0.616481	–0.992522	–0.281545	0.177528	–0.513051
Kurtosis	1.888002	3.094857	1.560351	2.309432	2.815601
Jarque-Bera	27.56735	39.49398	23.89660	6.029492	10.86888
Probability	0.000001	0.000000	0.000006	0.049058	0.004364
Observations	240	240	240	240	240

Correlation Analysis

The Table 3 depicts correlation among the stock market exchanges of BRICS nations by estimation of Pearson correlation coefficient. The empirical results of the correlation indicating India as a highly correlated in nature with other stock market exchange i.e. 94.77 % with Brazil, 79.68 % with Russia, 75.28 with China and 95.11 % with South Africa. The results confirm that stock market of China is less correlated with other selected stock markets.

Table 3
Results of Correlation Statistics

Variables	*IBOVESPA*	*RTS*	*SENSEX*	*SSE*	*JSE*
IBOVESPA	1	0.8963760951	0.947708386	0.7405014944	0.9015680110
RTS	0.8963760951	1	0.7968818554	0.5954426774	0.8081912465
SENSEX	0.947708386	0.7968818554	1	0.7528383404	0.9511519203
SSE	0.7405014944	0.5954426774	0.7528383404	1	0.7199115890
JSE	0.9015680110	0.8081912465	0.9511519203	0.7199115890	1

Source: Author's own calculations.

Figure 2 Graph of Stationary Data.

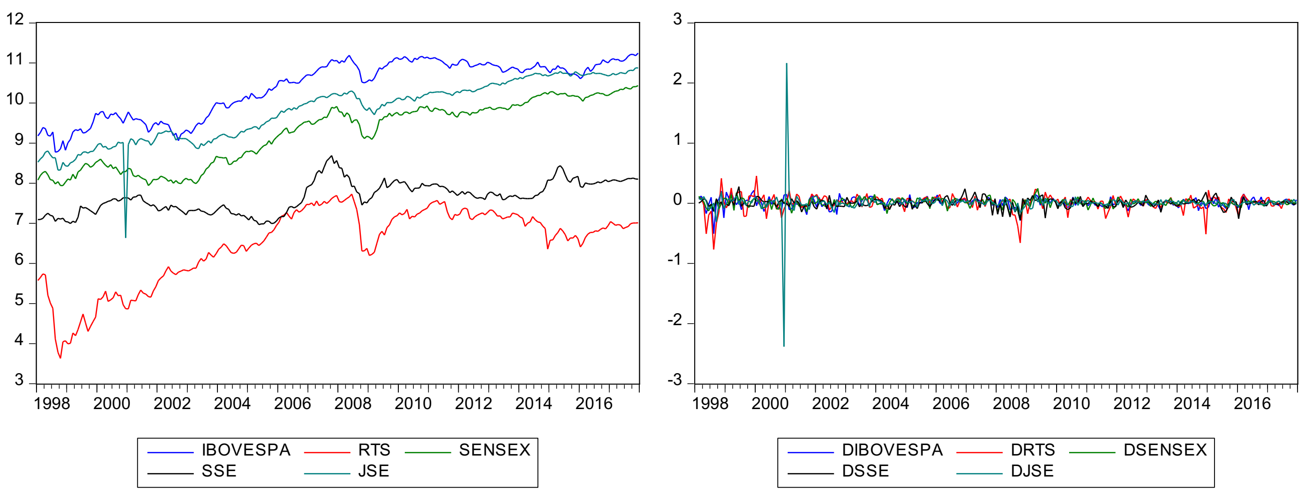

Figure 2: Time series data: (a) Non-stationary series data; (b) stationary series data

Source: Author's own calculations.
Note: X-axis represents the numbers of observations whereas Y-axis represents the values of economic variables at their natural log in left side and difference of their natural log in right side of Figure 2.

Unit Root Test (Augmented Dickey-Fuller)

Table 4 depicts the results of augmented Dickey and Fuller (ADF) test. The results confirm that the data of time series possessed a unit root at their level whereas at their first difference data become stationary and showing no unit root in the result. Consequently, the time series have been integrated by an order of one, or simply I(1). The data following time series is integrated by order of one I(1). The very first step for time series analysis is to convert the data into stationary form for any advanced econometric analysis thus now we can proceed this converted data series for further analysis.

Table 4
Results of stationarity (Augmented Dickey-Fuller Test)
(At level)

Variable	*t-statistics*	*Critical Value (5%)*	*p-value*	*Null Hypothesis*	*Remark*	*Unit Root*
IBOVESPA	–1.315692	–2.873440	0.6226	Accepted	Non-stationary	Unit Root
RTS	–1.475217	–2.873492	0.5446	Accepted	Non-stationary	Unit Root
SENSEX	–0.646432	–2.873440	0.8564	Accepted	Non-stationary	Unit Root
SSE	–1.717337	–2.873440	0.4212	Accepted	Non-stationary	Unit Root
JSE	–0.957523	–2.873596	0.7683	Accepted	Non-stationary	Unit Root

(At first difference)

Variable	*t-statistics*	*Critical Value (5%)*	*p-value*	*Null Hypothesis*	*Remark*	*Unit Root*
IBOVESPA	–14.79957	–2.873492	0.0000	Rejected	Stationary	No Unit Root
RTS	–11.91459	–2.873492	0.0000	Rejected	Stationary	No Unit Root
SENSEX	–14.53579	–2.873492	0.0000	Rejected	Stationary	No Unit Root
SSE	–13.75823	–2.873492	0.0000	Rejected	Stationary	No Unit Root
JSE	–14.55658	–2.873596	0.0000	Rejected	Stationary	No Unit Root

Source: Author's own calculations.

Selection of Lag Length Criterion

The selection of appropriate lag length is very necessary step for applying cointegration analysis. The results of the augmented Dickey and Fuller (ADF) unit root test shows that the variables are stationary at their first difference. In the next step Johansen multivariate cointegration techniques is used to analyze the degree of cointegration among selected variables. There are various criterion suggested by experts used to determine lag length i.e. Schwarz Info Criterion (SIC), Alkaike information criterion (AIC) and Hannan-Quinn information criterion (HQ) etc. but we have used Schwarz Info Criterion (SIC) to find out the optimum lag length of the data because it is showing minimum values. This Schwar Info Criterion (SIC) suggests one lags for the time series showing negative value of SIC, i.e., –8.85 corresponds to one lags for the selected time period as displayed in Table 5.

Table 5
Optimum lag length – Akaike information criterion
(Lag-1)

LAG	*LOGL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	–342.7263	NA	1.3×10^{-05}	2.959373	3.032981	2.989048
1	1122.858	2856.330	6.2×10^{-11}	–9.300916	–8.859267*	–9.122863
2	1176.043	101.3914	$4.9 \times 10^{-11*}$	–9.540790*	–8.731100	–9.214360*
3	1200.025	44.69848*	4.9×10^{-11}	–9.532127	–8.354396	–9.057320
4	1215.597	28.36034	5.4×10^{-11}	–9.451886	–7.906114	–8.828702
5	1234.428	33.49611	5.7×10^{-11}	–9.399388	–7.485575	–8.627827

Source: Author's own calculations.

Johansen Multivariate Cointegration Analysis

The results of augmented Dickey & Fuller (ADF) test for the selected time series demonstrated that the stock market indices of various stock markets of BRICS countries i.e. IBOVESPA, RTS, SENSEX, SSE and JSE have been integrated to I(1). Therefore, the next step is to employ Johansen cointegration multivariate technique. The results of Johansen multivariate cointegration depicted in Table 6(a) and 6(b) confirm that there is one cointegration equations in both cases. The existence of one cointegration vector confirms the long-run relationship among various stock market indices of BRICS stock market. The results of trace statistics has rejected the null hypothesis because their values of trace statistics is greater than their corresponding critical value, and the corresponding probability value (0.00) is less than the 0.05 ($p < 0.05$). The results of maximum eigenvalues depicted in Table 8 also confirmed one cointegrating vector presented in the model because the maximum eigenvalue is greater than their critical value and their corresponding probability value is also less than 0.05($p < 0.05$). The result of Johansens multivariate cointegration analysis confirms existence of the long-run relationship among these stock market exchanges of BRICS nations.

Table 6(a)
Johansen test results (trace test) – unrestricted cointegration rank test (trace vlues)

Hypothesised no. of CE(s)	*Eigenvalues*	*Trace statistics*	*Critical values at 0.05 level*	*Probability***
None*	0.236763	91.71224	69.81889	0.0004
At most 1	0.050103	27.40782	47.85613	0.8384
At most 2	0.042471	15.17417	29.79707	0.7687
At most 3	0.017803	4.845152	15.49471	0.8250
At most 4	0.002391	0.569836	3.841466	0.4503

Existence of one cointegrating vector at 5% level of significance.
Asterisk (*) Indicates the rejection of the null hypothesis at 5% level of significance.
Asterisk (**) Indicate MacKinnon & Haug-Michelis (1999) *p*-values;
Source: Author's own calculations.

Table 6(b)
Johansen maximum eigenvalue test–unrestricted cointegration rank test (maximum eigenvalue)

Hypothesised no. of CE(s)	*Eigenvalues*	*Maximum eigenvalue statistics*	*Critical values at 0.05 level*	*Probability***
None*	0.236763	64.30443	33.87687	0.0000
At most 1	0.050103	12.23364	27.58434	0.9229
At most 2	0.042471	10.32902	21.13162	0.7133
At most 3	0.017803	4.275316	14.26460	0.8292
At most 4	0.002391	0.569836	3.841466	0.4503

Existence of one cointegrating vector at 5% level of significance.
Asterisk (*) Indicates the rejection of the null hypothesis at 5% level of significance.
Asterisk (**) Indicate MacKinnon & Haug-Michelis (1999) *p*-values;
Source: Author's own calculations.

Impulse Response Function (IRF)

The transmission from one variable to any other variable can be investigated by employing the Impulse response function (IRF) mechanism. The result of Impulse response function (IRF) provides evidence to analyze that how one variable reacting to other variable. Figure 3 representing the graphical chart of Impulse response function (IRF) of selected variables. Figure 3 showing the response of one variable after giving them one standard deviation shock. The graph of Impulse response function (IRF) shows a snapshot of a single time period stun to other variable to one period. It is also graphically representing the changes in dependent variable. This graph represents the impact and impulse response function of one stock market index on other stock market index. This graph is showing the impulse response of IBOVESPA to RTS, SENSEX, SSE and JSE. The maximum part of impulse response of IBOVESPA is due to their own shock whereas the other stock market indices also confirm certain effect on IBOVESPA. In case impulse response of IBOVESPA it shows all positive at each time in the responsive period and every response of SENSEX, SSE, RTS and JSE also showing positive shock. The impulse response of RTS shows negative response to SENSEX, SSE and JSE where as in case of impulse response of other variables on RTS it shows positive shock. The impulse response of SENSEX shows positive shock to IBOVEDSPA and RTS but representing negative shock to SSE and JSE. The impulse response of SSE on other variable shows positive shock except

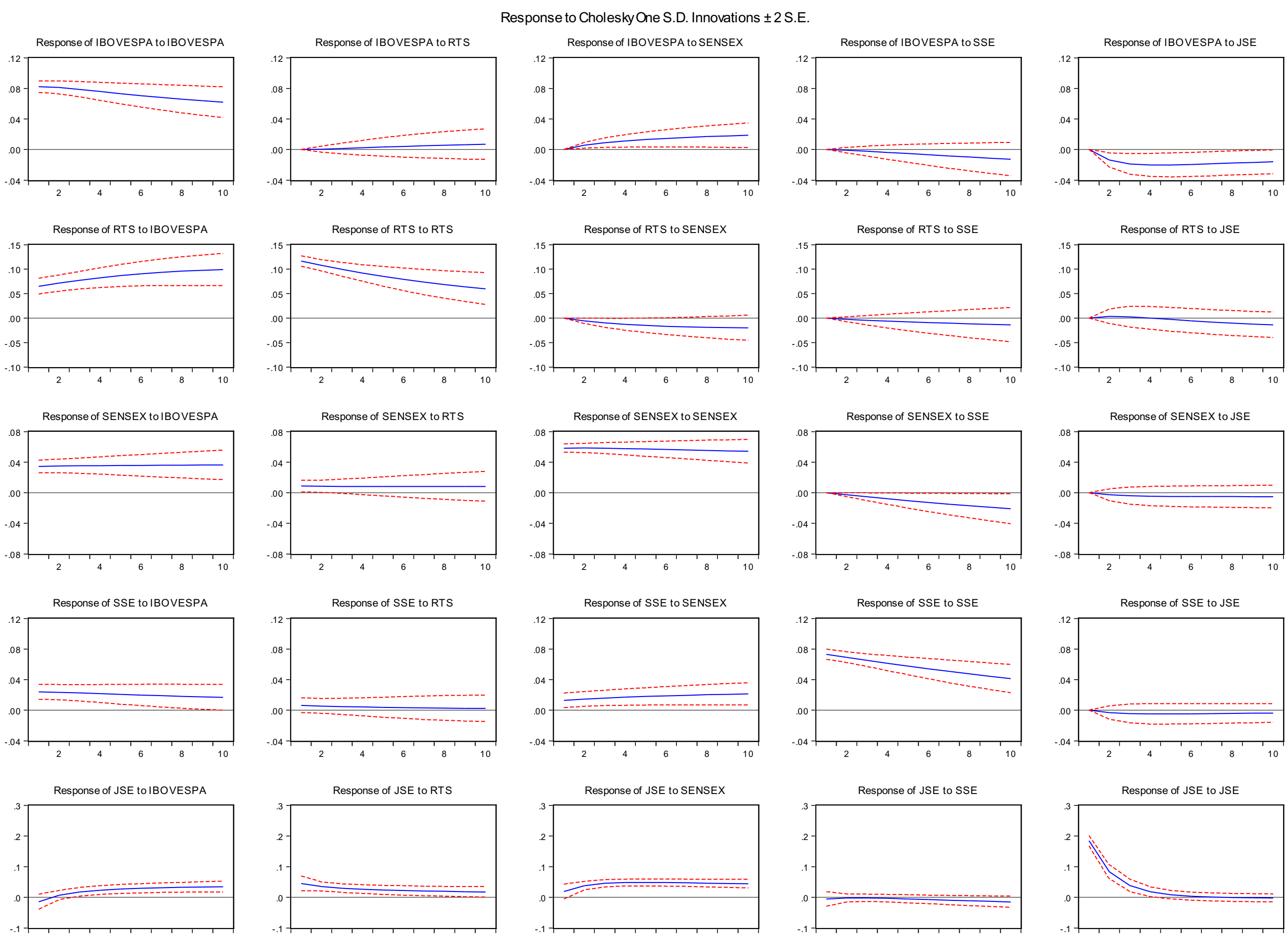

Figure 3: Graphical Representation of Impulse Response Function (IRF)
***Source:* Author's own calculations**

JSE whereas impulse response of JSE showing positive shock on other variables except SSE. Therefore, it can be concluded that the stock market index of China and South Africa i.e. SSE and JSE have inverse relationships whereas RTS and SENSEX have positive effect on IBOVESPA.

Vector Error Correction Model (VECM)

The selection of appropriate lag-length is very first step for performing Vector Error Correction Model (VECM) mechanism. The results of the lag-length suggested lag 1 structure thus we have chosen lag 1 fur further analysis. Table 7 depicts the result of regression coefficients. IBOVESPA is selected as a dependent variable where other is as independent variable which is known as target model for the Vector Error Correction Model (VECM). The result of Johansen's cointegration test confirms only one cointegration equations are reported in the result output. The Vector Error Correction Model (VECM) automatically converts all the variables into their first difference. There are only one error correction term is found in the result output. The values of standard error is represented in brackets '( )' and the values of *t*-statistics is reported in bracket '[]'. The value of *t*-statistics is found after dividing coefficient values by its standard error but in the result output does not provides *p*-value so we cannot determine whether accept or reject null hypothesis. Least Square method is used for the purpose to check the *p*-value which provides various C1, C2, … values represent the coefficient of cointegration model of data sets for least square method. These C1, C2, … values are known as speed of adjustment towards equilibrium or error correction terms.

To check the long-run run causality running from IBOVESPA, RTS, SSE and JSE to SENSEX, C1 value is observed which suggest that the value of C1 is not negative in sign and the *p*-value (74.99 percent) is not significant in nature proves that there is no long run causality running from a long-run causality running from IBOVESPA, RTS, SSE and JSE to SENSEX. Thus as per the result output we can conclude that the stock market index of is not causing the stock market index of India in long run.

Table 7
Results of Vector Error Correction Model (VECM)

Error Correction	*ΔDIBOVESPA*	*ΔDRTS*	*ΔDSENSEX*	*ΔDSSE*	*ΔDJSE*
Constant	0.008309	0.000432	0.008971	0.003761	0.011176
(*p*-value)	(0.00541)	(0.00821)	(0.00444)	(0.00515)	(0.01162)
[*t*-statistic]	[1.53621]	[0.05265]	[2.02110]	[0.73094]	[0.96194]
EC_{t-1}	–0.061134	0.057972	–0.006270	–0.026622	–0.297930
(*p*-value)	(0.02394)	(0.03633)	(0.01965)	(0.02278)	(0. 05143)
[*t*-statistic]	[-2.55332]	[1.59579]	[–0.31911]	[–1.16883]	[–5.79263]
$\Delta DIBOVESPA_{t-1}$	–0.033529	0.593394	0.044859	–0.093369	0.769832
(*p*-value)	(0.07929)	(0.12031)	(0.06507)	(0.07543)	(0.17033)
[*t*-statistic]	[–0.42286]	[4.93235]	[0.68942]	[–1.23785]	[4.51972]
$\Delta DRTS_{t-1}$	0.065290	0.085831	0.092985	0.104114	0.226880
(*p*-value)	(0.04540)	(0.06888)	(0.03726)	(0.04319)	(0.09753)
[*t*-statistic]	[1.43809]	[1.24602]	[2.49579]	[2.41069]	[2.32637]
$\Delta DSENSEX_{t-1}$	0.045751	–0.039163	–0.022537	0.021431	–0.590335
(*p*-value)	(0.09778)	(0.14836)	(0.08024)	(0.09302)	(0.21005)
[*t*-statistic]	[0.46789]	[–0.26396]	[–0.28086]	[0.23039]	[–2.81045]

(*Contd...*)

Error Correction	*ΔDIBOVESPA*	*ΔDRTS*	*ΔDSENSEX*	*ΔDSSE*	*ΔDJSE*
$\Delta DSSE_{t-1}$	–0.087185	0.007415	–0.031119	0.085311	–0.223649
(*p*-value)	(0.07298)	(0.11073)	(0.05989)	(0.06943)	(0.15677)
[*t*-statistic]	[–1.19463]	[0.06696]	[–0.51959]	[1.22881]	[–1.42658]
$\Delta DJSE_{t-1}$	–0.018957	0.014652	–0.014214	0.006080	–0.279826
(*p*-value)	(0.02823)	(0.04283)	(0.02317)	(0.02686)	(0.06064)
[*t*-statistic]	[–0.67150]	[0.34207]	[–0.61354]	[0.22639]	[–4.61430]

Source: Author's own calculations.

Granger Causality Results

The pairwise Granger (1969) causality test is used to identify the direction of the causal relationship among the variables. The result of granger causality test helps to analyse the directional causality between two selected variables. The results shown in Table 8 confirm the unidirectional causal relationship between the Russia (RTS) and Brazil (IBOVESPA). The unidirectional causation was established from RTS to IBOVESPA at 5% significance level ($p < 0.05$) at two lags. It also demonstrates that there is unidirectional causal relationship between JSE and IBOVESPA; JSE and RTS; JSE and SENSEX; at 5% level of significance ($p < 0.05$) whereas other variables showing the bidirectional causal relationship at 5% level of significance ($p > 0.05$).

Table 8
Results of pairwise Granger causality at one lags

Null Hypothesis	*Observation*	*F-statistics*	*Probability*	*Decision*
RTS does not Granger Cause IBOVESPA	238	0.53622	0.5857	Failed to reject
IBOVESPA does not Granger Cause RTS		13.6388	3.E-06	Rejected
SENSEX does not Granger Cause IBOVESPA	238	1.96665	0.1422	Failed to reject
IBOVESPA does not Granger Cause SENSEX		1.22970	0.2943	Failed to reject
SSE does not Granger Cause IBOVESPA	238	0.39837	0.6719	Failed to reject
IBOVESPA does not Granger Cause SSE		1.76884	0.1728	Failed to reject
JSE does not Granger Cause IBOVESPA	238	2.00579	0.1369	Failed to reject
IBOVESPA does not Granger Cause JSE		21.3480	3.E-09	Rejected
SENSEX does not Granger Cause RTS	238	1.39434	0.2501	Failed to reject
RTS does not Granger Cause SENSEX		3.75166	0.0249	Rejected
SSE does not Granger Cause RTS	238	0.59355	0.5532	Failed to reject
RTS does not Granger Cause SSE		2.67991	0.0707	Failed to reject
JSE does not Granger Cause RTS	238	0.68604	0.5046	Failed to reject
RTS does not Granger Cause JSE		7.96364	0.0005	Rejected
SSE does not Granger Cause SENSEX	238	2.08345	0.1268	Failed to reject
SENSEX does not Granger Cause SSE		2.96989	0.0533	Failed to reject
JSE does not Granger Cause SENSEX	238	0.18121	0.8344	Failed to reject
SENSEX does not Granger Cause JSE		19.5954	1.E-08	Rejected
JSE does not Granger Cause SSE	238	1.92207	0.1486	Failed to reject
SSE does not Granger Cause JSE		0.87710	0.4174	Failed to reject

Source: Author's own calculations.

3. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this research study was to analyze the long-run relationship of stock exchange of BRICS countries i.e. IBOVESPA of Brazil, RTS of Russia, SENSEX of India, SSE of China and JSE of South Africa. This research study is based on monthly data from January 1998 to January 2018. Firstly, We have transformed data into stationary form and further used Johansen multivariate cointegration test is used to check the long-run relationship. The Granger causality test is used for the causal relationship among variables. The descriptive statistics result reveals that the monthly average return of IBOVESPA is 10.38 percent with the volatility of 6.76; monthly average return of RTS is 6.47 % with the variation of 14.76 %; monthly average return of SENSEX, SSE and JSE is 9.23 %, 7.64 % and 9.78 % respectively. The statistics of the kurtosis shows that the data series following normality patterns. All the data are non-stationary at their level whereas at first difference it became stationary. Johansen multivariate cointegration techniques used to examine the long-run relationship which confirms the possibility of the long-run relationship. The results of the Granger causality test indicated unidirectional causation in many cases. The results of the impulse response functions indicating change in the all the stock market index happened due to their own shocks. Therefore, it can be concluded on the basis of empirical analysis that stock market of BRICS has the long-run relationship. Thus, it can be concluded that variation in one stock market leads to cause other stock market of BRICS countries.

The following points can be suggested and recommended on the basis of findings that:

- Institutional investors, Individual and financial experts are advised to consider secured investment on the basis of safety issue in developing stock markets.
- Since the stock markets are highly sensitive and volatile in nature depends on financial structure of the country across the world, any investors should be aware of any information regarding their investment in stock market.
- Since the economic policy of the BRICS countries are very much important for the financial market growth of the country therefore policy makers and the regulatory bodies should give more attention on the issue involvement of various new policies and standards specially related with financial market.
- Similarly, each government of BRICS country and their respective Central Banks should play an important role in strengthen their financial markets by employing good and suitable monetary policies.

References

Abas, M., (2009). Analysis of stock market linkages: Chinese, Indian and major markets. *University of Malaya Report*. pp. 1-94.

Akaike, H. (1969). Fitting autoregressive model for prediction. *Annals of International Statistics and Mathematics*, 21, pp. 243–247.

Akaike, H. (1973). Information theory and an extension of the maximum likelihood principle. In B. N. Petrov & F. Csáki, 2nd International Symposium on Information Theory, Tsahkadsor, Armenia, USSR, September 2-8, 1971 (pp. 267–281). Budapest: Akadémiai Kiadó.

Bhar, R. and B. Nikolova, (2009). Return, volatility spillovers and dynamic correlation in the bric equity markets. An analysis using a bivariate egarch framework. *Global Finance Journal*, 19(3), pp. 203-218.

Bora A., Pinar E.M., Baris S.K. & Bülent E. (2009). "Behaviour of emerging stock markets in the global financial meltdown: Evidence from bric-a", *African Journal of Business Management*, Vol. 3 (7), pp. 396-404.

Chittedi, Krishna Reddy. (2009). Global Stock Markets Development and Integration: with Special Reference to BRIC Countries. University Library of Munich, Germany, MPRA Paper.

Dirceu P., (2018). Financial Contagion in the BRICS Stock Markets: An empirical analysis of the Lehman Brothers Collapse and European Sovereign Debt Crisis, *Journal of Economics and Financial Analysis*, Vol. 2, No. 1, pp. 1-44.

Granger, C, and O. Morgenstern (1970). "Predictability of Stock Market Prices", MA: Lexinton.

Granger, C.W.J. (1988). Some recent development in a concept of causality. *Journal of Econometrics*, *39*(1), 199–211.

Grubel, H. (1968). Internationally diversified portfolio: Welfare gains and capital flows, *The American Economic Review*, Vol. 58, pp. 1299-1314.

King, R.G. and R. Levine (1993). "Finance and Growth: Schumpeter Might be Right", *The Quarterly Journal of Economics*, Vol. 108, pp. 717-737.

Hendry, D.F. (1986). Econometric modelling with cointegrated variables: An overview. *Oxford Bulletin of Economics and Statistics*, *48*, 201–212.

Hilliard. J. (1979). "The Relationship between Equity Indices on World Exchanges" *Journal of Finance*, 34 (March 1979), 103-114.

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrics, 59*, 1551–1580.

Johansen, S., & Jusellius, K. (1990). Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. *Oxford Bulletin of Economics and Statistics, 52*, 169–210.

Kishor N. & Singh R.P. (2017). "Contagion Effect among the BRICS Stock Market Indices", *Journal of Poverty, Investment and Development*, Vol. 31.

Mensi, W., S. Hammoudeh, J.C. Reboredo, and D.K. Nguyen (2014). Do global factors impact BRICS stock markets? A quantile regression approach. *Emerging Markets Review*, 19, 1–17.

Panton, D.; V. Lessig; and O. Joy (1976). "Co-movements of International Equity Markets: A Taxonomic Approach", *Journal of Financial and Quantitative Analysis*, 11 (Sept. 1976), 415-432.

Pretorius, E. (2002). Economic determinants of emerging stock market interdependence, Emerging Market Review, Vol. 3, pp. 84-105.

Ramaprasad B. & Biljana N. (2009). "Return, volatility spillovers and dynamic correlation in the BRIC equity markets: An analysis using a bivariate EGARCH framework", *Global Finance Journal*, 19, pp. 203–218.

Ripley, D. (1973). "Systematic Elements in the Linkage of National Stock Market Indices", *Review of Economics and Statistics*, 55 (Aug. 1973), 356-361.

Sharma, G.D., M. Mahendru and S. Singh, (2013). Are the stock exchanges of emerging economies interlinked? Evidence from BRICS. *Indian Journal of Finance*, 7(1), pp. 26-37.

Singh, G., and Singh, P., (2010). Chinese and Indian Stock Market Linkages with Developed Stock Markets, *Asia Journal of Finance & Accounting*, Vol. 2, No. 2, pp. 21-39.

Visalakshmi, S. and P. Lakshmi (2016). BRICS market nexus for cross listed stocks: A VECX framework. *The Journal of Finance and Data Science*, 2 (1), pp. 76–88.

Kumar, V. (2017). "Stock Market Movement of BRICS countries: An Empirical Analysis", *Research Review International Journal of Multidisciplinary*, Vol. 02, Issue 09, pp. 83-89.