# Are The Stock Exchanges Of Emerging Economies Interlinked ? : Evidence From BRICS

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## ABSTRACT

**This paper studies the interlinkages between stock markets of Brazil, Russia, India, China and South Africa (BRICS) with the help of benchmark indices of these stock exchanges. Daily closing levels of the benchmark indices in the five countries were taken for a period from April 1, 2005 to March 31, 2010. Line charts and unit-root tests were applied to check the stationary nature of the series; Regression Analysis, Granger's Causality Model, Vector Auto Regression (VAR) Model, and Variance Decomposition Analysis were performed to find out the linkages between the markets under study. The analysis revealed that the stock markets under study were influenced by each other, but not to a great extent. It implies that there exists opportunities for diversification of the investors among the stock exchanges of BRICS. The paper also observed that there are domestic factors (macro-economic variables) that influence the stock markets.**

**Keywords: Interlinkages, Granger's Causality, Vector Auto Regression (VAR), Variance Decomposition, BRICS**
**JEL Code: G1, G15, N25**

## INTRODUCTION

Investment in foreign equity markets became a popular practice in the 1980s as investors became aware of the benefits from international portfolio diversification. International portfolio diversification helps investors in reducing their portfolio risk since securities happen to be less correlated across the countries than within a country. Intuitively, this is so because economic, political and institutional factors affecting securities returns tend to vary a great deal across countries. This results in a relatively low correlation among international securities.

The correlation and integration of the global stock markets has remained an issue of keen financial interest. The relationships between international stock markets have become increasingly important since Grubel (1968) analyzed the benefits of international diversification, which offers opportunities to the investors to invest their money in the country of their choice, not just in their own country. Eun and Resnick (1984) revealed that the intra-country correlation was higher than the inter-country correlation with respect to USA with Germany, and Japan with United Kingdom. Until the 1980s, cross border equity investment was largely confined to the equity markets of developed countries. In the 1990s, the economic growth potential of the developing countries got highlighted. The growing relevance of developing economies is also visible from the growth in GDP of these countries since 1990s. Exhibiting this growth in the developing countries, the Figure 1 shows that from 2003 to 2006, the collective GDP of developing countries grew more than 5 percent each year ; in 2006, the growth rate peaked at nearly 8 percent, with all developing regions close to or exceeding 5 percent GDP growth (World Bank, 2008).

This phenomenal GDP growth in developing economies led to the investors starting to invest in the equity markets of emerging economies. In 2007 alone, net private capital flows to developing countries increased by $269 billion, to a record $1 trillion. Global Development Finance 2008 noted that, "net bank lending and bond flows have increased from virtually zero in 2002 to 3 percent of developing countries' GDP in 2007; while net foreign direct and portfolio equity flows have increased from 2.7 percent of GDP to 4.5 percent." Among the developing countries, there are a few countries that are showing tremendous potential for huge growth. Brazil, Russia, India, China and South Africa (commonly known as BRICS) are leading this bunch of developing nations into a fast economic growth trajectory. The acronym BRICS symbolizes the collective economic power of Brazil, Russia, India, China, and South Africa.

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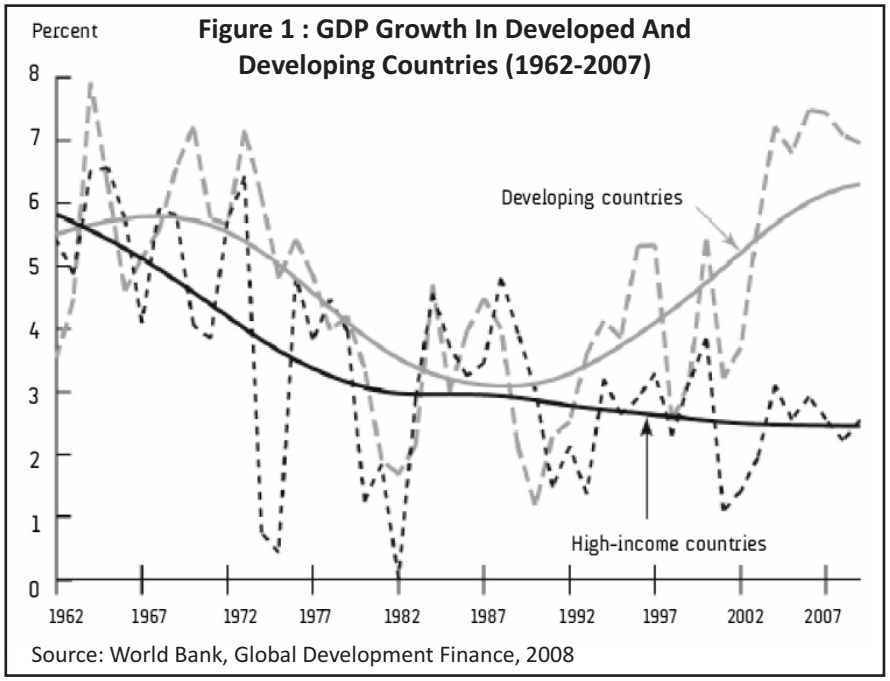



Together, the BRICS account for more than 40 per cent of the global population, nearly 30 per cent of the land mass, and a share in world GDP (in PPP terms) that increased from 16 per cent in 2000 to nearly 25 per cent in 2010 and is expected to rise significantly in the near future.

The growing significance of BRICS on the global economic scene is depicted in the Table 1. The Table 1 shows that the GDP growth rate in BRICS remained higher than that in the advanced economies, particularly after 2006. The higher GDP growth indicates towards the increased relevance of these economies at the global front.

**Table 1 : Real GDP (Percentage Change) Over The Years**

| Country | Real GDP (percentage change) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1994-2003 Average | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
| Brazil | 2.5 | 4.0 | 6.1 | 5.2 | -0.3 | 7.5 | 2.7 |
| Russia | 0.7 | 8.2 | 8.5 | 5.2 | -7.8 | 4.3 | 4.3 |
| India | 6.0 | 9.5 | 10.0 | 6.2 | 6.6 | 10.6 | 7.2 |
| China | 9.4 | 12.7 | 14.2 | 9.6 | 9.2 | 10.4 | 9.2 |
| South Africa | 3.0 | 5.6 | 5.5 | 3.6 | -1.5 | 2.9 | 3.1 |
| Advanced Economies | 2.8 | 3.0 | 2.8 | 0.0 | -3.6 | 3.2 | 1.6 |
| Source: World Economic Outlook, 2012 | | | | | | | |

With the BRICS economies demonstrating high growth rates and with the global economies becoming more interlinked financially, it needs to be seen how much financial interlinkages are present among the BRICS economies. Stock exchanges serve as an important measure of financial activity in a country. Therefore, the present research concentrates on studying the interlinkages between the stock markets of the BRICS nations.

## REVIEW OF LITERATURE

The interlinkage among stock markets is a subject that has attracted world - wide attention. This section of the paper presents a detailed review of the studies concentrating on emerging economies. However, a number of studies concerning these economies have studied the linkages between these markets and the markets of the developed world. Such studies are reviewed for the purpose of the current study and are included herein. Elyasiani et al. (1998), Verchenko (2000), Bala and Mukand (2001), Nath and Verma (2003), Hafiz Al Asad Bin Hoque (2007), Menon,

Subha and Sagaran (2009), Kamaralzaman, Samad and Isa (2011) observed no interlinkages between the stock markets under study.

Elyasiani et al. (1998) found no significant interdependence between the Sri Lankan market and the equity markets of the US and other Asian countries. Examining the nature and extent of linkages between the USA and the Indian stock markets, Verchenko (2000) provided an empirical analysis of potential portfolio diversification across Eastern European and former Soviet Union stock markets. Absence of co-integration and independence of stock market movements were detected; hence, profitable diversification opportunities were concluded. Bala and Mukand (2001) found that the movements in the US markets for the entire sample period did not affect the Indian stock market. Examining the interdependence of three major stock markets in South Asia, viz. India, Singapore and Taiwan, Nath and Verma (2003) found no cointegration between the stock market indices during the entire study period. Hafiz Al Asad Bin Hoque (2007) established that USA and India did not have any impact on Bangladesh's stock market. Referring to the Indian scenario, the study showed that it was not affected by its own lag or by USA or Japan. The study of Menon, Subha, Sagaran (2009) suggested the absence of cointegration between the Indian stock market and the American Stock market. The study further observed that the Indian stock market and the Hong Kong market operate independently of each other. Kamaralzaman, Samad and Isa (2011) reported that Malaysian investors would have little scope to include the stocks of US, Japan or Hong Kong, as it has minimal benefits of diversification, since the markets move towards a greater integration.

On the other hand, Wong et al. (2004), Kwan, Sim and Cotsotmitis (1995), MacDonald (2001), Serwa and Bohl (2003), Yalama (2009), Aktan et al. (2009), Aktar (2009), Mohammad and Hussain (2011), Singh and Singh (2011), Subhani et al. (2011), Sharma and Bodla (2011) found that the stock markets of different countries are interlinked with one-another.

Wong et al. (2004) investigated the long-run equilibrium relationship and short-run dynamic linkage between the Indian stock market and the stock markets in major developed countries. The findings of the study revealed that the Indian stock market is significantly cointegrated with the stock markets of USA, UK and Japan. Going further, the study brings forth that the Indian stock index and the mature stock indices form fractionally cointegrated relationships in the long run with a common fractional, non-stationary component. The study confirmed that the financial liberalization in India since 1991 has opened up the Indian stock markets vis-à-vis the world markets and ,therefore, the Indian markets got influenced by other markets. The theory of cointegration remains arguably, the most widely used method to analyze the data about stock market integration.

Kwan, Sim and Cotsotmitis (1995) found contrasting evidence to support the existence of causal relationships among the monthly stock returns of Australia, Hong Kong, Japan, Korea, Taiwan, the UK and the US. MacDonald (2001) studied the CE stock market indices as a group against each of the three developed markets (US, Germany, UK), and concluded significant long-run co-movements for each of the groupings. Serwa and Bohl (2003) investigated contagion implications for European capital markets that were associated with seven important financial shocks between 1997 and 2000. The study used correlation analysis and compared a number of developed European markets (Germany, UK, France, Ireland, Spain, Portugal and Greece) with major Central and Eastern European markets (Poland, Czech Republic, Hungary, Russia). Weak evidence of increased cross-market linkages following these crises was found, whereas emerging-market returns did not converge to the developed market returns. Yalama (2009) observed a significant market interrelationship between Turkey and Brazil's stock markets. The paper further found that the time zone problem is not affected in this relationship, which creates an opportunity for investors to use international hedging strategies and asset allocation. Aktan et al. (2009) established that the US market has a significant effect on all BRICA countries on the same trading day. The most integrated markets to the BRICA countries are Russia and Brazil; the least integrated ones are China and Argentina. Aktar (2009) observed a short-run relationship and causality among the stock indices of Turkey, Russia and Hungary. Mohammad and Hussain (2011) reported that the Pakistani equity market is well-correlated with the American equity market, while not correlated with the markets of UK, India, Germany and China. Singh and Singh (2011) found the Indian and Chinese stock markets to be correlated with the stock markets of US, UK, Japan and Hong Kong. Subhani et al. (2011) examined the linkage of the stock prices of the Karachi Stock Exchange with the stock prices of the Dhaka stock exchange ; while KSE is not co-integrated with the Bombay Stock Exchange and the Nepal Stock Exchange in terms of stock price indices. Sharma and Bodla (2011) concluded that while the National Stock Exchange (India) Granger causes Karachi Stock Exchange (Pakistan) and Colombo Stock Exchange (Sri Lanka), the vice versa does not hold true.

Researchers have used the Granger's causality model very extensively. Wong et al. (2004), Narayan et al. (2004), Mukherjee and Mishra (2005), Nair and Ramanathan (2003), and Hamid and Hasan (2011) applied the Engle-Granger residual based test of cointegration. Wong et al. (2004) applied the Granger's causality model in addition to the cointegration model applied by them in their study. Chuang et al. (2007), Wang and Gunasekarage (2005) applied the Vector Auto Regression (VAR) model to carry out their research. Chuang et al. (2007) used the VAR model in their paper to investigate the volatility interdependence in six East Asian markets under study. Wang and Gunasekarage (2005) investigated the interdependence of fifteen world indices, including India, in a framework of VAR.

The studies of Bala and Mukand (2001), Wong et al. (2004), Hoque (2007), Menon, Subha, Sagaran (2009), Nath and Verma (2003), Dwyer and Wallace (1992) applied the cointegration model in order to arrive at their research objectives. Bala and Mukand (2001) used the theory of cointegration to study the interdependence between the BSE, the NYSE and NASDAQ. Their data consisted of daily closing prices for the three indices from January 1991 through December 1999. Wong et al. (2004) investigated the pair-wise, multiple and fractional co-integrations between the Indian stock market and the stock markets of developed countries such as USA, UK and Japan. The above review of literature reveals that there have been studies concentrating on the stock markets of the world, but very few have concentrated on emerging economies. Out of the studies that have been undertaken, a majority have studied the linkages with the stock markets in the developed world. Moreover, there is hardly any research that has studied the stock market linkages between the BRICS nations.

The current study contributes to the literature in numerous ways. First, this is a study concentrating on the stock markets of BRICS; and examines the linkages within these rather than of those with the developed world. Secondly, it uses a combination of statistical methods to analyze the data. The study is vital from the viewpoint of the investing community. The investors in the present era diversify their investments not just within a country, but also between countries. With the advent of BRICS on the global screen, the investors may be willing to diversify their investments between the stock markets of BRICS. The present study focuses on the crucial question of whether or not the opportunities for diversification between the stock markets of these countries are available.

## OBJECTIVES OF THE STUDY

The study was conducted with the following objectives:

**1)** To study the return patterns in the equity markets of BRICS;

**2)** To find out the interlinkages between the stock exchanges under study ; and

**3)** To observe whether there exist enough opportunities for diversification among the stock exchanges of BRICS.

## RESEARCH METHODOLOGY

For the present research study, the researchers studied the linkages between the stock exchanges of Brazil, Russia, India, China and South Africa (BRICS). The study used one stock exchange from each of the five countries as a representative of the respective country. The stock exchange with the largest volumes from each of the countries was chosen for the study. The Bolsa de Valores, Mercadorias & Futuros de São Paulo (BM&FBOVESPA) was taken as the benchmark for Brazil, and the index of BOVESPA was used. From Russia, the Russia Stock Exchange (RSE) was taken as the representative exchange, and the All Share Price Index (ASPI) was used. National Stock Exchange from India was taken as the benchmark index and the Nifty Index was used. The Shanghai Stock Exchange (SSE) was taken as the benchmark stock exchange for China and SSE Composite Index was used as the benchmark index. Johannesburg Stock Exchange (JSE) was taken as the benchmark for South Africa and All Share Index was used for the research purpose. The daily closing level of the five representative indices for a period beginning on April 1, 2005 through March 31, 2010 was considered as the reference period. In this way, the data of a total of 60 months was considered for the purpose of the study. The data was analyzed by using econometric tools. The analysis of econometrics can be performed on a series of stationary nature. In order to check whether or not the series are stationary, the paper presents the line graph for each of the series. In order to further confirm the random nature of the series, Auto-correlation and Partial auto-correlation was computed for each of the series. Further, the study performed the Augmented Dickey-Fuller test under the unit root test to finally confirm whether or not the series are stationary. In order to make the series stationary, the paper took the log of the four series and arrived at the daily return of the two series. All the remaining analysis was performed at the daily return (log of the series) of the five exchanges. These

variables were named as dbrazil, drussia, dindia, dchina and drsa. At the stationary log series of the four stock exchanges, the study performed the Granger's causality model in order to observe whether the return at each stock exchange Granger causes the return at the stock exchanges. The Granger (1969) approach to the question of whether x causes y is to see how much of the current y can be explained by past values of y, and then to see whether adding lagged values of x can improve the explanation. y is said to be Granger-caused by x if x helps in the prediction of y , or equivalently, if the coefficients on the lagged x's are statistically significant. It is pertinent to note that two-way causation is frequently the case; x Granger causes y, and y Granger causes x. It is important to note that the statement *"x Granger causes y"* does not imply that y is the effect or the result of x. Granger causality measures precedence and information content, but does not by itself indicate causality in the more common use of the term.

The study follows the application of Granger's causality with the Vector Autoregression (VAR) Model. The Vector Autoregression (VAR) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system. The paper applies the Variance Decomposition Analysis in order to quantify the extent upto which the three indices are influenced by each other.

## FINDINGS AND ANALYSIS

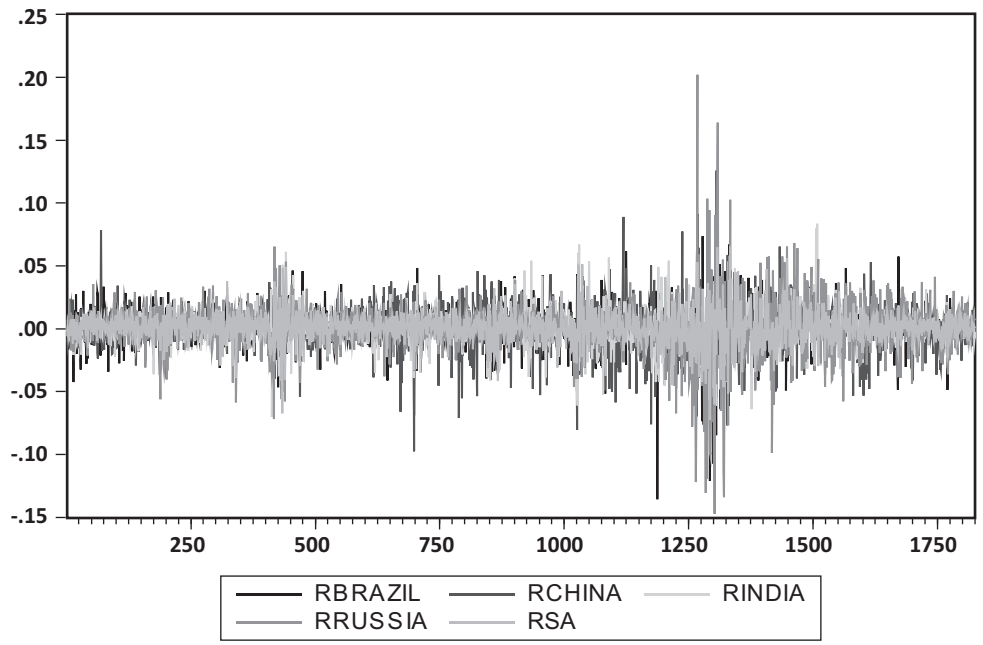
**Table 2 : Descriptive Statistics of Returns From BRICS Stock Exchanges**

| | RBrazil | RRussia | RIndia | RChina | RRSA |
|---|---|---|---|---|---|
| Mean | 0.000530 | 0.000459 | 0.000582 | 0.000673 | 0.000417 |
| Median | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| Maximum | 0.125968 | 0.0202039 | 0.083583 | 0.089776 | 0.065194 |
| Minimum | -0.135458 | -0.147166 | -0.070131 | -0.097525 | -0.072425 |
| Std Dev | 0.016814 | 0.020618 | 0.014833 | 0.016612 | 0.012214 |
| Skewness | -0.546125 | -0.127038 | -0.013122 | -0.406757 | -0.094894 |
| Kurtosis | 12.26846 | 17.65760 | 7.025835 | 7.180020 | 7.604886 |
| Jarque-Bera | 6619.397 | 16333.15 | 1231.810 | 1378.213 | 1614.316 |
| Probability | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |

Source : Authors' Research

The Table 2 shows that the average daily return at the BM&FBOVESPA (Brazil), Russia Stock Exchange (Russia), National Stock Exchange (India), Shanghai Stock Exchange (China) and Johannesburg Stock Exchange (South Africa) happened to be 0.0530%, 0.0459%, 0.0582%, 0.0673% and 0.0417% respectively. Taking the total observations over the period of five years, stock exchanges of Brazil, Russia, India, China and South Africa gave returns of 96.67%, 83.72%, 106.15%, 122.75%, and 76.06% respectively. The average annual returns for the five stock exchanges came out to be 19.33%, 16.74%, 21.23%, 24.55% and 15.21% respectively. It means that on an average, the return at the Shanghai Stock Exchange was the maximum out of the five, followed by the NSE, BM&FBOVESPA, RSE and JSE respectively. The Table 2 also depicts that the standard deviation of the Russian stock market is 0.020618, which shows that the highest probability of risk was at the Russian stock market, followed by the BM&FBOVESPA(0.016814), SSE (0.0166), NSE (0.014833) and JSE (0.012214). The Jarque - Bera probability value 0.00000 for all the five stock exchanges indicates that the null hypothesis of normality can be rejected for all the five stock exchanges. However, the non-normality is not a problem for the return series so far as these don't have fat tails (Brooks, 2008). All these five series are leptokurtic in nature as the kurtosis statistic for all the five happens to be more than 3 (kurtosis for normal distribution is 3). Further, all the five stock exchanges show a negative skewness statistic that indicates the series to be negatively skewed as against a normal distribution that has the skewness statistic of zero. The study proceeds to check the nature of the data as to whether it is stationary or not. The Figure 2 presents the combined graph of returns at all the five stock exchanges during the period of the study. It is indicated from the Figure 2 that the returns at all the five stock exchanges of BRICS are stationary in nature.

**Figure 2 : Line Chart of Benchmark Indices From The Stock Exchanges Considered For The Study**




Source : Authors' Research

**Table 3 : Augmented Dickey-Fuller Test**

| Exogenous: Constant | t-Statistic | Prob. |
|---|---|---|
| rbrazil has a unit-root | -47.64063 | 0.0001 |
| rrussia has a unit-root | -21.89053 | 0.0000 |
| rindia has a unit-root | -22.46627 | 0.0000 |
| rchina has a unit-root | -21.01058 | 0.0000 |
| rsa has a unit-root | -46.09475 | 0.0001 |

Source : Authors' Research

❖ **Augmented Dickey-Fuller Test For Unit-Root :** The unit-root test is performed on the five series in order to test the null hypotheses that the series has a unit root. The findings of the unit-root test and the augmented Dickey- Fuller test are shown in the Table 3.

The Table 3 presents the summary of the Unit - Root Test and the Augmented Dickey-Fuller test for the returns at the BM&FBOVESPA (Brazil), RSE (Russia), NSE (India), SSE (China) and JSE (South Africa) individually. The results show that the probability value of unit-root tests for all the stock exchanges is less than 0.05, which indicates towards the fact that the null hypothesis is rejected, and the series returns at all five stock exchanges are stationary in nature.

❖ **Granger Causality Tests :** The Table 4 presents the results about the application of Granger's Causality model to the stock exchanges of BRICS. From the probability values of the Granger causality test, the acceptance and rejection decision for the Null hypotheses can be taken. While the researchers accept the null hypotheses for the cases with probability value above 0.05, they reject the ones with lesser than 0.05 probability value. Going by this rule, the researchers accept the following null hypotheses :

**1)** RCHINA does not Granger Cause RBRAZIL.

**2)** RRUSSIA does not Granger Cause RBRAZIL.

| Table 4 : Pairwise Granger Causality Tests | | |
|---|---|---|
| **Null Hypotheses** | **F-Statistic** | **Prob.** |
| RCHINA does not Granger Cause RBRAZIL | 0.59727 | 0.5504 |
| RBRAZIL does not Granger Cause RCHINA | 11.5774 | 1.00E-05 |
| RINDIA does not Granger Cause RBRAZIL | 8.96442 | 0.0001 |
| RBRAZIL does not Granger Cause RINDIA | 12.2505 | 5.00E-06 |
| RRUSSIA does not Granger Cause RBRAZIL | 0.21843 | 0.8038 |
| RBRAZIL does not Granger Cause RRUSSIA | 83.6484 | 2.00E-35 |
| RSA does not Granger Cause RBRAZIL | 0.29043 | 0.748 |
| RBRAZIL does not Granger Cause RSA | 74.8226 | 6.00E-32 |
| RINDIA does not Granger Cause RCHINA | 4.06229 | 0.0174 |
| RCHINA does not Granger Cause RINDIA | 3.1999 | 0.041 |
| RRUSSIA does not Granger Cause RCHINA | 4.17346 | 0.0155 |
| RCHINA does not Granger Cause RRUSSIA | 2.62418 | 0.0728 |
| RSA does not Granger Cause RCHINA | 3.35503 | 0.0351 |
| RCHINA does not Granger Cause RSA | 1.51966 | 0.2191 |
| RRUSSIA does not Granger Cause RINDIA | 4.78941 | 0.0084 |
| RINDIA does not Granger Cause RRUSSIA | 26.1247 | 7.00E-12 |
| RSA does not Granger Cause RINDIA | 5.65018 | 0.0036 |
| RINDIA does not Granger Cause RSA | 13.1627 | 2.00E-06 |
| RSA does not Granger Cause RRUSSIA | 5.18332 | 0.0057 |
| RRUSSIA does not Granger Cause RSA | 0.58473 | 0.5574 |
| Source : Authors' Research | | |

**3)** RSA does not Granger Cause RBRAZIL.

**4)** RCHINA does not Granger Cause RRUSSIA.

**5)** RCHINA does not Granger Cause RSA.

**6)** RRUSSIA does not Granger Cause RSA.

Conversely, the researchers rejected the null hypotheses in the following cases, where they accepted the under-mentioned alternate hypotheses :

**1)** RBRAZIL Granger Causes RCHINA.

**2)** RINDIA Granger Causes RBRAZIL.

**3)** RBRAZIL Granger Causes RINDIA.

**4)** RBRAZIL Granger Causes RRUSSIA.

**5)** RBRAZIL Granger Causes RSA.

**6)** RINDIA Granger Causes RCHINA.

**7)** RCHINA Granger Causes RINDIA.

**8)** RRUSSIA Granger Causes RCHINA.

**9)** RSA Granger Causes RCHINA.

**10)** RRUSSIA Granger Causes RINDIA.

**11)** RINDIA Granger Causes RRUSSIA.

**12)** RSA Granger Causes RINDIA.

**13)** RINDIA Granger Causes RSA.

**14)** RSA Granger Causes RRUSSIA.

| Table 5 : Vector Auto-Regression | | | | | |
|---|---|---|---|---|---|
| | **RBRAZIL** | **RCHINA** | **RINDIA** | **RRUSSIA** | **RSA** |
| RBRAZIL(-1) | -0.114499 | 0.085096 | 0.091499 | 0.396124 | 0.230811 |
| | (0.02753) | (0.02713) | (0.02422) | (0.03231) | (0.01929) |
| | [-4.15958] | [ 3.13681] | [ 3.77770] | [ 12.2614] | [ 11.9673] |
| RBRAZIL(-2) | 0.055140 | -0.033157 | 0.014971 | 0.088608 | 0.047345 |
| | (0.02883) | (0.02842) | (0.02537) | (0.03384) | (0.02020) |
| | [ 1.91233] | [-1.16684] | [ 0.59009] | [ 2.61838] | [ 2.34352] |
| RCHINA(-1) | -0.006339 | -0.131805 | 0.038413 | -0.107145 | -0.028946 |
| | (0.02430) | (0.02395) | (0.02138) | (0.02852) | (0.01703) |
| | [-0.26089] | [-5.50403] | [ 1.79660] | [-3.75704] | [-1.70016] |
| RCHINA(-2) | 0.017761 | 0.056697 | 0.012556 | 0.000938 | 0.013411 |
| | (0.02438) | (0.02403) | (0.02145) | (0.02862) | (0.01708) |
| | [ 0.72842] | [ 2.35950] | [ 0.58523] | [ 0.03279] | [ 0.78502] |
| RINDIA(-1) | 0.125658 | 0.043911 | -0.149922 | 0.168044 | 0.072229 |
| | (0.02885) | (0.02843) | (0.02538) | (0.03386) | (0.02021) |
| | [ 4.35599] | [ 1.54458] | [-5.90646] | [ 4.96345] | [ 3.57355] |
| RINDIA(-2) | 0.043451 | 0.041101 | 0.022154 | 0.106397 | 0.037833 |
| | (0.02898) | (0.02856) | (0.02550) | (0.03402) | (0.02031) |
| | [ 1.49920] | [ 1.43896] | [ 0.86870] | [ 3.12787] | [ 1.86302] |
| RRUSSIA(-1) | -0.002379 | 0.022551 | 0.015060 | -0.125500 | -0.056154 |
| | (0.02496) | (0.02460) | (0.02197) | (0.02930) | (0.01749) |
| | [-0.09531] | [ 0.91661] | [ 0.68563] | [-4.28346] | [-3.21042] |
| RRUSSIA(-2) | -0.038359 | -0.021356 | 0.011320 | -0.027332 | -0.009439 |
| | (0.02444) | (0.02409) | (0.02150) | (0.02868) | (0.01712) |
| | [-1.56954] | [-0.88667] | [ 0.52641] | [-0.95288] | [-0.55121] |
| RSA(-1) | -0.055696 | -0.007323 | 0.005087 | -0.126697 | -0.198458 |
| | (0.04419) | (0.04355) | (0.03888) | (0.05186) | (0.03096) |
| | [-1.26043] | [-0.16816] | [ 0.13083] | [-2.44299] | [-6.40997] |
| RSA(-2) | 0.034056 | -0.001457 | 0.055016 | 0.062686 | 0.002173 |
| | (0.04338) | (0.04275) | (0.03817) | (0.05091) | (0.03039) |
| | [ 0.78512] | [-0.03409] | [ 1.44143] | [ 1.23133] | [ 0.07151] |
| C | 0.000488 | 0.000656 | 0.000531 | 0.000208 | 0.000333 |
| | (0.00039) | (0.00039) | (0.00034) | (0.00046) | (0.00027) |
| | [ 1.24933] | [ 1.70339] | [ 1.54355] | [ 0.45400] | [ 1.21536] |
| Source : Authors' Research | | | | | |

❖ **Vector Auto Regression Analysis :** The Table 5 presents the application of Vector Autoregression (VAR) Model at the BRICS stock exchanges.

By the application of the VAR Model, it has been observed that the integration of a stock exchange with the other can be established if the table value is more than 1.96. The Table 5 shows that rbrazil (Returns in Brazil) at the lag of 1 had influence on the returns of each of the BRICS stock exchanges under study. However, with a lag of 2, it had influence on Russia and South Africa only. RChina, with a lag of 1, influenced only the returns on China and Russia, while at the lag of 2, it had a significant effect on the returns on Russia only. At the lag of 1, returns on India influenced all the stock exchanges of BRICS except the Chinese stock exchange, while at the lag of 2, it influenced the returns on Russia only. Returns on Russia (at the lag of 1) influenced returns on Russia and South Africa, and did not influence the returns on

| Table 6 : Variance Decomposition Analysis | | | | | | |
|---|---|---|---|---|---|---|
| **Variance Decomposition of RBRAZIL:** | | | | | | |
| **Period** | **S.E.** | **RBRAZIL** | **RCHINA** | **RINDIA** | **RRUSSIA** | **RSA** |
| 1 | 0.016629 | 100.0000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.016807 | 98.95613 | 0.002236 | 0.925198 | 0.030659 | 0.085782 |
| 3 | 0.016866 | 98.78506 | 0.062166 | 0.921271 | 0.070710 | 0.160795 |
| 4 | 0.016867 | 98.77839 | 0.062721 | 0.921620 | 0.075043 | 0.162225 |
| 5 | 0.016868 | 98.77654 | 0.063657 | 0.921625 | 0.075882 | 0.162297 |
| **Variance Decomposition of RCHINA:** | | | | | | |
| 1 | 0.016388 | 2.408250 | 97.59175 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.016589 | 3.057725 | 96.72970 | 0.163498 | 0.047552 | 0.001522 |
| 3 | 0.016659 | 3.158353 | 96.45618 | 0.249295 | 0.133503 | 0.002667 |
| 4 | 0.016664 | 3.185721 | 96.40967 | 0.254252 | 0.142506 | 0.007850 |
| 5 | 0.016664 | 3.188510 | 96.40509 | 0.254947 | 0.142884 | 0.008573 |
| **Variance Decomposition of RINDIA:** | | | | | | |
| 1 | 0.014632 | 7.963028 | 1.420792 | 90.61618 | 0.000000 | 0.000000 |
| 2 | 0.014824 | 8.355914 | 1.452081 | 90.15364 | 0.037446 | 0.000920 |
| 3 | 0.014877 | 8.450915 | 1.449869 | 89.93423 | 0.089534 | 0.075455 |
| 4 | 0.014881 | 8.468451 | 1.449178 | 89.88795 | 0.112028 | 0.082388 |
| 5 | 0.014882 | 8.467882 | 1.450273 | 89.88402 | 0.113879 | 0.083943 |
| **Variance Decomposition of RRUSSIA:** | | | | | | |
| 1 | 0.019516 | 15.90968 | 0.592056 | 2.958308 | 80.53995 | 0.000000 |
| 2 | 0.020584 | 20.97946 | 1.219254 | 3.289187 | 74.21617 | 0.295928 |
| 3 | 0.020674 | 20.83986 | 1.356304 | 3.792491 | 73.59115 | 0.420195 |
| 4 | 0.020684 | 20.90367 | 1.355742 | 3.798666 | 73.52214 | 0.419786 |
| 5 | 0.020685 | 20.90217 | 1.357482 | 3.804514 | 73.51597 | 0.419863 |
| **Variance Decomposition of RSA:** | | | | | | |
| 1 | 0.011651 | 23.29201 | 0.266127 | 3.747167 | 15.15334 | 57.54136 |
| 2 | 0.012211 | 25.42937 | 0.442406 | 3.503248 | 16.17532 | 54.44966 |
| 3 | 0.012247 | 25.31624 | 0.663567 | 3.678583 | 16.14607 | 54.19555 |
| 4 | 0.012252 | 25.35534 | 0.667685 | 3.685601 | 16.13905 | 54.15232 |
| 5 | 0.012253 | 25.35570 | 0.669373 | 3.689319 | 16.13793 | 54.14768 |
| Source : Authors' Research | | | | | | |

any other stock exchange at the lag of 2. Returns on South Africa had a significant influence on the returns on Russia and those on South Africa at the lag of 1 had an influence on none of the stock exchanges under study at the lag of 2.

❖ **Variance Decomposition Analysis :** The Variance Decomposition Analysis of the three stock exchanges is presented in the Table 6. The Variance Decomposition Analysis as presented in Table 6 entails that in the case of BM&FBOVESPA (Brazil), the impact of other stock exchanges under study was negligible. The Table 6 reveals that in the case of the Chinese Stock Exchange, there was somewhat a visible impact of BM&FBOVESPA (Brazil) for the periods 1 to 5. In case of the Indian stock market, the impact of the Brazilian Stock Market was somewhat significant, while there was a visible impact of the Chinese stock market as well for period 1 to 5. The Table 6 also shows that there was a highly significant impact of the Brazilian Stock Market on the Stock Exchange of Russia from period 1 to 5, whereas the visible impact of the Indian and Chinese stock exchanges was also present.

Finally, the table reveals that there was a significant impact of return at the Brazilian Stock Market and RSE (Russia) from the period 1 to 5 on the South African Stock Exchange, whereas the visible effect of the Indian Stock Market from

a period of 1 to 5 can also be seen.

## CONCLUSION AND IMPLICATIONS

The study concludes that the annual returns from the stock exchanges in BRICS varied from 15.21% to 24.55%. The average annual return at the Shanghai Stock Exchange (China) was the maximum out of the five, followed by the NSE (India), BM&FBOVESPA (Brazil), RSE (Russia) and JSE (South Africa) respectively. The application of the Unit-Root Test (Augmented Dickey-Fuller test) revealed that the return series were stationary. Granger's Model when applied to the five series indicated that the return at the BM&FBOVESPA (Brazil) Granger causes the returns at Chinese, Indian, South African and RSE (Russia); returns at RSE (Russia) causes returns at Chinese and NSE (India); returns at South African stock exchange causes returns at Chinese, Indian and RSE (Russia); returns at the Chinese stock exchange causes returns at NSE (India), but does not cause returns at any other stock exchange of BRICS. Returns at NSE (India) causes returns at all the stock exchanges of BRICS. Results of VAR confirm the results of the Granger causality test that the returns at BM&FBOVESPA (Brazil) influenced all the stock exchanges of BRICS, while returns at Shanghai stock exchange influenced returns at the Russian stock market only, whereas returns at the National stock exchange impacted the returns at all the stock exchanges of BRICS. Returns at the Russia Stock Exchange and the returns at Johannesburg Stock Exchange influenced each other only. Further, the results of Variance Decomposition Analysis showed the extent upto which the returns at the stock markets under study were influenced by the returns at each other, and they differed significantly.

The age of globalization and liberalization is witnessing relatively free movement of capital within Nations. This has given rise to the increased Foreign Institutional Investment (FII) activity across the countries. In addition to the FIIs, individual investors are also diversifying their earnings across Nations. With the markets from developed nations reaching their saturation points, it becomes imperative for the investors to search for new investment avenues. The stock exchanges of BRICS have started to become the favored destinations for investors. The study brings home the point that the returns at the stock exchanges of these nations are not closely inter-linked. Though some models provide evidences of linkages of some stock exchanges in pairs, yet this evidence is not supported by all the models and surely, not for all the five countries. This implies that a rise in one stock exchange under reference does not necessarily lead to a corresponding rise in the other stock exchange(s) under reference, which means that the investors can reap profits by diversifying between the stock exchanges of BRICS. By doing this, they can expect the fall in one stock exchange from BRICS to be set-off by a rise in another stock exchange, and vice-versa. In this way, they would be able to reduce their risk to the optimum level while reaping the fruits of stock market growth in the emerging BRICS economies. However, while making investment decisions, investors would need to look beyond the impact of stock markets from other BRICS nations on a particular stock market. They would have to look for the residual variables, including domestic macro-economic factors, which would probably have an impact on the returns from these stock markets. This also opens-up an important topic for further research in stock markets of BRICS nations, wherein the impact of domestic macro-economic variables and other residual variables can be studied for maximizing the gains to global investors. Since the study dealt with the linkages between returns from the stock exchanges, the issues of volatility linkages and volatility spillover can be looked at as significant topics for future researchers.

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