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Contagion Effect among the BRICS Stock Market Indices

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Abstract
This paper deals with Stock market returns of five emerging economies i.e. Brazil, Russia, India, China, and South Africa (BRICS). The paper attempts to establish the linkages and relationship among the returns of these BRICS Stock Exchanges and examines the effect of the stock index of one country on the stock index of other country. The daily Index returns of all the five stock exchanges are taken from 2007 to 2014. Long term relationship has been tested by Johansen Co-integration test to show long run association among BRICS stock exchange indices. ADF, Unit Root Test and Granger Causality have been applied to find out the cause and effect relationship among the Nifty Index and BRICS Stock Exchanges Indices. Further Vector Auto Regression in the form of Impulse Response Function and Variance Decomposition Model are applied to validate the results obtained from Granger Causality Test. The study shows that there is a significant and positive correlation among Nifty and other BRICS indices. However long run association was not found among Nifty and rest of the stock indices. Unidirectional causality is observed in Nifty with South African and Chinese Stock Indices whereas bi-directional relationship was found among Indian, Brazil and Russian Stock Indices. The results reveal that there are visible effects of stock exchanges indices return on each other's stock returns. Since the study is confined to BRICS Stock Market only effect of FIIs investment and influence of leading Stock Market cannot be ruled out, which requires further study. The results suggest less co integration in the long run, therefore international investors can reap benefits from portfolio diversification. This paper offers insight into the inter linkages among the BRICS indices and provides important insights for investment and speculative decisions.
Keywords: Nifty Index, Co-integration, Stock Exchanges, Portfolio Diversification, Granger Causality, Interlinkages.

1. Introduction

The global growth of stock markets and the emerging market boom of BRICS countries have attracted the attention of academics, practitioners, and policy makers. People think that their money should be invested in the most flourishing and rapidly changing market where they can expand the size of their investment. In the year 2001 Goldman Sachs identified Brazil, Russia, India and China as four emerging markets and in this league of advancement South Africa entered in 2010. The BRICS economies have been identified as the fastest growing economies of the world and the engines of the global recovery process after subprime crisis in the year 2008. Even in the G-20 forum, BRICS are playing a key role in shaping macroeconomic policy after the recent financial crisis. The group of these five nations occupies 40 per cent of global population, 30 per cent of the land mass and nearly 25 per cent of the GDP in PPP terms. According to an estimate by Goldman Sachs, the original four BRIC countries are expected to represent 47 per cent of the global GDP by 2050, which would dramatically change the list of world's 10 largest economies. The inherent strength of the BRICS emanates from strong domestic based economies in the case of Brazil and India and significant outward linkages of Russia and China. South Africa benefits from its large resource base and proximity to untapped growth potential of the African continent. (BRICS Report, 2012)

In a country like India where the stock market is undergoing significant transformation with liberalisation measures, the analysis of the nature of co-integration with other developed and emerging markets would give an idea of possible gains to be reaped out from diversification of Indian markets. The BRICS countries also attracted significant foreign investment which looked for higher returns especially after the developed markets failed to deliver sustained growth. Each country of the BRICS group has a fairly developed stock market.

2. Review of literature

The research in the area of integration among world stock markets began in 1968 with (Grubel, 1968) followed by (Agmon, 1972; Hilliard, 1979; Becker *et al.,* 1990; Hamao *et al.,* 1990) etc. Their work focused on the correlation among the developed markets i.e. the USA, the UK, Germany and Japan. The objective initially was to ascertain whether international diversification of portfolio would be beneficial or not. The results broadly indicated that the markets did have some integration but the correlation was low. Both (Eun & Shim, 1989; Dwyer and Hafer, 1988) concluded that there were considerable interactions among stock market indexes, with

one-way causality running from the US to other markets, including Hong Kong, Japan.

Agmon (1972) found that share prices in Germany have a very close relation with the US market and similar relation has been found in Japan and US. Hilliard(1979) examined the relationship among the 10 major equity market indices during worldwide financial crisis and found closed relationship among the indices. Eun and Shim(1989) investigated the transmission of stock markets of Australia, Canada, France, Germany, Hong Kong, Japan, Switzerland, UK and US and observed that there were multilateral interactions among the stock markets and US played a dominant role. Becker *et al.*(1990) studied the interpersonal relation between US and Japanese markets and observed that although high profits were reaped out but this strategy was eliminated due to high transaction cost and taxes. Hamao*et al.*(1990) analysed the short term linkages among 3 major stock markets New York, Japan and London and found the integration among these markets.

Rao(1990) pointed out that Japanese market acts like an independent factor in relation to US and Indian Stock markets. Fisher and Palasvirta(1990) also found a high level of interdependence among stock market of 23 countries; they further concluded that US index prices led almost every country index in the sample. Mathur and Subrahmanyam(1990) found that Nordic stock markets are less than fully integrated with US markets. Granger &Hallman (1991) concluded that investment decision merely based on short term asset returns is inadequate, as the long term relationship of asset price is not considered. Chan*et al.*(1992) used unit root and co-integration tests to examine the relationships among the stock markets in Hong Kong, South Korea, Singapore, Taiwan, Japan and the United States and found that the stock prices in major Asian markets and United States are weak form efficient individually and collectively in the long run. Cheung and Mak(1992) concluded that the US markets can be considered as a global factor and is found to lead most of the Asian Pacific emerging markets with the exception of three relatively closed markets i.e. Korea, Taiwan and Thailand. Kasa(1992) suggested that the short term return correlation between stock markets is not appropriate from the perspective of long horizon investors driven by common stochastic trends. Malkamaki(1992) found that Scandinavian markets seem to be led by the German and UK market.

Confirming the previous study Smith *et al.*(1993) also found evidence of Granger unidirectional causality running from the US to the other countries immediately after 1987 worldwide crash. Park and Fatemi(1993) found that Australia is most sensitive to the US market. Singapore, Hong Kong and New Zealand form the next group and exhibit moderate linkage.Campbell and Ammer(1993) showed that short- term interest affects stock prices. Choudhury (1994) examined the relationship among the Asian Newly Industrialized Economies (NIEs), Japan and the US and found that US led the NIEs and there were significant linkage among the markets. Blackman *et al.*(1994) further suggested that, while such relationships were unlikely before 1980, markets are now expected to move together.

Arshanapalli*et al.*(1995) examined the co integration among stock markets of US, Japan & five other Asian countries and found that the extent of co integration among all these markets have increased after the 1987 crash signifying arbitrage activities between US and other Asian markets. Both Harvey(1995) and Korajczyk (1996) suggested that the improvement in market efficiency is consistent with increasing integration with world markets. Hassan and Naka(1996) investigated the dynamic linkages among the U.S., Japan, U.K. and German stock market and found significant evidence in support of both short –run and long run relationship among these four stock market indices. Karolyi and Stutz(1996) studied the daily return co-movement between the Japanese and U.S. stocks during 1988 to 1992 and found evidence that correlations are high when there are significant market movements. Markellos and Siriopoulos (1997) examined the diversification benefits available to U.S. and Japanese investors and found no significant common trend between the U.S. and Japanese markets. Palac-McMiken (1997) found that with the exception of Indonesia, all the ASEAN markets are linked with each other.

Kanas (1998) discovered that the U.S. stock market does not have pair wise co-integration with any of the European markets. Janakiramanan and Lamba (1998) examined the linkages among the Pacific –Basin stock markets. The influence of the US markets on the Australian markets has diminished during the recent years and the emerging markets of Indonesia are becoming more integrated with these markets. Elyasiani *et al.* (1998) found no significant interdependence between Sri Lanka markets and the equity markets of the U.S. and the Asian market. Liu *et al.*(1998) examined the stability of the interrelationship among the emerging and developed stock markets and found an increase in the general stock markets interdependence. Ramchand and Susmel (1998) found that the correlation between the U.S. and other world markets are 2 to 3.5 times higher when the U.S. markets are in a high variance state as compared to a low variance regime. Janakiramanan and Lamba (1998) conducted a study to find the long term linkages among nine stock markets of Pacific-Basin countries and found positive correlation except in case of Indonesia and found that US market indirectly influence these markets especially in case of New Zealand and Australia. Liu *et al.*(1998) examined the short run dynamic interactions among the US and five Asian Pacific stock and found no significant causal relationship among these markets in the pre-crash period except Japan leads US.

Masih and Masih(1999) found high level of interdependence among markets in Thailand, Malaysia, the U.S, Japan, Hong Kong andSingapore during 1992 to 1997. Gerrits and Yuce(1999) tested the interdependence

among stock prices in Germany, the UK, the Netherlands and the US. Results showed that the US exerts a significant impact on European markets.Alexander(1999) applied co-integration analysis to portfolio asset allocation and trading strategies and proved that Index tracking and portfolio optimization based on co-integration rather than correlation alone may result in higher asset returns.

There are varied views on the after effect of the Asian financial crisis on the integration of the Asian markets. Ghosh *et al.*(1999) examined nine Asia-Pacific markets with either the US or Japanese stock market and found that some markets are co-integrated with the US, some are co-integrated with Japan, and others are not co-integrated. Christofi and Pericli(1999) investigated the short term dynamics among five major Latin American stock markets during 1992 to 1997 and found significant first and second moment time dependencies. Smith(1999) applied Cross Spectral analysis to six of G-7 markets to determine whether frequency domain correlation has increased for most of the markets.

Sheng and Tu(2000) applied co-integration and variance decomposition analysis to examine the linkages among the stock markets of 12 Asia-Pacific countries, before and during the period of the Asian financial crisis. Ng(2000) found that regional and world factors are important for market volatility in the pacific-Basin region, though world market influence tends to be greater. Scheicher(2001) studied the regional and global integration of stock markets in Hungary, Poland and the Czech Republic and found limited interaction. Verchenko (2000) found absence of co-integration and independence of stock market movements in Eastern European and former Soviet Union stock markets. 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 movement for each of the grouping. Bhattacharya and Samantha (2001) investigated the extent to which news on NASDAQ helped price formation at the beginning and at the end of a trading day at the Indian bourses using daily data of stock price indices and found the integration of the Indian capital market with the US market. Roca and Selvanthan (2001) have analyzed price linkage among the equity market of Australia and those of Hong Kong, Singapore and Taiwan and concluded that Australian market is not significantly linked with any of these markets.

Kumar (2002) confirmed that stock index of Indian stock market was not co-integrated with that of developed markets. Mishra (2002) investigated the international integration of Indian Stock market and found no co-integration vector between BSE and NASDAQ indices that signifies no long run relationship between these two stock exchanges. Ng (2002) found no evidence of a long run relationship among the South-East Asian stock markets. Yang and Lim (2002) found some evidence of short term linkages and concluded that there is no long run co-movement among the East Asian stock markets. Johnson and Soenen (2002) found that equity markets of Australia, China, Hong Kong, Malaysia, New Zealand and Singapore are highly integrated with the stock market in Japan. Darrat and Zhong (2002) examined the linkages among the eleven emerging Asia-Pacific markets with US and Japan. They argued that the effect of the movement in the Japan market on the Asia- Pacific region is only transitory. Pretorius (2002) examined the factors behind the stock markets integration among the emerging economies i.e. Argentina, Brazil, China, Greece, India, Korea, Malaysia, Mexico, South Africa and Turkey and found bilateral significant relationship among the emerging stock markets.

Yang *et al.*(2003) examined relationships among the five largest emerging African stock markets and the US market. There is evidence of both long-run relationships and short-run causal linkages among these markets. Baharumshah *et al.* (2003) examined the dynamic interrelationship among four Asian markets Malaysia, Thailand, Taiwan and South Korea and showed that the degree of integration among the Asian emerging markets and the US increased following the deregulation period. Nath and Verma (2003) analyzed the level of capital market integration by examining the transmission of market movements among three major stock markets in Asian region and suggested that international investor could achieve long term gains by investing in stock markets because of the independencies of the stock markets. Bessler and Yang (2003) concluded that the US market is highly influenced by its own historical innovation, but also influenced by market innovations from UK, Switzerland, Hong Kong, France and Germany. Darrat and Benkato (2003) analyzed stock returns and volatility relation between the Istanbul Stock Exchange (ISE) and the stock markets in the US, the UK, Japan and Germany and found that the two matured markets of the US and the UK shoulder significant responsibility for the stability and financial health of smaller emerging markets like the ISE. Johnson and Soenen (2003) found the co-movement between US-Canada and US-Mexico as well as least co movement between US-Colombia and US-Venezuela. Lee (2004) analyzed the transmission of stock markets of US and Korea and investigated the price and spill over effects across the international markets. High volatility rates were experienced in the Korean markets but not in the US markets.

Mixed evidence is found for the integration of the Indian stock market with the developed nations. Narayan*et al.*(2004) examined the dynamic linkages among the stock markets of Bangladesh, India, Pakistan and Sri Lanka and found unidirectional Granger causality running from stock prices in Pakistan to India, Sri Lanka to India and Pakistan to Sri Lanka. Bangladesh is the most exogenous of the four markets. Hatemi and Roca (2004) examined the equity market price interaction between Australia and European Union and concluded that

Australia had no causal links with Germany and France but it had with the UK, with causality running from the UK to Australia but not vice-versa. Choudhry and Lin (2004) showed significant long run relationship between the Far East markets before and during/ after the Asian financial crisis. Lamba (2004) examined whether the Indian stock markets is influenced by France, Germany, US, UK and Japan and found that there was lack of relationship among South Asian markets with the developed markets. Kearney and Lucey (2004) examined the existing literature in the area of international equity market integration.

Mukherjee and Mishra (2005) discovered that the Indian stock market was integrated with the emerging Asian markets of Indonesia, Malaysia, Philippines, Korea and Thailand. Ahmad *et al.*(2005) revealed that there was no long term relationship among the Indian equity market with the US and Japanese equity markets. Granger causality test suggested that there was a unidirectional relationship from NASDAQ and Nikkei with Indian stock markets. Click and Plummer (2005) examined the stock market integration of ASEAN during 1998-2002 and revealed that there is only one co integrating factor and all the markets participate equally. Maghyereh (2006) investigated the interdependence among the daily equity market returns of four major Middle Eastern and North African (MENA) emerging markets and found that none of the MENA markets is completely isolated and independent. Wong *et al.* (2005) using weekly data found that Indian stock market was integrated with the USA, the UK and Japan for the post liberalization period.

However, Bose and Mukherjee (2006) could not prove the integration of the Indian stock market with the seven Asian markets and the USA. By including India, co-integrating equation was found and when India was excluded, no co-integration was found indicating that the Indian stock market plays a unique role in the integration of Asian markets.

After analysing markets of 23 different countries Mukherjee and Mishra (2007) identified increasing tendency of integration among the markets and discovered that countries of same region are found to be more integrated than others. Janor *et al* .(2007) studied the equity market integration among the five (5) ASEAN countries vis-à-vis the USA and Japan. Their results evidenced towards the regional integration across some of the countries. Hoque (2007) explored the dynamics of stock price movement of an emerging market such as Bangladesh with USA, Japan and India and found that co-integration stock markets weaken the benefits of international portfolio diversification in the long run. Chowdhry *et al* .(2007) and Subramanian (2008) examined the long term equilibrium relationship among the five major East Asian equity markets and found a linear combination of five indices that forces these indices to have a long term equilibrium relationship implying diversification among these five equity markets cannot benefit international portfolio investors. Priyanka *et al* .(2008) found significant two ways Granger Causality of Indian market with US, Japan, Korea and Canada and one way causality relationship between France, United Kingdom and Hong Kong on Indian markets.

Siddiqui (2009) analyzed the association of the Indian stock market with US and selected markets and found that there is an increase in the interdependence among the indices of the countries under consideration and high degree of integration was shown among these markets. Sarkar and Sen (2009) found strong evidence of global and regional contagion effect. Chittedi (2009) found that the US and Japanese stock market influenced the Indian stock market and that the Indian market is not influenced by UK, Brazil, Russia and China's stock markets.

Singh (2010) studied the linkages between Indian and Chinese market with major developed markets and found short run causality between India and UK. Tripathi and Sethi (2010) examined the integration of the Indian stock market with four other major stock markets in the world. The results of this study contradicted the earlier findings by (Mukherjee and Mishra, 2005; Bose and Mukherjee, 2006) which showed that the Indian stock market is not integrated with the US stock market. Singh and Kishor (2014) examined the effect of macro-economic variables on stock market indices and found no inter linkages between gold price and Nifty indices. Sharma and Bodla (2011) studied the inter linkages among the stock market of India, Pakistan and Sri Lanka from 2003-2010 and found that while the National Stock Exchange (NSE) influenced Karachi Stock Exchange and Colombo Stock, the vice versa is not true. Iqbal *et al.* (2012) found that there was no integration among US, Pakistan and India. However, the Granger Causality test showed the evidence of unidirectional causality running from NYSE to Bombay and Karachi Stock Exchange. Gupta (2012) studied links among Indian stock market and three developed Asian markets and found that correlation mounted dramatically during the period of crisis but returned to their original level after crisis. Singh (2012) concluded that there are visible effects of stock exchange on each other. The Russian, Indian and Brazilian stock exchanges affected each other and get affected by their own returns but none of these affect Chinese stock exchange rather they all get affected by Chinese stock exchange.

3. Objectives

After having viewed the theoretical background which exists for integration among the emerging economies Stock Exchange Indices, the objective of the present study is to examine; Firstly, to analyze the trends in the Stock Exchange Indices of BRICS countries; Secondly, to study the correlation among the Indices of BRICS

nations; Thirdly, to study the long term relationship among Stock Exchanges of BRICs countries and Lastly, to examine whether there exists a cause or effect relationship among the Nifty Index and other BRICS indices.

4. Hypotheses

The hypotheses of the study are:

H_{01}: BRICS Indices are not stationary or got unit root.

H_{02}: BRICS Stock Exchange Indices do not affect or cause Nifty Index & vice-versa.

H_{03}: There is no co-integration between Nifty Index returns and other BRICS indices returns.

5. Research Methodology

5.1 Data sources and Time period

This study is mainly based on secondary data that have been collected from the database maintained by BRICS Stock Exchanges websites and from websites like www.investing.com and www.yahoofinance.com. The study analyses the daily data on Stock indices return of Brazil, Russia, India, China and South Africa for the aforesaid period. Wherever data were missing, the averages of the data of the previous date and next date have been taken. The paper examined the BRICS countries Stock Indices over the period of seven years starting from 1st January 2007 to 31st December 2014.Daily adjusted closing value on the day has been used. The daily stock market returns (R t) based on individual BRICS indices have been calculated by the logarithmic difference change in the BRICS stock indices i.e.,

$R_t = \text{Log}\ (I_t / I_{t-1})$ where I_t and I_{t-1} are the closing value of daily BRICS stock indices at time 't' and "t-1" respectively. Where $I_t$is the present indices value and I_{t-1} is the previous day's indices value.

5.2 Tools and Techniques

The following tools and techniques have been used to test the hypotheses:

Descriptive Statistics: The basic tools of descriptive statistics like mean, median, mode, standard deviation, Min. & Max values, Jarque Bera tests are applied to define the general characteristics of the stock index return series of BRICS countries.

Correlation matrix: Karl Pearson's co-efficient of Correlation has been calculated to study the correlation among various BRICS stock market indices.

Unit Root Test: In order to check whether or not the series are stationary or not correlogram have been prepared for each series. Augmented Dickey-Fuller unit root test has been applied to examine the stationarity of the time series of the study and to find the order of integration among them. The ADF unit root test has been performed by estimating the regression:

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum \gamma_j \Delta Y_{t-j} + \varepsilon_t$$

The ADF unit root test is based on the null hypothesis $H_{0:}$ Y_t is not I (0). If the calculated ADF statistics is less than the critical value, then the null hypothesis is rejected.

Johansen Co integration Test: The Johansen's co-integration test has been applied to check whether the long run equilibrium relation exists between the variables. The Johansen approach to co-integration test is based on two test statistics one is trace test statistics and second is maximum Eigen value test statistics.

The trace test statistics can be specified as: τ trace = $-T \sum \log (1-\lambda i)$, Where λ is the ith largest Eigen value of matrix Π, and T is the number of observations. In the trace test, the null hypothesis is the number of distinct co integrating vector(s) is less than or equal to the number of co integration relations (r).

Granger Causality Test: The vector of endogenous variables is divided in two sub-vectors, Y_{1t} and Y_{2t} with dimensions K_1 and K_2 respectively, so that $K = K_1 + K_2$. The sub-vector Y_{1t} is said to be Granger-causal for Y_{2t} if it contains useful information for predicting the latter set of variables. For testing this property, the levels VAR following form without exogenous variables of the model is considered.

$$A_0 Y_t = A_t Y_{t-1} + \ldots\ldots + A_{p+1} Y_{t-p-1} + B_0 X_t + \ldots\ldots + B_q X_{t-q} + C^* D^*_t + u_t$$

If that model contains p=1 lags of the endogenous variables as in the above model, the test is based on a model with p+2 lags of the endogenous variables.

Vector Auto Regression Model: A VAR describes the dynamic relationship and evolution of numbers of variables. Sims (1980) and Box & Jenkins (1976) have advocated the use of the VAR model instead of structural simultaneous equation model (SEM) because the distinction between endogenous and exogenous variables is not required. 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 mathematical representation of a VAR is:

$$y_t = A_1 y_{t-1} + \ldots\ldots + A_p y_{t-p} + B x_t + \varepsilon_t$$

Where y_t is a k vector of endogenous variables, x_t is a d vector of exogenous variables, $A_{1,\ldots\ldots,}$ A_p and B are matrices of coefficient to be estimated , and t is a vector of innovation that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right- hand side variables..

Variance Decomposition Analysis: The Variance Decomposition Analysis has been applied in order to finally quantify the extent up to which the five indices are influenced by each other. Variance decomposition provided information about the relative importance of each random innovation in affecting the variables in the VAR. They give the proportion of the movement in the dependent variables that are due to their own shocks, versus shocks to the other variables.

6. Discussion and Analysis

The sample consists of daily closing price of Nifty, Micex, JSETOP40, SSE composite and Bovespa from January 1st, 2007 to December 31st, 2014. The daily closing price data of the five indices have been obtained from (www.investing.com, www.yahoofinance.com) and from their respective websites. For performing the econometrics analysis, it is essential to make sure that the series under reference are stationary. The log of the five series has been taken. In this way five new variables are created which denote the return on Brazil Stock Exchange, Russian Stock Exchange, National Stock Exchange, Shanghai Stock Exchange and Johannesburg Stock Exchange respectively.

[Table 1]

Table 1 shows the results of descriptive statistics for the daily return series of all the five BRICS markets. The highest return was reported by the Indian stock market index i.e. Nifty index followed by South African JSE top 40 and Russian Micex indexes. The Russian Stock Indices Micex is found to be most sensitive index among the BRICS stock exchanges followed by Brazil and China as coefficient of standard deviation is highest in this case. The less than normal distribution of stock indices returns series through skewness and kurtosis coefficient is further supported by Jarque- Bera statistics. The probability of Jarque Bera statistics has shown that all market indices of the present series are less than normally distributed in their historical movements. Negative skewness in three indices indicates that series have a long left tail and positive skewness in two indices indicating a long right tail. The kurtosis for the normal distribution is 3 (Table: 1), where the kurtosis statistics for all the stock exchange is higher than 3, we may infer that the distribution are peaked (leptokurtic) related to the normal distribution.

[Table2]

Table 2 reflects that all the BRICS stock markets are positively correlated. The highest level of correlation was found between Indian and South African stock indices followed by Indian and Brazilian stock indices. Nifty Index has positive and significantly correlated relationship with JSE, Micex and Bovespa but correlation was positive and very low with Chinese Stock market. The lower order correlation was noticed in case of Chinese stock indices with other stock market indices also. Chinese stock indices is significantly and positively correlated with Russian stock indices whereas in case of South African stock indices, it is negatively and least correlated. Brazilian stock indices and Indian stock indices are positively and in some case significantly correlated with other BRICS stock indices. The correlation study has given prime cues that out of five BRICS stock markets the Chinese stock market is relatively less related with other BRICS market.

Granger Causality Test and Co integration analyses require the unit root test as both the test presume that the given time series are stationary. In the first step stationarity of indices of BRICS has been tested applying Augmented Dickey Fuller (ADF) test. Since we have taken the returns of the indices using Log natural returns of each index, so the issue of stationarity is taken care off at the level only and further correlogram reflect that all the indices are stationary in nature.

[Table 3]

The results in Table 3 indicate that the unit-root is not present in the levels of all indices. In all the cases of BRICS indices the P value of individual index is less than 5 per cent. Therefore, the null hypothesis of existence of unit root is rejected at level indicating stationarity in data which means equity stock indices of BRICS are integrated at level only as we have taken Log natural returns of each index. It suggests further study of co-integration in the market proxies of BRICS stock markets. Now through correlogram we can establish stationarity nature of the indices. Figures 1 to 5 demonstrate the returns of the five BRICS stock indices. It is indicated from the figures that all the five stock exchanges are stationary.

Figure 1: Bovespa returns

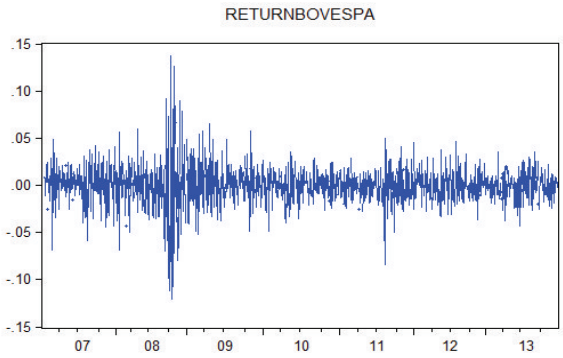


Figure 2: JSETOP 40 returns

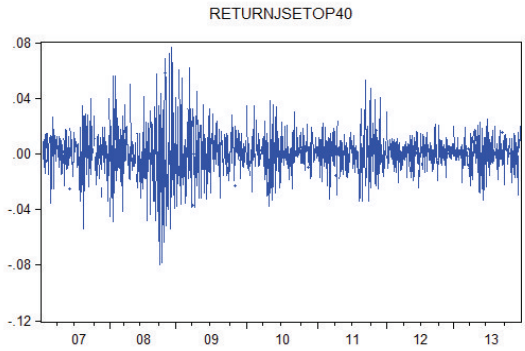


Figure 3: Micex returns

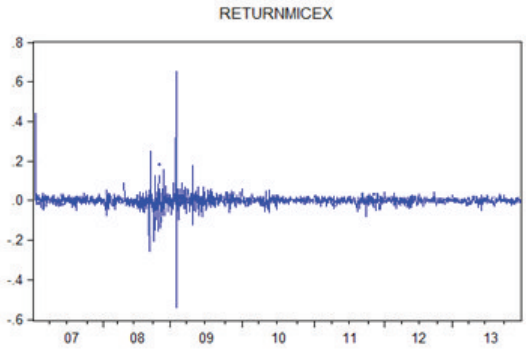


Figure 4: Nifty returns

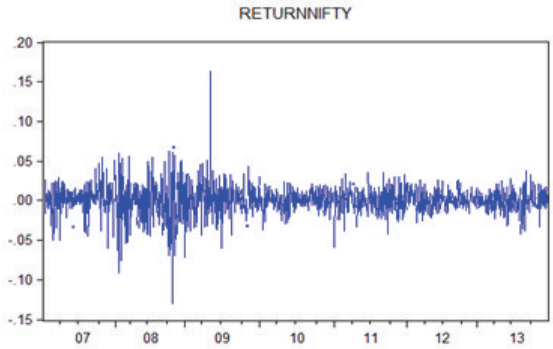
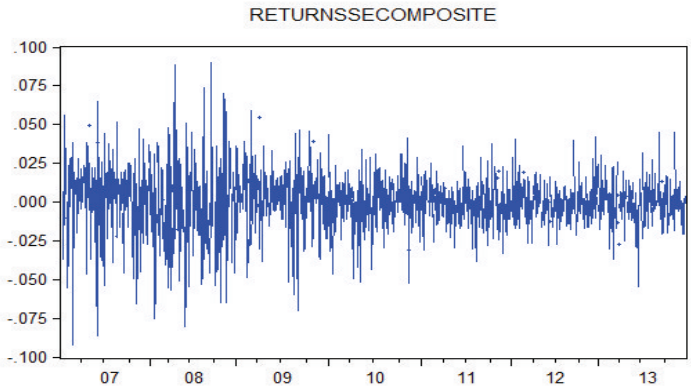


Figure 5: SSE composite returns



To run Granger Casualty Test we need stationary units and since all the BRICS index returns are stationary we can run the test. The Granger Causality Test can be performed to determine the direction of the causation among the BRICS stock indices. To test the causal relationships, the following models are applied:

$$\log(Y_t) = \sum_{j=1}^{k} a_j \log(X_{t-j}) + \sum_{j=1}^{k} b_j \log(Y_{t-j}) + \mu_{1t} \quad \text{….. (1)}$$

$$\log(X_t) = \sum_{j=1}^{k} c_j \log(X_{t-j}) + \sum_{j=1}^{k} d_j \log(Y_{t-j}) + \mu_{2t} \quad \text{….. (2)}$$

Where u_{1t} and u_{2t} are two white noises random disturbance terms which are serially uncorrelated with mean zero and k is the maximum number of lags. For analyzing the relationship between the Stock indices the Granger Causality test and for long run relationship Johansen Co-integration test are applied. In order to run these tests a lag length is determined from Vector Auto Regression (VAR) test. A lag length is selected on the basis of

Akaike Information Criteria (AIC); the maximum negative value of AIC is taken. As most suggested lag is 2 as per Lag order selection criteria. Model is tested for adequacy using VAR adequacy test in which stability, normality and serial correlation are tested.

[Table 4]

To determine the optimal lag length (k), Akaike Information Criterion (AIC) has been applied. In our model equation (1) and (2) are applied to test causation among the BRICS stock market indices equation. Results obtained from equation (1) and (2) are summarized in Table 5.

[Table 5]

The causality relationship has been studied between the pairs of market to discover which market exerts stronger influence on the others. The results presented in Table 5 show that Bovespa and Micex have a bi-directional relationship with Nifty indices. There is a cause and effect relationship between the two indices. There is a unidirectional relationship between Nifty and JSE, SSE composite. JSE affects Nifty but Nifty does not cause and affect JSE. Similarly SSE composite does not cause and effect Nifty but Nifty cause and effect SSE composite which means Indian investors can be benefitted if they invest in Chinese stock market as Nifty returns have impact on the SSE composite indices whereas in case of downfall, Chinese stock indices has no impact on Nifty indices in short run as there is unidirectional causality flowing from Nifty to SSE composite Indices not the other way. Nifty get affected by all the other indices except SSE composite and Nifty affect all other indices except JSE.

The pattern of dynamics response of each of the five BRICS stock markets to a shock, i.e., positive residual of one standard deviation unit in the Indian stock market, has been examined and presented in Figure 6.

Figure 6: Impulse Response Function

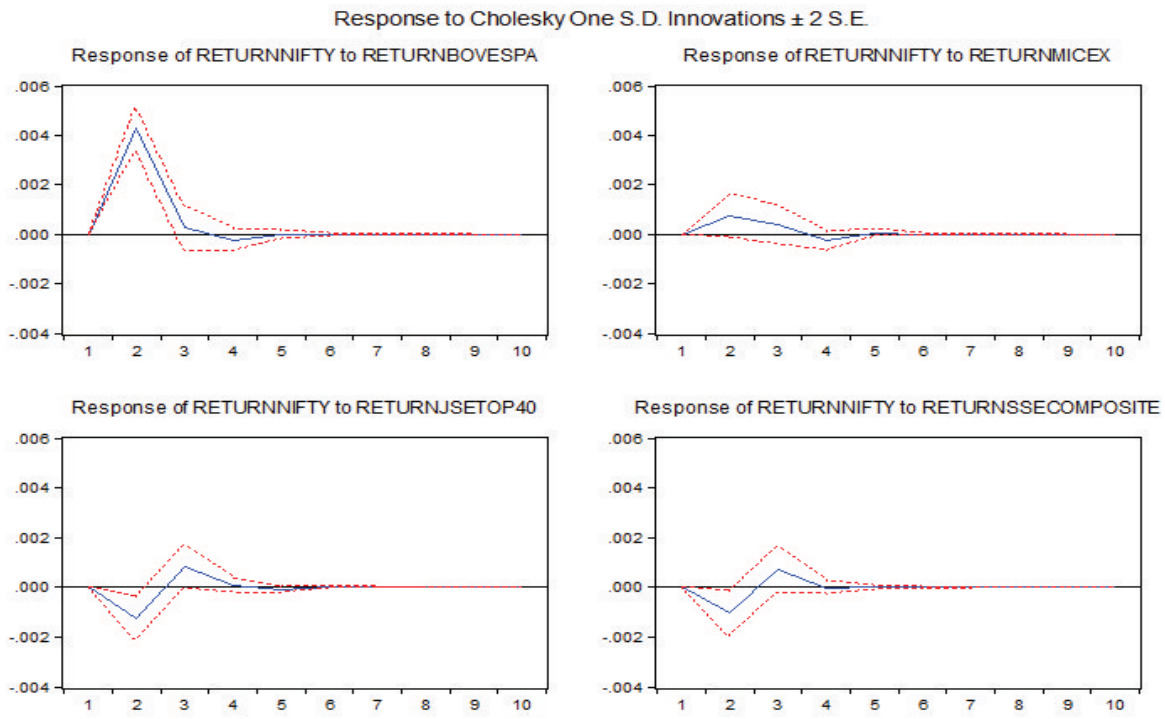
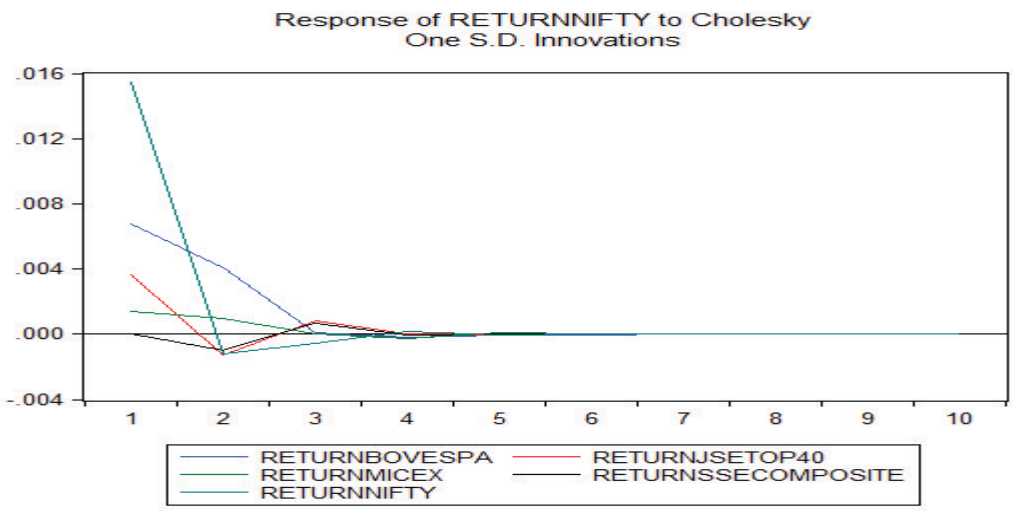


Figure 7: Response of BRICS Indices to One S.D. Innovations



Figures 6 and 7 provide plots of the time path of impulse response for those BRICS stock markets to a market shock during the study period. The dynamic linkages of the Nifty, Bovespa, SSE composite, JSEtop40 and Micex indices are quite clear from them. A positive one standard deviation shock to the BRICS stock market indices has a negative effect on the Indian stock market throughout the study period.

Further the co-integration between the two stationary variables has been tested by the Johansen's Trace and Maximum Eigen value tests. We have used the daily data from January 2007 to December 2013 and 1510 observations are included after adjustment.

[Table 6]

The results of the Johansen Cointegration test are shown in Table 6. At the 5% significance level the trace and maximum Eigenvalue tests suggest that the variables are not co-integrated at all. These tests indicate that there are no co-integrating vectors in order to establish the long run relationship among the BRICS stock markets. It signals that the asset allocation for diversification benefits can be achieved in the long run and incase of crisis in any of the stock market would not have impact in the long run on other BRICS stock market indices.

[Table 7]

Finally, the Variance Decomposition Analysis of the five Stock exchanges is presented in the Table 7.The Table decomposes the returns of the five stock exchanges for the period. In case of Brazil stock exchange Bovespa indices table decomposes the variance of returns and reveals that by and large, the returns at the exchange is composed by the previous days' levels/returns at the same. In lag 2 there is an effect but at a very low level from JSE, Micex and Nifty, SSE has no effect on Bovespa which is in conformity with the result produced by Granger Causality model and Vector Auto Regression (VAR) model. Variance Decomposition of JSE indices clearly shows that JSE is influenced by Bovespa returns and its own return only and not by any other indices. Results are in conformity with the Granger Causality and VAR model. In table 7 Micex is influenced by JSE, Bovespa and by its own return in a big way and by Nifty in a very insignificant way. Nifty is influenced by all the indices except from SSE composite. Nifty is influenced by Bovespa, JSE, and Micex along with from its own returns.

It is also observed from Table 7 that the Chinese stock exchange impact on Indian stock market is negligible. Return at the Indian stock exchange is composed by the exchange itself from the period 1 to 10 and Brazil stock exchange Bovespa also put a large impact on the Indian stock exchange followed by South African stock exchange. SSE composite is influenced by all the other indices at lag 1 only and predominately by its own returns also. These results are in conformity with results obtained from Granger Causality test and Vector Auto Regression (VAR) model.

7. Conclusion

The correlation of Nifty with South African Stock market is highest and it is significant with others. There has been positive correlation but no long run association among the Nifty and rest of the Stock exchanges. An unidirectional causality is observed with South African and Chinese stock exchanges whereas bi-directional relationship was found between Indian, Brazil and Russian stock markets implying that development in Brazil, South African and Russian markets are transmitted to the Indian Stock markets and further, the Indian Stock market is not found to have any impact on South African market even though correlation between the two were found highest as compared to other BRICS indices. The impulse response function has revealed that in the short

run the shocks do have impact on the Indian stock market. The results of Granger Causality have been confirmed by Variance Decomposition Analysis. The VDA analysis has clearly pointed out that the Indian Stock market has been taking the most dominant role in influencing the other BRICS stock markets more than others. The results and the outcomes may be used to make analysis for better investment and speculative purposes. Benefits can be derived from diversifying portfolio by investing funds in BRICS markets and it can be concluded that the BRICS stock market are one of the favorable destination for global investors as well as Foreign Institutional Investors.

8. Policy Implications

The findings suggest that there is short run relationship among the Indian stock indices and rest of the BRICS stock indices and there is no long run co-integration among the Indian stock market and emerging BRICS economies. The Granger Causality test shows that majority of BRICS stock markets have two way causality. They affect BRICS emerging economies stock markets and simultaneously are affected by movement in fellow emerging economies stock markets. It implies that investing in BRICS stock markets having two way linkages will make both the markets equally sensitive to certain macroeconomic parameters at global level. The findings of co-integration test support no long run association between the Nifty and other indices of BRICS stock markets. It suggests that there is no specific trend or movement in the long run. Therefore a strategy of international diversification by the portfolio manager will not cover the risk of international investors in the long run. There are ample opportunities for the investors to broaden the horizons of their investments not only in Indian equity market but also in selected BRICS stock markets to reap the benefits of such diversification with risk reduction. The BRICS nations may have little worries in respect to the market crash in this region as there remain very less co-integration among the BRICS stock markets in the long run but there will be a visible impact in the short run if any of the market crashes.

9. Limitations of the Study

This study is based on secondary data collected from the various sources mentioned earlier. Thus, the conclusion drawn can be more meaningful if high frequency data is used. The study confines to BRICS stock markets. All these are emerging markets and are highly influenced by capital floated by FIIs. Similarly other common factors influencing all BRICS stock markets can be impacted by other stronger stock market in the world economy like US, London or Tokyo stock market. Therefore a further study of the examination of co-movement in BRICS stock markets along with leading stock markets of the world can be helpful for future prediction. Simultaneously application of a model detecting vector error popularly known as VECM (Vector Error Correction Model) can be included to the findings of co-integration.

10. Scope for Further Research

The future studies can focus on the impact of Foreign Institutional Investments and Foreign Direct Investment on the market returns of BRICS stock indices individually. Another interesting area of future research could be impact of macro-economic variables like Gold price, Crude oil, Foreign exchange rate and GDP on stock index of emerging economies. The result of the study are subjected to the measure of stock index returns only but there are other factors like stock index turnover , stock index volume and stock index volatility which can also be studied. The future studies can focus on the other variables relating to the regional competency of the BRICS nations as well as equivalent to the home countries of the foreign investors.

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