LINKAGES AMONG STOCK MARKETS: BRICS COUNTRIES

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ABSTRACT
The purpose of the study is to look into the short-run and long-run relationships between Indian stock market (Nifty) and stock indices of BRICS countries. Monthly closing stock market indices of India (Nifty) and that of the Brazil (IBOVESPA), Russia (RTSIndex), China (SSE Composite) and South Africa (FTSE) for the period of April, 2009 to March, 2014 are taken as sample.

The study is tested with Cross correlation, Unit root test, Granger causality test and Johansen cointegration test to seek the relationship, stationarity, directional causality and either short or long run equilibrium between the Nifty and the selected indices of BRICS stock markets. The result obtained by the econometric tools shows that the correlation between the Nifty and the other selected indices is significant, the data are stationary at their level and its first difference (ADF and PP), both unidirectional and bidirectional causality occurs and the long term relationship is found between Nifty and selected indices.

Key Words: Stock Indices, BRICS, Cointegration, Causality

INTRODUCTION
The globalization of the world stock markets is the most noteworthy development that has occurred during the last decade. Various factors contributed to this including: the advancement of technology and remote access which have been utilized in security trading, the emergence of new international financial institutions offering financial services regardless of geographical jurisdictions, trends of liberalization and the removal of restrictions used to be imposed on foreign ownership, and the movement towards regional integration of that stock exchanges, clearing and settlements organizations, and other financial institutions.

Along with various measures, opening up of the home market for the foreign investors is one of the important steps taken by the Indian Government that may lead the Indian stock market to be strongly integrated with the stock market of the rest of the world.

The globalization phenomenon may be blessing, since many experts believe that globalization may improve market efficiency, lower its risk due to the possibility of diversification, and use arbitrage in a relevant way. On the other hand, it may increase pricing volatility and trading instability, due to the high correlation between leading - major- stock markets (BRICS) and other markets as well as to the fact that the irrational trading in one market may move to other markets as witnessed in the last two decades.
IMPORTANCE OF BRICS NATIONS

In the past few decades, some large economies such as Brazil, Russia, India and China, (BRICs) have acquired a vital role in the world economy as producers of goods and services, receivers of capital, and as potential consumer markets. The BRICs economies have been identified as some of the fastest growing countries and the engines of the global recovery process, which underscores the changed role of these economies. Even in the G-20 countries’ forum, BRICs are playing a formidable role in shaping the macroeconomic policy after the recent financial crisis. At present, these four countries encompass over 40 per cent of the global population and a share in world GDP (in PPP terms) that increased from 16 per cent in 2000 to nearly 27 per cent in 2011, and is expected to rise significantly in the near future. If one compares the GDP in PPP terms for 2011, four economies figure among the G-20 top ten, with China, India, Russia and Brazil in 2nd, 4th, 6th and 8th place respectively. In terms of contribution to growth of PPP-adjusted global GDP of the world, these four economies accounted for 55 per cent during 2000–11, and their contribution is expected to rise in the coming years.

According to an estimate by Goldman Sachs, the four original BRICs countries are expected to represent 47 per cent of global GDP by 2050, which would dramatically change the list of the world’s 10 largest economies. An important change that we may expect over the medium to long term is that the top 10 countries in terms of GDP may be different from the top 10 countries in terms of per capita GDP. The inherent strength of the BRICs emanates from strong domestic demand-based economies in the case of India and Brazil and the significant outward linkages of China and Russia.

LITERATURE REVIEW

Bailey & Stulz (1990) applied simple correlation technique to find interrelationship among US and Pacific basin stock market and found that the correlation differed in terms of daily, weekly and monthly time series data.

Arshanapalli & Doukas (1996) applied Johansen cointegration technique on daily data belonging to different Asian markets and found that there was no long term relationship among the Asian stock market.

Ghosh (1999) in contrary to Arshanapalli & Doukas (1996) found that some of the Asian market showed a long run equilibrium relationship with the world’s major stock market.

Floros (2005) found a long term relationship among the stock prices of US, Japan and UK. He also observed that through Granger causality test some of the stock indices have shown bidirectional effect and some other showed unidirectional effect.

Amanulla & Kamaiah (1995) examined the long run equilibrium between the RBI stock price indices of Bombay, Calcutta, Madras, Delhi and Ahmedbad. They found that there existed long run equilibrium.

Nath & Verma (2003) tested the cointegration between India and other selected countries with daily price indices and found that no cointegration
Linkages Among Stock Markets: BRICS Countries

existed among India, Taiwan and Singapore for the period January 1994 to November 2002. Jayanthi & Pandiyan (2008) tested the cointegration between the stock price indices of India, Malaysia, Taiwan, China, South Korea, US, UK, Germany, Singapore, Hong Kong and Japan. The study period was from April 2000 to March 2007 and they found that no correlation and cointegration among the selected stock price indices.

Chakravarty & Ghosh (2011) made an attempt to find the relationship among the indices of Sensex 30, S&P 100 and FTSE 100 through Granger causality test and found that unidirectional causality occurred for S&P 100 and FTSE 100 from Sensex.

Sen (2011) made an attempt to investigate the relationship between Sensex and some selected Stock Price Indices of the Asia Pacific region and found that the correlation among the selected Stock Price Indices were highly correlated and significant. Granger causality test revealed the unidirectional effect from the Asian tigers to Sensex and Johansen cointegration test clearly showed that there existed a long run relationship between sensex and stock indices of the major Asian Pacific countries.

It is worth mentioning that the present study is carried out as an extension of the study of Sen (2011) with the time interval from January 2000 to June 2013 to find out the relationship among the selected market indices in amid strident recessionary trends.

OBJECTIVES OF THE STUDY

1. To test the stationarity of the BRICS Stock Market Indices
2. To examine directional effect among the BRICS Stock indices
3. To understand the effect of Long term relationship among the BRICS market.

METHODOLOGY

This study is conducted in an empirical format by using secondary data gathered from monthly stock market indices of India (Sensex) and that of the Brazil (IBOVESPA), Russia (RTS Index), China (SSE Composite) and South Africa (FTSE).

DATA

Monthly time series data of the above-mentioned indices have been used for the purpose of empirical investigation covering the study period from April, 2009 to March 2014. The data for these indices were collected from the website www.Finance-yahoo.com.

The following standard statistical and economic tools have been applied for empirical investigation.

- Cross Correlation,
- Unit root test,
- Granger causality test, and
- Johansen cointegration test.
Cross-Correlation
Cross-Correlation is a useful statistical tool to measure the co movement of variables and the lead-lag relationship between them.

Using the following formula, pair-wise cross-correlations between Sensex and other prices indices have been computed

\[ r = \frac{\sum (x_i - \bar{x})(y_{i-d} - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2} \sqrt{\sum (y_{i-d} - \bar{y})^2}} \]  
\[ (A1) \]

Where \( r \) is greater than, equal or less than zero.

From the cross-correlations, it would be clear whether Nifty is correlated to other selected stock price indices in different times (monthly) lags.

Unit Root Test
Before using the time series data for further investigation, all the time series data must be tested for stationarity. Mean, Variance and covariance of such stationary time series data do not change with the time shift. If the data is non-stationary, then regression results using such data would be spurious, as the usual t test would not be applicable to test the significance of coefficients.

To test the stationarity, the unit root test has been applied on the time series index data. In this, regard, the Phillips-Perron unit root test has been preferred against ADF test, as the latter is considered the low power test. In Phillips-Persson test, non-parametric statistical methods are used to take care of the serial correlation in the error term(\( \mu_t \)) of the following equation.

\[ \nabla Y_t = \nabla Y_{t-1} + \mu_t \]

The test is based on the null hypothesis \( H_0: Y_t \) is not \( I(0) \). If the computed PP statistics are less that the critical value, the \( Y_t \) is non-stationary.

Granger Causality Test
Granger causality test has carried out to observe the direction of the short-run relationship between the sensex and other indices. To test for Granger causality between two stock price indices \( Y_t \) and \( X_t \), the following two equations have been estimated.

\[ Y_t = \sum_{i=1}^{m} \alpha_i Y_{t-i} + \sum_{i=t}^{m} \beta_i X_{t-i} + i_t \]
\[ X_t = \sum_{i=1}^{m} \gamma_i Y_{t-i} + \sum_{i=1}^{m} \delta_i X_{t-i} + e_t \]
Where \( Y_t \) and \( X_t \) are the first difference of time series variable. Therefore, F-test has been conducted for joint insignificance of the coefficients. The null hypothesis of such test \( Y_t \) does not Granger cause \( X_t \) and vice versa. A rejection of the null hypothesis indicates the existence of Granger causality; for each of the stock indices, two Granger causality tests have been performed to investigate whether \( Y \) Granger causes \( X \) or \( X \) Granger causes \( Y \) or both or there is no causal relationship between the variables.

**Johansen cointegration test**

The condition for testing Johansen cointegration test for anytime series data is that the data should be non stationary at their level i.e. the natural logarithm of time series data should be non stationary and the first difference in the data should be stationary. If the return indices of different markets are correlated, the value may raise or fall. On the other hand, if the time series data are cointegreted, then the series in the long run will come to equilibrium point.

**EMPIRICAL RESULTS AND ANALYSIS**

**Descriptive statistics results**

Figure 1 to 5 revealed that the variables considered in the scope of the analysis are examined, the average values of variables were found to be Nifty (0.011316), BOVESPA (0.001169), SSE (-0.0028), RTSINDEX (0.0065) and FTSE (0.0142), standard deviation values are found to be Nifty (0.06075), BOVESPA (0.054), SSE (0.068), RTSINDEX (0.0882) and FTSE (0.038). When average values of the variables are considered in terms of the case that data do not have normal distribution and that variables are not distributed normally in full, but are distributed very close to normal distribution as the median values of variables are very close to average values.

Regarding whether series are distributed normally or not; skewness, kurtosis and Jarque-Bera statistics were considered. If kurtosis value of relevant variables is bigger than three, it indicates that series is sharp, if it is smaller than three, it indicates that series is oblate. In consideration of skewness values, if skewness value is equal to zero, it indicates that series has normal distribution, if the skewness value is bigger than zero; it means that series is skew in the positive direction, if skewness value is smaller than zero; it indicates that series is skew in negative direction.

Following values were found: skewness value of Nifty variable 0.8622), kurtosis value (5.32), Jarque-Bera value (20.95), skewness value of BOVESPA (0.142), kurtosis value (2.831), Jarque-Bera value (0.27), skewness value of SSE(-0.5356), kurtosis value (4.5619), Jarque-Bera value (8.968), skewness value of RTSINDEX(-0.2595), kurtosis value (4.5022), Jarque-Bera value (6.3152) and skewness value of FTSE(0.2547), kurtosis value (2.488), Jarque-Bera value (1.303).
It has been found that Nifty variable is skew (inclined) and sharp in the positive direction, BOVESPA variable is skew (inclined) and oblate in positive direction and SSE variable is skew (inclined) and sharp in negative direction, RTSINDEX variable is skew (inclined) and sharp in negative direction and FTSE variable is skew (inclined) and oblate in positive direction.

Figure: 1

Figure: 2

Figure: 3
Linkages Among Stock Markets: BRICS Countries

Figure: 4

Series: RTSINDEX
Sample 1 61
Observations 60

Mean 0.006503
Median 0.009242
Maximum 0.266842
Minimum -0.249303
Std. Dev. 0.088165
Skewness -0.259505
Kurtosis 4.502245
Jarque-Bera 6.315281
Probability 0.042526

Figure: 5

Series: FTSE
Sample 1 61
Observations 60

Mean 0.014211
Median 0.015858
Maximum 0.097900
Minimum -0.059785
Std. Dev. 0.038195
Skewness 0.254723
Kurtosis 2.488402
Jarque-Bera 1.303167
Probability 0.521220

Table 1: Unit Root Statistics

<table>
<thead>
<tr>
<th>Country</th>
<th>Augmented Dickey-Fuller test statistic</th>
<th>Order of integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>1st Difference</td>
</tr>
<tr>
<td>Brazil</td>
<td>-3.6897</td>
<td>-5.1982</td>
</tr>
<tr>
<td>Russia</td>
<td>-3.0949</td>
<td>-5.1411</td>
</tr>
<tr>
<td>India (Nifty)</td>
<td>-3.9177</td>
<td>-6.1017</td>
</tr>
<tr>
<td>China</td>
<td>-3.4205</td>
<td>-4.8305</td>
</tr>
<tr>
<td>South Africa</td>
<td>-3.6552</td>
<td>-4.8777</td>
</tr>
</tbody>
</table>

Note: ADF Test critical values: 5% level-2.88.
Source: Computed Data
Table 2: Unit Root Statistics

<table>
<thead>
<tr>
<th>Country</th>
<th>Phillips-Perron test statistic</th>
<th>Order of integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>1st Difference</td>
</tr>
<tr>
<td>Brazil</td>
<td>-7.0434</td>
<td>-21.2432</td>
</tr>
<tr>
<td>Russia</td>
<td>-7.9918</td>
<td>-23.4722</td>
</tr>
<tr>
<td>India (Nifty)</td>
<td>-9.0819</td>
<td>-23.0056</td>
</tr>
<tr>
<td>China</td>
<td>-8.9224</td>
<td>-24.7345</td>
</tr>
<tr>
<td>South Africa</td>
<td>-11.083</td>
<td>-36.5119</td>
</tr>
</tbody>
</table>

Note: PP Test critical values: 5 % level -2.88
Source: Computed Data

Table 3: Unit Root Statistics

<table>
<thead>
<tr>
<th>Country</th>
<th>Kwiatkowski-Phillips-Schmidt-Shin test statistic</th>
<th>Order of integration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>1st Difference</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.3491</td>
<td>0.1067</td>
</tr>
<tr>
<td>Russia</td>
<td>0.4373</td>
<td>0.07307</td>
</tr>
<tr>
<td>India (Nifty)</td>
<td>0.2251</td>
<td>0.10202</td>
</tr>
<tr>
<td>China</td>
<td>0.1957</td>
<td>0.07949</td>
</tr>
<tr>
<td>South Africa</td>
<td>0.1654</td>
<td>0.08274</td>
</tr>
</tbody>
</table>

Note: KPSS Asymptotic critical values: 5% level 0.46, 10% level 0.34.
Source: Computed Data

The BRICS stock market indices are tested with both ADF and PP test and it is shown in the Table 1 and Table 2. The results obtained by both the tests to seek for stationarity revealed that all time series data are stationary at their level and also attained stationarity after first differencing. Therefore, all time series data achieved stationarity at their level and first differenced.

Table 3 revealed that the KPSS results obtained that all time series data are non stationary at their level and after first differencing.
The pair-wise cross correlation coefficient between Nifty and other indices are presented in Table 4. It that there is a positive correlation between the Nifty and other selected indices at 1% level of significance.

The pair-wise Granger causality test is shown (Table-5) that no causality exists between

(i) RTSINDEX and BOVESPA  
(ii) NIFTY and BOVESPA  
(iii) BOVESPA and NIFTY  
(iv) SSE and BOVESPA  
(v) BOVESPA and SSE  
(vi) FTSE and BOVESPA  
(vii) BOVESPA and FTSE  
(viii) NIFTY and RTSINDEX  
(ix) RTSINDEX and NIFTY  
(x) SSE and RTSINDEX  
(xi) RTSINDEX and SSE  
(xii) FTSE and RTSINDEX  
(xiii) RTSINDEX and FTSE  
(xiv) SSE and NIFTY  
(xv) FTSE and NIFTY  
(xvi) NIFTY and FTSE and  
(xvii) SSE and FTSE.

The only bidirectional causality exists between

(i) BOVESPA and RTSINDEX  
(ii) NIFTY and SSE  
(iii) FTSE and SSE.

It is important to note that the pronouncement of causality between the selected variables does not mean that movement in one variable actually causes movements in another variable. To a certain extent, causality basically entails in order of movements in the time series.
Table 5: Granger Causality Test-Results

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>F-Stat.</th>
<th>P-Value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTSINDEX does not Granger Cause BOVESPA</td>
<td>2.08192</td>
<td>0.1348</td>
<td>No Causality</td>
</tr>
<tr>
<td>BOVESPA does not Granger Cause RTSINDEX</td>
<td>3.47199</td>
<td>0.0383</td>
<td>Bi-directional</td>
</tr>
<tr>
<td>NIFTY does not Granger Cause BOVESPA</td>
<td>19.4874</td>
<td>5.00E-07</td>
<td>No Causality</td>
</tr>
<tr>
<td>BOVESPA does not Granger Cause NIFTY</td>
<td>2.71817</td>
<td>0.0754</td>
<td>No Causality</td>
</tr>
<tr>
<td>SSE does not Granger Cause BOVESPA</td>
<td>1.54488</td>
<td>0.2228</td>
<td>No Causality</td>
</tr>
<tr>
<td>BOVESPA does not Granger Cause SSE</td>
<td>2.36276</td>
<td>0.104</td>
<td>No Causality</td>
</tr>
<tr>
<td>FTSE does not Granger Cause BOVESPA</td>
<td>26.1302</td>
<td>1.00E-08</td>
<td>No Causality</td>
</tr>
<tr>
<td>BOVESPA does not Granger Cause FTSE</td>
<td>0.05678</td>
<td>0.9449</td>
<td>No Causality</td>
</tr>
<tr>
<td>NIFTY does not Granger Cause RTSINDEX</td>
<td>14.5548</td>
<td>1.00E-05</td>
<td>No Causality</td>
</tr>
<tr>
<td>RTSINDEX does not Granger Cause NIFTY</td>
<td>1.84631</td>
<td>0.168</td>
<td>No Causality</td>
</tr>
<tr>
<td>SSE does not Granger Cause RTSINDEX</td>
<td>0.06349</td>
<td>0.9386</td>
<td>No Causality</td>
</tr>
<tr>
<td>RTSINDEX does not Granger Cause NIFTY</td>
<td>3.09227</td>
<td>0.0537</td>
<td>No Causality</td>
</tr>
<tr>
<td>FTSE does not Granger Cause NIFTY</td>
<td>17.6885</td>
<td>1.00E-06</td>
<td>No Causality</td>
</tr>
<tr>
<td>FTSE does not Granger Cause NIFTY</td>
<td>1.64957</td>
<td>0.2018</td>
<td>No Causality</td>
</tr>
<tr>
<td>SSE does not Granger Cause FTSE</td>
<td>8.39016</td>
<td>0.0007</td>
<td>Bi-directional</td>
</tr>
<tr>
<td>SSE does not Granger Cause FTSE</td>
<td>0.41982</td>
<td>0.6594</td>
<td>No Causality</td>
</tr>
</tbody>
</table>

The result obtained in the table 6 through Johansen cointegration test revealed that trace statistics is significant at 5% level in cases and it leads to conclude that there is long run equilibrium between the Nifty and other selected indices of the stock market. Therefore, this suggests that there will belong run relationship among the BRICS economics.

Table 6: Johansen Cointegration Test Results (Lags Interval: 1 to 4)

<table>
<thead>
<tr>
<th>Hypothesized</th>
<th>Trace 0.05</th>
<th>0.05</th>
<th>Prob.**</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of CE(s)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None *</td>
<td>0.508015</td>
<td>119.8398</td>
<td>69.81889</td>
</tr>
<tr>
<td>At most 1 *</td>
<td>0.383041</td>
<td>80.11860</td>
<td>47.85613</td>
</tr>
<tr>
<td>At most 2 *</td>
<td>0.341966</td>
<td>53.07321</td>
<td>29.79707</td>
</tr>
<tr>
<td>At most 3 *</td>
<td>0.260582</td>
<td>29.63730</td>
<td>15.49471</td>
</tr>
<tr>
<td>At most 4 *</td>
<td>0.203355</td>
<td>12.73137</td>
<td>3.841466</td>
</tr>
</tbody>
</table>

Note: Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-value
Linkages Among Stock Markets: BRICS Countries

CONCLUSION
The study revealed certain facts that there is positive correlation between Nifty and other selected indices (BRCS) during the study period April, 2009 to March 2014. Further it is worth noted that both unidirectional and bidirectional causality effect took place among the selected indices. The result obtained through cointegration test proved that long run equilibrium exists between the Nifty and other selected market indices. Due to this cointegration prices indifferent markets cannot move away far from each other and therefore the investor community cannot get abnormal gain due to the price differences among the markets.

REFERENCES