Correlation and Co-integration of BRIC Countries' Stock Markets

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ABSTRACT

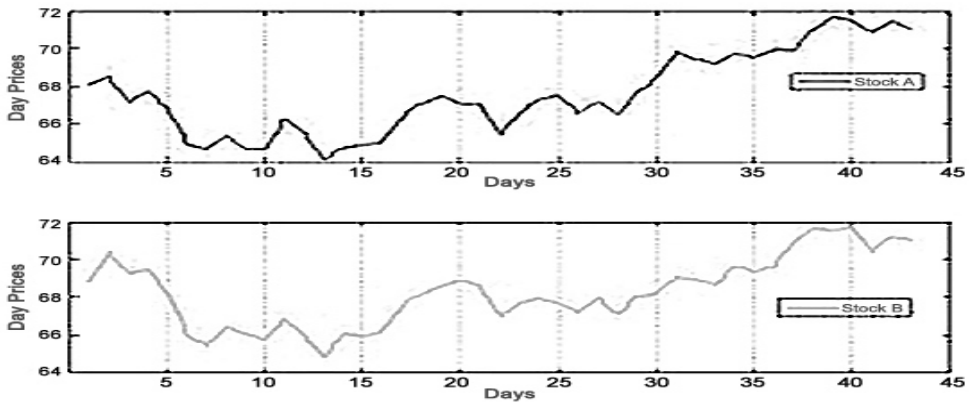
The relationship between the stock markets of developed countries and developing countries has been examined extensively in literature. However, stock markets of BRIC (Brazil, Russia, India and China) countries have received little attention separately despite the rapid growth and liberalization among these countries. So, the present study examines the relationship and co-integration of stock prices of BRIC countries' stock markets. To investigate the relationships, the researcher examined the stock indices of BRIC countries and employed the daily closing price data (all converted in to Indian Rupees) in two different phases. The first phase was from April 2002 to March 2007 (Pre-crisis period); the second phase was from April 2007 to March 2012 (Crisis Period). However, the crisis period was actually till 2010, but to have an equal observation, the study used five years' data. Stock price linkages were examined through Correlation analysis and the Engel Granger co-integration test was also used to study the long term equilibrium relationships. The results revealed that the Indian market has a strong positive correlation with Brazil and Russia, and further, India has a long term equilibrium relationship with China and Russia, which means that Investors have no diversification opportunity in these countries. Furthermore, the Indian market had no long term equilibrium relationship with Brazil, so the Indian investors have an opportunity to earn more in the Brazilian stock market.

Keywords: BRICs Stock Markets, Stationary and Non - stationary, Correlation and Co-integration
JEL Classification : C58

INTRODUCTION

Financial markets have dramatically accelerated during the last decades in terms of global business. Further liberalization and deregulation of stock markets across countries has lead to increasing co-movements of financial assets. This process requires investors - who possess the stocks of some countries - to bear the risk attributed to political and economic environment of that state to rebalance their portfolios. However, due to the enormous increase of integration of the stock markets, the possibility to diversify internationally has decreased substantially. Researchers have tried to deal with the problem by analyzing the possibility of diversification opportunities across emerging markets of BRIC countries through correlation and co-integration analysis. BRIC countries are developing quickly, and offer high return potential for investors. Now, let us understand the correlation and co-integration from the

Figure 1 : Correlation Between Stock A and Stock B



Source : Ernest P. Chan (November 6, 2006). "Cointegration is not the same as correlation." http://epchan.com/downloads/cointegration.pdf accessed on February 10, 2013.

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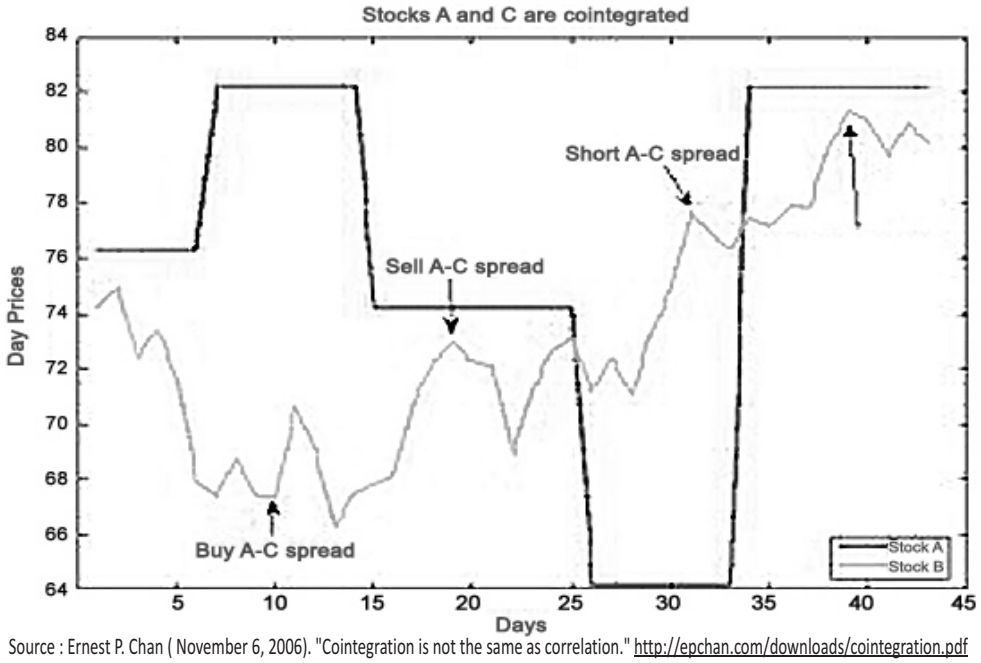
Figure 2 : Cointegration Between Stock A and B



Source : Ernest P. Chan (November 6, 2006). "Cointegration is not the same as correlation." http://epchan.com/downloads/cointegration.pdf accessed on February 10, 2013.

hypothetical graphs. The Figure 1 clearly indicates that Stock A and Stock B are correlated. Their prices move in the same direction almost every day. However, as can be inferred from the Figure 2, Stock A clearly doesn't move in any correlated fashion with Stock B. Some days, they move in the same direction, on the other days, they move in the opposite direction. On most days, Stock A doesn't move at all. It is to be noticed that the spread in stock prices between A and B always returns to about unit after a while. This is a sign of co-integration between A and B. In short, the two price series cannot wander off in opposite directions for very long without coming back to a mean distance eventually. However, it doesn't mean that on a daily basis, the two prices have to move in synchrony at all (Chan, 2006, para 2 and 3).

LITERATURE REVIEW

It was found that a few studies have analyzed the cointegration of BRIC countries' stock markets. Thus, further literature is extended towards the cointegration methodology to identify the international diversification opportunity with special reference to BRIC countries. Guha and Oak's (2005) paper titled "International Financial Markets Integration: A Case Study Approach on Equity Market" attempted to identify the interdependence of world's major stock markets. They found that the equity markets of India and Hong Kong are cointegrated with each other's markets, where as the markets of USA and UK are not. Further research was conducted by Singh and Sharma (2008) on "Inter-linkages between Stock Exchanges: A Study of BRIC Nations." The results revealed that there are visible effects of stock exchanges on each other. The Russian, Indian and Brazilian stocks exchanges affect each other; however, none of these stock markets affected the Chinese stock exchange. Further, Reddy's (2009) paper "Global Stock Markets Development and Integration: With Special Reference to BRIC Countries" revealed that a cointegrating relationship was found between BRIC countries and developed countries. Furthermore, it implies that these markets share the forces of short-run adjustment to long run equilibrium.

However, most of this research idea was taken from the thesis by Balarezo (2010) on international diversification using cointegration and modern portfolio theory. Balarezo argued that investors looking to diversify internationally need to be very selective with reference to the countries they invest into, since international diversification will benefit the investor only in the cases that the home country does not cointegrate with the foreign market. The study also concluded that the researcher did not find any indication that BRIC countries share a long run equilibrium relationship,

which is excellent news for investors, as they could invest in any or all of these markets and reap the benefits of being exposed to these emerging economies while being fully diversified. An and Brown (2010) examined the co-movement and indicated that there is some cointegration between the stock markets of United States and China, while there is no cointegration between the US and other emerging markets by themselves. Therefore, all of the BRIC stock markets, with the exception of China, provide attractive portfolio diversification opportunities for global investors.

Further, Hellstrand and Korobova (2010) studied the cointegration and causality in international stock markets. By using the Augmented Engle-Granger test for Cointegration, it was found that there is more cointegration in the Oil & Gas sector as compared to the Financials sector, and that for both the sectors, there was less cointegration during the recent financial crisis.

Further research idea regarding the phase wise study was drawn from the research conducted by Fahami (2011) on the structure of linkages and causal relationships between BRICs and developed equity markets. He examined the structure of linkages and causal relationship between the world's fastest emerging BRIC economies and other developed countries. The period of study under analysis was in three different samples as the pre-crisis period, the crisis period and the post crisis period. The results showed that all the stock markets under study were cointegrated in the pre-crisis, during crisis and post -crisis period. In Sheu and Liao's (2011) study "Dynamics of stock market integration between the US and the BRICs", the empirical results demonstrated that the stock markets of Brazil, Russia and China have begun exerting significant influences on the Dow Jones, to some extent, after 2006.

Jeyanthi (2012) in the study "Are the BRIC Equity Markets More Interdependent after the Global Financial Crisis?" used the daily closing price of all stock indices in three different phases as the pre and post crisis phase, and overall from 2000 to 2010. No evidence of long - run relationships was found between the stock prices indices of BRIC partners before and after the financial crisis, with the exception of Brazil. After the global financial crisis, there was no cointegration between India and Brazil.

Vanitha, Srinivasan and Karpagam (n.d.) attempted to analyze the integration between different BRIC countries and developed countries. The test results revealed that the returns of the BRIC Countries were higher during the period, which gives a better option for investment by consistent returns. Further, they concluded that investing in the BRIC countries will be beneficial in the long run.

OBJECTIVES OF THE STUDY AND SOURCES OF DATA

The present study examines correlation and cointegration of the Indian stock market with other members of BRIC countries (Brazil, Russia and China) through Correlation Analysis and residual based Engel Granger Co-integration Test and also studies the pattern of returns (descriptive statistics) of each selected indices. However, selected indices for each country are BOVESPA - Brazilian market, RTS - Russian Trading System, SSE - Shanghai Stock Exchange for China and BSE - Bombay Stock Exchange for the Indian market. The sample is divided into two broad categories as Phase I (April 1, 2002 to March 31, 2007 – Pre crisis period), Phase II (April 1, 2007 to March 31, 2012 – Crisis period). Some adjustments were made in the daily data because of different holidays in the stock markets of different countries. However, it is to be noted that the crisis period was mentioned in many literatures till 2010, but to have an equal observation, this study considered five years' data till March 31, 2012 as the crisis period. The necessary daily closing price data and exchange rates were sourced from yahoo finance and oanda.com respectively and were converted into local currency (In Rupees).

METHODOLOGY

To satisfy the objectives of the study, various time series econometrics models were applied to study the long term equilibrium relationship between India and other BRIC nations. The whole analysis was carried out in EVIEWS 6. The following are some of the tools used for the analysis of the study :

a) Descriptive Statistical Analysis

b) Correlation Analysis

c) Engel Granger Co-integration Test

Descriptive statistical analysis and correlation are well known to everybody. The first step in the co-integration technique is to check whether the series considered are stationary or not at the level, and if it is non-stationary, then the

next step is to find out the order in which they are integrated. Augmented Dickey Fuller (ADF) test is widely used in literature, so the present study also revealed the ADF test statistics. However, a series is said to be stationary if the mean and auto-covariance of the series do not depend on time. While performing the ADF test, we proceed by considering the three equations :

$\Delta Y_t = \gamma Y_{t-1} + \varepsilon_t$ **(Pure Random Walk Model)..... (1)**

$\Delta Y_t = a_o + \gamma Y_{t-1} + \varepsilon_t$ **(An Intercept indicating the presence of drift)..... (2)**

$\Delta Y_t = a_o + \gamma Y_{t-1} + a_2 t + \varepsilon$ **(Drift and a linear time trend)..... (3)**

The researcher tests the null hypothesis Ho: $\gamma = 0$ i.e. presence of unit roots for each of these equations. The test statistics against the critical values are checked, the null hypothesis is accepted or rejected if the t-statistics is greater or less than the critical value respectively. Once the researcher obtained the order of integration using the ADF test, he proceeded with the method of co-integration to test the presence of co-movement between the different stock market indices.

The fundamental aim of cointegration analysis is to detect any common stochastic trends in the price data, and to use these common trends for a dynamic analysis of the correlation in return. In the analysis, the researcher used the Engle-Granger Testing Procedure for testing the presence of cointegration among the stock prices. So, for co-integration testing, the researcher again analyzed the need to check for stationarity for the obtained residuals. To test the stationarity of the residuals, the researcher again applied the ADF test. The parameter of interest is a_1. If the null hypothesis cannot be rejected at $a_1=0$, the researcher concludes that the residual series has unit roots. In other words, if it is not possible to reject the null hypothesis $a_1=0$, we cannot reject the hypothesis that the variables are not co-integrated.

EMPIRICAL RESULTS

Table 1 : Descriptive Statistics for Daily Stock Return

April 1, 2002 to March 30, 2007 (Phase I - Pre Crisis Period)							
Country	**Mean**	**Maximum**	**Minimum**	**S.D.**	**Skewness**	**Kurtosis**	**Observation**
Brazil	0.127391	12.20732	-9.293189	2.248392	-0.104865	4.969989	1242
Russia	0.161832	10.00464	-10.07392	1.794958	-0.598943	6.766846	1242
China	0.054329	8.086388	-8.728477	1.317113	0.231233	6.760699	1242
India	0.115442	8.254091	-11.13855	1.361209	-0.57157	9.281071	1242
April 1, 2007 to March 30, 2012 (Phase II - Crisis Period)							
Country	**Mean**	**Maximum**	**Minimum**	**S.D.**	**Skewness**	**Kurtosis**	**Observation**
Brazil	0.079677	14.76277	-12.10773	2.412713	0.009181	7.463937	1233
Russia	0.044961	17.33933	-10.95644	1.893347	0.482052	10.82776	1233
China	0.033753	23.47894	-20.25538	2.831623	0.080772	12.11927	1233
India	0.023734	11.55253	-7.914793	2.087615	-0.088069	5.231198	1233
Source: E - Views Output							

The Table 1 presents that in the first phase, Russia showed the highest average daily return across all markets, i.e. 0.16% followed by Brazil (0.12%), and the lowest return was reported by China (0.05%). The volatility among the four markets was measured by the standard deviation of returns, and Brazil was found to be a highly volatile market followed by Russia and the lowest volatility was found in the Chinese market. So, it can be said that the markets giving high returns entailed a high risk as well. In the second phase, all the studied countries reported lower return as compared to the before crisis periods. However, Brazil reported higher returns i.e. 0.08% followed by Russia i.e. 0.04%, while the Indian market reported the lowest returns i.e. 0.02% in the crisis period. On the contrary, China, Brazil and India were highly volatile as compared to Russia in the crisis period. Skewness and kurtosis are the measure of the underlying statistical distribution of stock returns. It is evident that skewness was negative in all markets except

China, that shows left skewness in before crisis periods, while all markets except India show right skewness in crisis periods. Further, kurtosis statistic for all stock exchanges are higher than 3 in both the studied phases. Hence, it can be inferred that distributions are peaked (leptokurtic) relative to the normal distributions.

Table 2: Correlation of BRIC Indices Stock Prices

Phase I				
Country	**Brazil**	**India**	**Russia**	**China**
Brazil	-	0.986619	0.96783	0.423017
India	0.986619	-	0.976533	0.47152
Russia	0.96783	0.976533	-	0.562404
China	0.423017	0.47152	0.562404	-
Phase II				
Country	**Brazil**	**India**	**Russia**	**China**
Brazil	-	0.819915	0.449838	0.151953
India	0.819915	-	0.569853	0.488631
Russia	0.449838	0.569853	-	0.610093
China	0.151953	0.488631	0.610093	-

Source: E - Views Output.

❖ **Results from Correlation Analysis:** From the Table 2, it is very clear that in the first phase, the Indian market is highly correlated with Brazil and Russia (with the correlation values 0.98 and 0.97 respectively), while the lowest correlation was found with China, i.e. with a correlation of 0.47. In the second phase, India is again highly correlated with Brazil (0.81), and low correlation was found with the Chinese market (0.49). So, it suggests that Indian investors would have benefitted by investing in the Chinese market for a short term because in both the phases, lower correlation was observed in case of China as compared to Brazil and Russia.

❖ **Ho: Unit Root exists (Non Stationary Data) ;**

❖ **Ha: Unit Root does not exist (Stationary Data).**

Table 3 : ADF Unit Root Test Statistics

Levels				
Country	**Phase I**		**Phase II**	
	Test Stat	**Prob.**	**Test Stat**	**Prob.**
Brazil	-2.90301	0.1618	-2.14358	0.5203
Russia	-1.19127	0.911	-1.20450	0.9084
India	-2.31604	0.4243	-1.83339	0.6880
China	2.04242	1	-2.36329	0.3988
First Difference				
Country	**Phase I**		**Phase II**	
	Test Stat	**Prob.**	**Test Stat**	**Prob.**
Brazil	-31.5269	0	-35.7393	0
Russia	-32.3928	0	-31.4182	0
India	-32.6079	0	-32.4842	0
China	-36.7303	0	-36.1348	0

Source: E - Views Output.

The critical values for ADF test is -3.41, significant at 5% level.

❖ **Results from Cointegration Analysis:** The Table 3 shows all the market indices are non-stationary because all ADF test statistics are higher than ADF critical value in both phases at a level. On the contrary, all probability values are also greater than 0.05. So,the null hypothesis is not rejected. However, the unit root tests reject the same null hypothesis in the first-differenced form of the series, which indicates that in the first differenced form, all the series are stationary. Therefore, each stock market index is integrated in order one, or I (1). So, the following is the result of residual based Engel Granger test, which strongly demands that all variables must be in the same order.

❖ **The Engel Granger Cointegration Test Results (India as a Dependent Variable) :** Further bivariate Engle-Granger cointegration test was performed on the four series of stock price indices, which are integrated in the same order, i.e. I (1), taking India as a dependent variable to investigate the long term equilibrium relationship between India and other markets. The obtained residuals from each equation were further tested for stationarity. The Table 4 represents the test statistics with the hypotheses.

❖ **Ho: No Cointegration exists between India-Brazil, India-Russia and India-China in both the phases .**

❖ **Ha: Cointegration exists between India-Brazil, India-Russia and India-China in both the phases.**

Table 4 : Test Statistics for Residuals (Engel Granger Test)

Phase I			
Country	**Test Stat for Residual**	**P - Value**	**Result**
India-Brazil	-5.145223	0.0001	Cointegrated
India- Russia	-3.182143	0.0885	Not Cointegrated
India-China	-0.135781	0.9943	Not Cointegrated
	Phase II		
Country	**Test Stat for Residual**	**P - Value**	**Result**
India-Brazil	-3.588665	0.0311	Cointegrated
India- Russia	-2.784595	0.2032	Not Cointegrated
India-China	-2.916556	0.1575	Not Cointegrated

Sources: E - Views Output

The critical values for ADF test is -3.41, significant at 5% level.

From the Table 4, it is very clear that India and Brazil are cointegrated in both the phases. So, there is a long term equilibrium relationship between the Indian and the Brazilian stock market. Furthermore, India is not cointegrated with Russia and China in both the phases, so we can say that India had a long term equilibrium relationship with Brazil only with reference to the BRIC countries.

CONCLUSION

The study examines the correlation and cointegration between the stock prices of BRIC nations. However, investors who sought higher returns, they could go for Russia and Brazil because both these countries gave the highest return in both the examined phases as compared to rest of the two BRIC members. From the correlation analysis, we can conclude that for both the sample periods, the Indian market was highly correlated with Brazil and Russia. Thus, Indian investors had no opportunity of diverting their portfolio in BOVESPA and RTS in the short run; while the Chinese market was less correlated with India, so investors could diversify in SSE for short term periods.

Based on the bivariate cointegration results, the Chinese and the Russian market had no long term equilibrium relationship with the Indian market in both the phases, which is good news for the Indian investors as there was some portfolio diversification opportunity for them in SSE and RTS. Further, there was cointegration between India and Brazil before and after the financial crisis. Thus, based on the bivariate cointegration results, it can be said that there was no diversification opportunity for Indian investors in the Brazilian market.

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