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Study of BRIC countries in the financial turmoil

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Abstract:

This paper analyzes the dynamic relationship among the emerging countries specially BRIC countries in condition of financial turmoil. The time span from the year 2008 till now seemed to be full of financial tantrum – Sub Prime Crisis, US debt Crisis and European debt crisis. This financial ups and down seemed to have embraced BRIC countries as well. In this paper I attempted to quantify the interrelationship between these promising countries. Popular Indices of BRIC countries have taken as the proxy of their Stock market. In this paper I have taken IBOV, RTS Index, S&P Nifty, SCI (Shanghai Composite index) as the proxy for the stock market of BRIC countries respectively. Several statistical tests have been applied in order to study the behavior and dynamics of time series of BRIC countries indices. The period for the study is taken from January 2008 to November 2011 using the daily closing indices. Kurtosis, Skewness and Jarqus-Bera test is done to investigate the normal distribution of time series and it is found them non-normally distributed. Though Unit root test, it is established that all these time series indices are stationary at the level form itself. Granger Causality test is done to find out the causal relationship between the time series of BRIC countries indices.

Keywords: Stock Return, Unit Root Test, Correlation test, Granger Causality

1. Introduction:

Interrelationship and dynamic linkage among the countries has been the most interesting topic of the researchers, policy makers especially after the Asian Crisis1997/98. Global integration is occurring at a rate faster than the eye can see. The world is becoming interconnected culturally, politically, militarily and economically. The current economic crisis has illustrated just how integrated the financial markets truly are. As the world becomes increasingly interconnected financially it's important for policy makers and global investors to understand the relationships that exist between certain economies in order to gain proper diversification and adjust their portfolios accordingly. The impact of U.S. economy on the rest of the world can be measured by the effect of Subprime Crisis originates from the U.S. on the rest of the world. When the US sneeze the rest of the world catches a cold, some might say. U.S. is considered to be the most

influential economy in whole world. Many studies has been done on the interrelation between Us and the rest of world economy but very less study is being done on the interrelationship between the emerging countries themselves. In a lot of ways we are entering into unchartered territory. There is much interest in discovering the relationship among the worlds' fastest emerging economies. **Jim O'Neil** from Goldman Sachs created a BRIC report in 2001 that stated by 2050 the combined economies of Brazil, Russia, India, and China will transcend the combined economies of the current developed countries of the world. Of late world has witnessed the major financial crisis happened in European or American continents which has a reverberated impact on all over the world especially the emerging markets.

Till the 19th century Asiatic economies were considered to be decoupled with the rest of world economic swings. Now the theory of decoupling is replaced by the recoupling as the whole world economies are interconnected with each other credit given to the open economy. This study attempts to find the interrelationship among the emerging countries themselves with the special reference to BRIC countries are these are the most promising emerging markets.

1.1Financial Crisis:

Global financial crisis was brewing for a while but it starts showing its effects in the middle of 2007 and 2008. After six years of exceptional growth, the world economy entered into the period of financial turmoil triggered by the subprime mortgage crisis in 2008. The mess caused by the loose credit policy of US banks engulfed the whole world which leads to downgrade U.S. debt rating from AAA to AA+ by Standards and Poor's. Efforts to streamline the economy of the world faced another setback by sovereign debt crisis which is popularized as Euro Zone crisis. The sovereign debt crisis refers to budget deficit which is caused by insufficient tax revenue, excessive spending, or both in several Mediterranean states including Portugal, Italy, Greece and Spain (PIGS). Theses crisis are considered to be the worst financial crisis often called the Global Recession, Global financial Crisis.

1.2BRIC Countries:

Brazil, China, India, and Russia (BRIC) were collectively one of the strongest economies of the world, with growth rates that were higher than the well established industrial countries of Europe, Japan, and the U.S. For example, between 2002 and 2008, China's economy grew on an average of 10 percent per year. Similarly, India's economy grew by an average of 8 percent per year. But, the recent surging economic crisis has also affected these high flying four economies with potential to derail their phenomenal resurgence in the world economic order.

2. Literature Review:

In general, lack of interdependence is supported the belief that leads to the benefit of international portfolio diversification. According to Markowitz (1952), investors can improve the performance of their portfolios by allocating their investments into different classes of financial securities and industrial sectors that would not move together in the event of valuable new information. Others who extend the domestic CAPM suggest that diversifying internationally enables investors to reach higher efficient frontier than doing so domestically.

In the same vein, many researchers have studied long term and short term relationship among international markets. The co-integration studies done on different markets provide conflicting evidence. With the increased globalization now the emerging countries are not decoupled from the other developed market. The focus of major studies has been on the stock market of developed countries and cointegration of developed and the emerging market.

Numerous studies beginning with Taylor and Tonks (1989), Chowdhry (1997) and Masih & Masih (2001) are among other researchers who have utilized Granger (1969) and Johansen Juselius (1990) techniques to assess international stock market cointegration in their studies. Noted that, majority of the studies focuses on the developed equity markets until recently, the equity markets of emerging economies has aroused remarkable interest among researchers. Examples of these studies are Ibrahim (2005), Yusof and Majid (2006), Majid et. al (2008) and Majid & Kassim (2009). They documented that United State (US) market is the most influential market in leading other equity markets.

Bhar and Nikolova (2009) who explored the level of cointegration of the BRIC with their respective regions and the world in the post-liberalization period has found that India has the highest level of integration on a regional and world level amongst the BRIC countries followed by Brazil, Russia and lastly China. The study also suggested the existence of diversification opportunities for China, given its closed nature of the financial system. Another study on co-movement among selected stock market conducted by Modi et. Al (2010) found that the correlation of BSE (India) with BVSP (Brazil), MXX (Mexico), FTSE100 (UK), DJIA and NASDAQ (US) is low. Therefore, these combinations provide attractive portfolio diversification opportunities for Indian investors.

Chaudhuri (1997) used the Engle-Granger cointegration and Granger causality test to examine the relation among six Latin American countries for the period of 1985 -1993 and found a long run relationship between them. In addition, they found a significant causal relationship in both directions. Chen et al. (2002) examined the relationship between six Latin American countries including Argentina and Brazil, and employed the error correction VAR technique using daily returns from 1995 - 2000 and argued that the diversification benefit in different Latin American markets was limited.

Aloui et. al (2011) who also evaluate on the co-movements between the BRIC markets and the US during the period of the global financial crisis indicate that dependency on the US is higher and more persistent to Brazil-Russia than for China-India. In their study, the author paired Brazil and Russia - countries which are highly dependent on commodity prices and China-India whose economic growth is largely influenced by finished-products export-price level. The authors who utilize copula functions in their study also revealed the high level of dependence persistence for all market pairs during both bullish and bearish markets.

Lien(2010) indicate in his research paper that there is some cointegration between the United States and China, while there is no cointegration between the US and the 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.

3. Data and Methodology:

The present study is directed towards studying the dynamics among the stock market of BRIC countries. For the study purpose I have taken most prominent stock indices of Brazil (IBOVESPA), Russia (RTSI), China (SCI) and India (S&P CNX NIFTY). Daily indices are taken for the research purpose as the high frequency of data is more precise and are better to capture the dynamics among the Indices of BRIC counties. The time span for the study is taken from January 2008 to November 2011. Data consists of daily stock prices of selected indices.

NAME OF COUNTRIES, INDICES AND DATA PERIOD:

Country	Index	Data Period	observations
Brazil	IBOVESPA	2008:1-2011:11	960
India	S&P CNX Nifty	2008:1-2011:11	940
China	Shanghai composite	2008:1-2011:11	940
Russia	RTSI index	2008:1-2011:11	944

Data has been taken from Yahoo finance (www.Finance.yahoo.com)

Daily stock returns have been calculated by taking the natural logarithm of the daily closing price relatives i.e.

$R_t = \ln (I_t/I_{t-1})$

Where R_t and I_t indicates return and Index value respectively at time 't'.

The value so obtained of all the four indices is used to study the interrelationship. Line plots of daily return value of IBOVESPA, RTSI, S&P CNX NIFTY and SCI are shown in figure 1.1, 1.2, 1.3 and 1.4 respectively.

In order to accomplish the objectives of this paper, a group of econometrics approaches are used. Begins with unit root test, the main reason to conduct unit root test is to acquire a meaningful, valid and non-spurious regression. The most popular of these tests is the Augmented Dickey-Fuller (ADF) test. ADF tests use a parametric autoregressive structure to capture serial correlation. In ADF, the null hypothesis is that a series is non-stationary (existence of unit root) whereas rejection of the unit root hypothesis supports stationarity. Correlation test is done to find out the dependency among the BRIC economies with Granger Causality test to decipher the direction of the relationship among BRIC economies.

4. Methodology:

Following methods are used to test the interrelationship among the economies of the BRIC countries and draw the inference about the behavior and dynamics of the time series of BRIC countries.

4.1Normality Test: The Jarque-Bera test (Gujatati2003) is used to test whether stock indices of BRIC countries individually follow the normal probability distribution. The JB test of normality is asymptotic or large –sample test. This test computes the skewness and kurtosis measures and uses the following test statistics:

$JB= n [S^2/6 + (K-3)^2/24\}$

Where n=sample size, S= skewness coefficient, and K= kurtosis coefficient. For a normally distributes variable, S= 0 and K=3. Therefore, the JB test of normality is a test of the joint hypothesis that S and K are 0 and 3 respectively

4.2Unit root analysis (Stationarity test)

Empirical work based on time series data assumes that the underlying time series is stationary. Broadly speaking a data series is said to be stationary if its mean and variance are constant (non-changing) over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed [Gujrati (2003)].A unit root test has been applied to check whether a series is stationary or not. Stationarity condition has been tested using Augmented Dicky Fuller Test(Dickey and Fuller(1979,1981), Gujrati (2003), Enders(1995)).

4.3 Augmented dickey fuller

Augmented Dickey-Fuller (ADF) test has been carried out which is the modified version of Dickey-Fuller (DF) test. ADF makes a parametric correction in the original DF test for higher-order correlation by assuming that the series follows an AR (p) process. The ADF approach controls for higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression. The Augmented Dickey-Fuller test specification used here is as follows:

$\Delta Y_t = b_0 + \Delta Y_{t-1} + \mu 1\ \Delta Y_{t-1} + \mu 2\ \Delta Y_{t-2} + \ldots.. + \mu p\ \Delta Y_{t-p} + et$

Y_t represents time series to be tested, b0 is the intercept term, Δ is the coefficient of interest in the unit root test, μi is the parameter of the augmented lagged first difference of Yt to represent the pth-order autoregressive process, and et is the white noise error term.

4.4Granger Causality:

According to the concept of Granger's causality test (1969, 1988), a time series x_t Granger-causes another time series y_t if series y_t can be predicted with better accuracy by using past values of x_t rather than by not doing so, other information is being identical. If it can be shown, usually through a series of F-tests and considering AIC on lagged values of x_t (and with lagged values of y_t also known), that those x_t values provide statistically significant information about future values of y_t time series then x_t is said to Granger-cause y_t i.e. x_t can be used to forecast y_t . The pre-condition for applying Granger Causality test is to ascertain the stationarity of the variables in the pair. Engle and Granger (1987) show that if two non-stationary variables are co-integrated, a vector auto-regression in the first differences is unspecified. If the variables are co-integrated, an error-correcting model must be constructed. In the present case, the variables are not co-integrated; therefore, Bivariate Granger causality test is applied at the first difference of the variables. The second requirement for the Granger Causality test is to find out the appropriate lag length for each pair of variables. For this purpose, we used the vector auto regression (VAR) lag order selection method available in Eviews. This technique uses six criteria namely log likelihood value (log L), sequential modified likelihood ratio (LR) test statistic, final prediction error (F & E), Akaike information criterion

(AIC), Schwarz information criterion (SC) and Hannan–Quin information criterion (HQ) for choosing the optimal lag length. Among these six criteria, all except the LR statistics are monotonically minimizing functions of lag length and the choice of optimum lag length is at the minimum of the respective function and is denoted as a * associated with it.

Since the time series of exchange rates is stationary or I(0) from the ADF test, the Granger Causality test is performed as follows:

$$\Delta N_t = \alpha_1+\beta_{11}\Delta N_{t-1}+ \beta_{12}\Delta N_{t-2}+...+ \beta_{1n}\gamma N_{t-n}+ \gamma_{11}F_{t-1}+\gamma_{12}F_{t-2}+...+ \gamma_{1n}F_{t-n}+\varepsilon_{1,t}$$

$$F_t =\alpha_2+ \beta_{21}F_{t-1}+\beta_{22}F_{t-2}+...+ \beta_{2n}F_{t-n}+ \gamma_{21}\Delta N_{t-1}+ \gamma_{22}\Delta N_{t-2}+...+ \gamma_{2n}\Delta N_{t-n}+\varepsilon_{2,t}$$

Where n is a suitably chosen positive integer; βj and γ j, j = 0, 1… k are parameters and α's are constant; and ε t's are disturbance terms with zero means and finite variances.

5. Results Summary:

As outlined in the methodology, the analysis of the data was conducted in the four steps

First, normality test was done on stock indices to determine the type of distribution. Jarque-Bera statistics were computed, which is shown in table 1 along the descriptive statistics for the indices. Skewness value 0 and Kurtosis value 3 indicates the normality of the distribution. The skewness coefficient, in excess of unity is taken to be fairly extreme (Chou 1969). High or low kurtosis indicates the case of leptokurtic or platykurtic (Parkinson 1987). From the obtained statistics, it is evident that all the four stock indices are not normally distributed as the value of skewness and kurtosis for IBOV,RTSI,S&P CNX, SCI are -0.446803, 0.197913, 0.179348, -0.068426 and 7.757551, 9.823199, 11.42640, 5.723698 respectively.

Second, having affirmed the non-normal distribution of the four stock indices, next question is about the stationarity. Simple way to check the stationarity is to plot time series graph and observe the trend in mean, variance and autocorrelation. A time series is said to be stationary when the mean and variance are constant over time. The line plot for all the series (Log normal value) is shown in figure1.1to1.4. As seen in the plots, for these stocks return series, mean and variance appears to be constant as the plot trends neither upward nor downward. At the same time, the vertical fluctuations also indicate that the variance too is not changing. It is evidence that the data is stationary at level forms.

In addition to the figural inspection, formal econometric tests are also applying to emphasis the result of visual inspection. So ADF (Augmented Dickey-Fuller Test) was performed to check the stationarity of the time series. The results for the BRIC countries stock indices series are shown in table 2.1, 2.2, 2, 3 and 2.4 respectively.

Comparing the obtained ADF statistics for these stock return series with the critical values of rejection of hypothesis of existence of unit root, it becomes evident that the obtained statistics for these IBOV,RTSI,S&P CNX, SCI are -31.77634, 25.59362, -27.05202, -29.76729 respectively, fall behind the critical value(at 1% significance level value -3.9887). Thus the probability value was 0.00 which lead to conclusion of rejection of null hypothesis of presence of unit root. Hence the all these four time series are non stationary. It is important to note that as a consequence of stationarity at the level form in all the time series, Johansen cointegration test cannot be applied to the variables to determine the long term relationship.

Third, to find out the correlation among the BRIC countries time series correlation test was done. Correlation test can be seen as the indication of interrelationship between BRIC countries stock return. Table 3 shows the correlation matrix. From the Eview obtained statistics it is observed that there is positive correlation between all these four series. Brazil statistic shows its interdependency with Russia (.49322) is stronger than India (.329619) and China (.221667). Similarly India is also having strong interdependency with Russia (.430889) as compare to the Brazil (0.329619) and China (0.313859). Russia having a strong interdependency with India and Brazil as compare to China. China is more influenced by the Indian economy as compare with Russia and Brazil. This correlation statistics needs to be verified for the direction of influence by the Granger Causality test

In the Fourth step, I tried to capture the degree and direction of long term correlation between the BRIC countries indices. Results of Granger Causality test are presented in the Table 4. From the statistics it is deduce that null hypothesis “S&P CNX NIFTY does not Granger Cause IBOV” cannot be rejected as the obtained f-statistic, 2.39731 fall behind the critical value as also shown in p-value (0.0916). However, we can certainly reject the null hypothesis that S&P CNX NIFTY does not Granger Cause IBOV. In other words, the results for the Granger Causality test show that IBOV clearly, Granger causes the S&P CNX NIFTY. Thus causality is unidirectional among S&P CNX NIFTY and IBOV. Similarly Null hypothesis that RTSI, SCI does not causes the IBOV is not accepted as the f-statistic 2.41754 and 0.48302 falls behind the critical value as p-value is 0.0898 and 0.6171 respectively But the reverse is true IBOV does not Granger Cause RTSI and SCI. Null hypothesis that “SCI does not Granger cause the S&P CNX NIFTY” and “S&P CNX NIFTY does not Granger Cause SCI” cannot be rejected as p- value 0.0089 and 0.0002 is less than critical value 0.05.

Thus SCI and S&P CNX NIFTY have bidirectional causal relationship.

6 Conclusions:

This research empirically examines the dynamics between the BRIC countries, in terms of the extent of interdependency and causality. To begin with absolute value of stock indices are converted to log normal return and checked for normality. Jarque-Bera test yielded statistics affirmed that the all the time series of stock returns of BRIC countries are non normal distribution. This posed the questions on the stationarity of the return series. Hence subsequently, stationarity of these time Series is tested by the ADF Test and the results showed stationarity at level forms for all these time series. To test the correlation among the stock indices series, correlation matrix was computed which shows the positive correlation among all the proxy indices of BRIC countries. This made way for determining the direction of influence between the two variables. Hence, Granger Causality test was applied to stock indices series of BRIC countries which proved that economy of India, Russia and China Granger causes the Brazil economy but the converse is not true. But Russia does not granger causes the Indian economy but Indian economy granger cause the Russian economy. Granger causality test gives statistic that china economy have the bidirectional causality with India and Russia. Thus Chinese economy is largely interdependent of Indian and Russian Economy.

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Appendix:

Table 1.Descriptive Statistics:

	IBOVESPA	RTSI	S&P CNX NIFTY	SCI
Mean	-0.065878	-0.034503	-0.030900	-0.069654
Median	0.069957	0.101308	-0.006127	0.048421
Maximum	9.135420	20.20392	16.33432	9.034251
Minimum	-12.09605	-14.71659	-13.01419	-8.043697
Std. Dev.	2.108767	2.894157	2.023315	1.995040
Skewness	-0.446803	0.197913	0.179348	-0.068426
Kurtosis	7.757551	9.823199	11.42640	5.723698
Jarque-Bera	786.9522	1568.769	2388.878	249.7679
Probability	0.000000	0.000000	0.000000	0.000000
Sum	-53.09790	-27.80980	-24.90577	-56.14087
Sum Sq. Dev.	3579.752	6742.798	3295.512	3204.048

Table: 2.1 IBOV (BRAZIL)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-31.77634	0.0000
Test critical values:	1% level	-3.436892	
	5% level	-2.864317	
	10% level	-2.568301	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IBOV)
Method: Least Squares
Date: 12/03/11 Time: 18:14
Sample (adjusted): 1/03/2008 11/25/2011
Included observations: 967 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IBOV(-1)	-1.023101	0.032197	-31.77634	0.0000
C	-0.012293	0.070431	-0.174547	0.8615

R-squared	0.511327	Mean dependent var	0.001968
Adjusted R-squared	0.510821	S.D. dependent var	3.131349
S.E. of regression	2.190108	Akaike info criterion	4.407845
Sum squared resid	4628.693	Schwarz criterion	4.417926
Log likelihood	-2129.193	Hannan-Quinn criter.	4.411683
F-statistic	1009.735	Durbin-Watson stat	1.998487
Prob(F-statistic)	0.000000		

Table 2.2 RSTI (RUSSIA)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-25.59362	0.0000
Test critical values:	1% level	-3.437549	
	5% level	-2.864607	
	10% level	-2.568457	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RTSI)
Method: Least Squares
Date: 12/03/11 Time: 18:15
Sample (adjusted): 1/10/2008 11/24/2011
Included observations: 881 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RTSI(-1)	-0.852913	0.033325	-25.59362	0.0000
C	-0.057759	0.097677	-0.591326	0.5545

R-squared	0.427001	Mean dependent var	0.013398
Adjusted R-squared	0.426349	S.D. dependent var	3.826313
S.E. of regression	2.898040	Akaike info criterion	4.968214

Sum squared resid	7382.401	Schwarz criterion	4.979068
Log likelihood	-2186.498	Hannan-Quinn criter.	4.972364
F-statistic	655.0335	Durbin-Watson stat	1.974431
Prob(F-statistic)	0.000000		

Table 2.3 S&P CNX NIFTY (INDIA)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-27.05202	0.0000
Test critical values:	1% level	-3.437783	
	5% level	-2.864711	
	10% level	-2.568512	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(S_P_CNX_NIFTY)
Method: Least Squares
Date: 12/03/11 Time: 18:21
Sample (adjusted): 1/03/2008 11/24/2011
Included observations: 854 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
S_P_CNX_NIFTY(-1)	-0.957513	0.035395	-27.05202	0.0000
C	-0.034840	0.069070	-0.504425	0.6141

R-squared	0.462057	Mean dependent var	0.028701
Adjusted R-squared	0.461426	S.D. dependent var	2.748796
S.E. of regression	2.017275	Akaike info criterion	4.243712
Sum squared resid	3467.129	Schwarz criterion	4.254836
Log likelihood	-1810.065	Hannan-Quinn criter.	4.247972
F-statistic	731.8120	Durbin-Watson stat	1.957382
Prob(F-statistic)	0.000000		

Table 2.4 SCI (CHINA)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-29.76729	0.0000
Test critical values:	1% level	-3.437483	
	5% level	-2.864578	
	10% level	-2.568441	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(SCI)

Method: Least Squares
Date: 12/03/11 Time: 18:23
Sample (adjusted): 1/03/2008 11/24/2011
Included observations: 889 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SCI(-1)	-1.015960	0.034130	-29.76729	0.0000
C	-0.060512	0.066250	-0.913397	0.3613

R-squared	0.499744	Mean dependent var	0.001068
Adjusted R-squared	0.499180	S.D. dependent var	2.789868
S.E. of regression	1.974352	Akaike info criterion	4.200605
Sum squared resid	3457.585	Schwarz criterion	4.211381
Log likelihood	-1865.169	Hannan-Quinn criter.	4.204724
F-statistic	886.0914	Durbin-Watson stat	1.977069
Prob(F-statistic)	0.000000		

Table 3 CORRELATION MATRIX:

	IBOV	S_P_CNX_NIFTY	RTSI	SCI
IBOV	1.000000	0.329619	0.493229	0.221667
S_P_CNX_NIFTY	0.329619	1.000000	0.430889	0.313859
RTSI	0.493229	0.430889	1.000000	0.226681
SCI	0.221667	0.313859	0.226681	1.000000

Table 4 Grangur Casuality Test

Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
RTSI does not Granger Cause IBOV	849	2.41754	0.0898
IBOV does not Granger Cause RTSI		34.3747	4.E-15
SCI does not Granger Cause IBOV	866	0.48302	0.6171
IBOV does not Granger Cause SCI		17.6019	3.E-08
S&P CNX NIFTY does not Granger Cause IBOV	810	2.39731	0.0916
IBOV does not Granger Cause S&P CNX NIFTY		20.7512	2.E-09
SCI does not Granger Cause RTSI	773	3.25342	0.0392
RTSI does not Granger Cause SCI		8.56873	0.0002
S&P CNX NIFTY does not Granger Cause RTSI	711	2.40033	0.0914

RTSI does not Granger Cause S&P CNX NIFTY		3.80756	0.0227
S&P CNX NIFTY does not Granger Cause SCI	729	8.80468	0.0002
SCI does not Granger Cause S&P CNX NIFTY		4.74962	0.0089

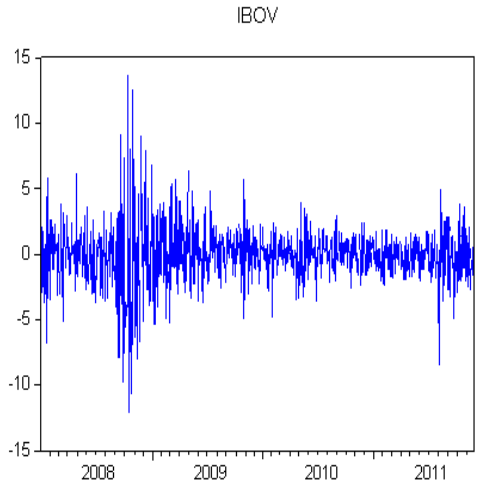

Figure 1.1 Daily stock returns (IBOV)

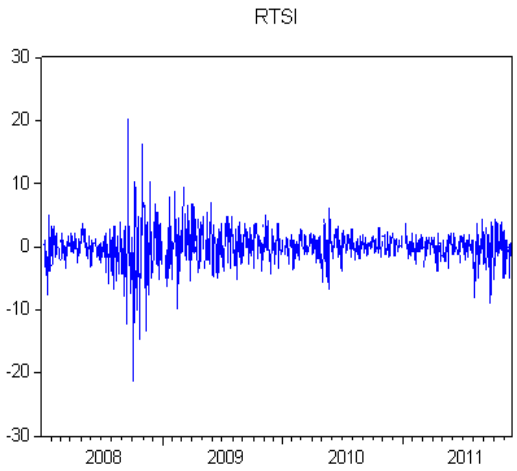

Figure 1.2 Daily stock returns (RTSI)

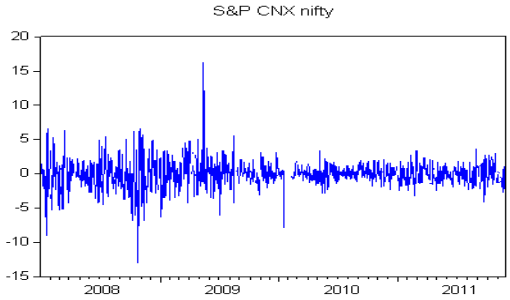

Figure 1.3 Daily stock return (S&P CNX)

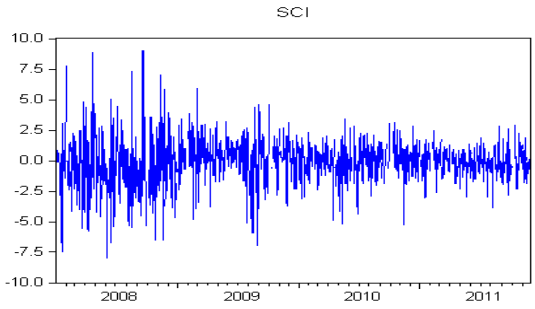

Figure 1.4 Daily stock returns (SCI)