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Testing Co-integration of Exchange Rate Movements on Indian Stock Market Return - Post Subprime Crisis

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ABSTRACT

Over the years since 1991 the economic liberalization has led to more capital inflows to India through inter-linkages of capital market and adoption of flexible exchange rate mechanism. Such inter-linkages also augmented the transition of economy internationally and made it more responsive towards dynamism of international economic events. The obvious effect was a systematic development of interdependency between stock market and foreign exchange market. The paper tries to convey the long term relationship between Indian stock market return and the return on foreign currency movements. The testing of this relationship is not new of its kind but here the researcher has taken a period of analysis when there was a structural break in the economy propelled by sub-prime crisis. The daily data was used for analysis for a period of seven years from 2008 to 2015 and two indices of stock exchanges and four currency pair has been selected for the analysis. The paper uses the Johansen's co integration test to identify the long term relationship. The co-integration test suggests that there is no significant co-integration between the stock index return and the foreign exchange rate movement post sub-prime crisis.

INTRODUCTION

There has been a phenomenal growth in the stock market of India in the past decades. India being an emerging economy drew major attention of foreign institutional investors (FII). As the liberalization continued in the Indian Stock Market through relaxation of restrictions on international capital flows the market has started integrating with the major world market and economy which has brought some significant changes in the behaviour of the stock market. As a result flexible exchange rate mechanism has moved in, coupled with transition in economies which have created a systematic interdependency between and within the stock and foreign exchange market (Aydemir & Demirhan, 2009). In that case finding the relationship between stock market return and exchange rate return will bring an insight towards the contagion effect on their integration process (Zubair, 2013). A decade ago the sub-prime crisis had made major structural changes in the economy of USA followed by Europe and rest of the world. Banks reported about $600 billion losses and raised new capital of $430 billion (Soros, 2009).In India story was the same as the stock market collapsed in 2008-09 and INR also depreciated drastically. There was a significant structural break in the capital market of India where market capitalization, trading volume and stock market returns saw new lows with huge depreciation of INR which further started stabilising 2013 onwards. The approach used in this paper is to understand the relationship between Stock market returns and exchange rate return after the structural break. Lin in 2012 analysed the relationship between stock prices and exchange rate and it was found that there is a contagion between two variables as

the relationship becomes stronger during crisis period compared to normal periods. The flow of foreign funds have increased significantly in India after the subprime crisis with increased participation of foreign investors thereby further strengthening the equity market of India. However structural breaks like Asian crisis in 1998-99 have proved that different results can be obtained between pre and post crisis period (Sundaram, 2009).

LITERATURE REVIEW

In a common economic framework it is assumed that exchange rate changes influence firm's international competitiveness thereby increases or decreases their operating cash flows position and valuation of their assets and liabilities thereby affecting their firm value as a whole (Dombusch & Fischer, 1980). On the other hand in a portfolio adjustments approach the inflow and outflow of foreign capital is induced by changes in stock price movements. Again an appreciation or depreciation in home currency will have a negative and positive effect on international trades leading to bearish or bullish market (Jorion, 1991). A rise in stock price will enhance the inflow of capital and in a downturn there will be outflow of capital. A number of analysis were conducted to examine the relationship between stock price & exchange rate from the year 1972 to 1992 where in some cases with positive & negative relationship were found in different time frames (Christopher & Wenchi Kao, 1990) and in some cases bidirectional Granger causality was claimed with no long term relationship (Bahmani & Sohrabian, 1992). In 1999 using Granger causality and Engle-Granger co-integration test it was found that Korean stock market index is co-integrated with exchange rates (Kwon & Shin, 1999). A study conducted to identify the dynamic linkages between foreign exchange rate and stock market in India by applying Granger Causality test for a 10 years period from 1992 to December 2002 revealed that there is no causal relationship between these two markets (Nath, 2003). A causality study using Johansen co-integration test was conducted in four ASEAN countries (Thailand, Singapore, Philippines and Indonesia) to examine the relationship between stock prices and exchange rates revealed that stock prices and exchange rates are co-integrated in those four countries and the causality moves from exchange rate to stock prices (Agus & Carl, 2004). Investigation of the varying macroeconomic variables on stock return of Turkey suggested that industrial production and exchange rate movements were positively related with the stock return (Erdogan & Ozlale, 2005). In 2005, Phylaktis and Ravazolo applied the co-integration methodology and multivariate Granger causality test to find the relation between the stock and foreign exchange market for a group of Pacific Basin Countries and they found the relationship is positively correlated. It was argued by Wooldridge in 2006 ceteris paribus is an important assumption in most of the economic models and that is why they are used in causal analysis. We can know the causal relationship only when other relevant variables are kept as constant. So the disparity in research results arises while impact of exchange rate on stock market return is researched (Wooldridge, 2006). In 2011 Diamandis and Drakos worked on two markets (Latin American Countries and US stock market) to understand the long run and short run dynamics between foreign exchange market and the stock market and they found these two markets are positively related. A strong causality from stock price return to foreign exchange rate return was

also found in Korea in 2012 when Yoon and Kang tried to examine the price return and volatility linkages between these two variables. (Yoon & Kang, 2012). All these discussions actually points out that though several studies were conducted but result remained diverse depending on the countries and time of the study.

RESEARCH METHODOLOGY

The objective of the paper is to find out the long term relationship between the exchange rate return and the stock market return with the help of daily data ranging from year 2008 to 2015 which were obtained (comprising of 1772 data points) for the analysis. The two stock indices have been chosen SENSEX (Bombay Stock Exchange, BSE) and NIFTY (National stock Exchange, NSE). Reason for choosing of two indices was to understand whether the result changes when the index is more diversified or not as SENSEX and NIFTY are consisting of 30 and 50 stocks respectively. The stock market data is consisting of daily closing prices of SENSEX and NIFTY which were collected from the official websites of BSE and NSE. For exchange rate movements four major exchange rates were selected USD-INR, GBP-INR, EUR-INR & JPY-INR and the daily closing data were collected from the website of Reserve Bank of India. Till date most of research used the data related to USD-INR only. The researcher has tried to find whether same results are obtained when the different currency pairs are used.The exchange rate return and stock market return was calculated using Natural Logarithm Return as follows:

Log Normal Returns (Rn) = Ln (P1/P0) where P1 is the current day's price and P0 is previous day's price.

In a time series analysis the data series must follow the time series properties which imply that the data must be stationary and that the mean and variances should be constant over time and the covariance value between the two periods will be dependent only on the distance between two periods. So unit root test was carried out following the standard procedure of Augmented Dickey-Fuller (ADF) Test to check the stationary nature of the data series. AIC-Akaike Information Criteria and SIC- Schwartz Bayesian criteria were used in this process. It is assumed that the series will follow an auto regressive process as the test makes a parametric correlation and controls for the higher order correlations and adds the lagged difference terms of the dependent variable to the right hand side of regression.

The Johansen's co-integration test was carried out as a maximum likelihood method where whole system of equations can be tested for co-integration. Two types of tests may be carried out either with trace or with eigenvalue and inferences drawn may differ a little bit also.

Data Analysis and Discussion:

The ADF test was performed to check whether the series is stationary. A series can be said stationary if it has constant mean, constant variance and constant auto covariance for each given lag. Non Stationary data can lead to spurious regression and interpretations taken from that value can be misleading. Schwarz criterion was selected to choose the optimum lag length.

Null Hypothesis: LDOLLAR has a unit root
Null Hypothesis: LEURO has a unit root
Null Hypothesis: LNIFTY has a unit root
Null Hypothesis: LPOUND has a unit root
Null Hypothesis: LSENSEX has a unit root
Null Hypothesis: LYEN has a unit root
Exogenous: Constant, Linear Trend

The table 1 in appendix shows the result of the ADF test. The table shows the ADF test statistics, t statistics and its associated p value. Schwarz's criterion has in this case chosen to include 0 lags of the dependent variable in the test regression. As the p value for all the test statistics are greater than 0.05, null hypothesis of a unit root in the series cannot be rejected. Hence it can be concluded that all series are not stationary at level. Since the series are not found stationary, the ADF test is performed again on first difference. Following hypothesis was taken.

Null Hypothesis: D(LDOLLAR) has a unit root
Null Hypothesis: D(LEURO) has a unit root
Null Hypothesis: D(LNIFTY) has a unit root
Null Hypothesis: D(LPOUND) has a unit root
Null Hypothesis: D(LSENSEX) has a unit root
Null Hypothesis: D(LYEN) has a unit root

It can be seen from the table 2 that the p value for the test statistics is 0.000. Hence the null hypothesis can be rejected at 5 % level of significance. So it can be concluded that all the series is stationary at 1st difference.

To check the long run association between the series, Johansen's co integration test is performed. Following hypothesis and their results are discussed below.

Null Hypothesis (Ho): LDOLLAR and LNIFTY Series are not co-integrated.

As the ADF test suggests that the both series Ldollar and LNifty are AR(1). Hence it would be appropriate to check the co-integration between them. The table no 3 shows the results of the Johansen's Co integration test carried out on Dollar and Nifty. The value of the Trace Statistics is 7.368 and its associated P value is 0.5351. The Maximum Eigen Statistics is 7.29 and its associated P value is 0.455. Hence both tests statistics cannot be rejected at 5 % level of significance. So it can be concluded that there is no co integration between the Nifty and Dollar.

Null Hypothesis (Ho): LEURO and LNIFTY Series are not co-integrated.

As the ADF test suggests that the both series LEuro and LNifty are AR(1). Hence it would be appropriate to check the co-integration between them. The table no 4 shows the results of the Johansen's Co integration test carried out on Euro and Nifty. The value of the Trace Statistics is 6.09 and its associated P value is 0.683. The Maximum Eigen Statistics is 5.22 and its associated P value is 0.71. Both tests statistics cannot be rejected at 5 % level of significance. Hence it can be concluded that there is no co-integration between the Nifty and Euro.

Null Hypothesis (Ho): LNIFTY and LYEN Series are not co-integrated.

As the ADF test suggests that the both series LYen and LNifty are AR(1). Hence it would be appropriate to check the co-integration between them. The table no 5 shows the results of the Johansen's Co integration test. The value of the Trace Statistics is 11.74 and its associated P value is 0.169. The Maximum Eigen Statistics is 7.73 and its associated P value is 0.40. Both tests statistics cannot be rejected at 5 % level of significance. Hence it can be concluded that there is no co-integration between the Nifty and Yen.

Null Hypothesis (Ho): LPOUND and LNifty Series are not co-integrated.

As the ADF test suggests that the both series LPOUND and LNifty are AR(1). Hence it would be appropriate to check the co-integration between them.

The table no 6 shows the results of the Johansen's Co integration test. The value of the Trace Statistics is 5.92 and its associated P value is 0.7044. The Maximum Eigen Statistics is 5.90 and its associated P value is 0.62. Both tests statistics cannot be rejected at 5 % level of significance. Hence it can be concluded that there is no co-integration between the Nifty and Pound.

Null Hypothesis (Ho): LSENSEX and LDOLLAR Series are not co-integrated.

As the ADF test suggests that the both series LSENSEX and LDOLLAR are AR(1). Hence it would be appropriate to check the co-integration between them. The table 7 shows the results of the Johansen's Co integration test. The value of the Trace Statistics is 7.22 and its associated P value is 0.55. The Maximum Eigen Statistics is 7.11 and its associated P value is 0.47. Both tests statistics cannot be rejected at 5 % level of significance. Hence it can be concluded that there is no co-integration between the Sensex and Dollar.

Null Hypothesis (Ho): LSENSEX and LEURO Series are not co-integrated.

As the ADF test suggests that the both series LSENSEX and LEURO are AR(1). Hence it would be appropriate to check the co-integration between them. The table 8 shows the results of the Johansen's Co integration test. The value of the Trace Statistics is 6.22 and its associated P value is 0.66. The Maximum Eigen Statistics is 5.32 and its associated P value is 0.70. Both tests statistics cannot be rejected at 5 % level of significance. Hence it can be concluded that there is no co-integration between the Sensex and Euro.

Null Hypothesis (Ho): LSENSEX and LPOUND Series are not co-integrated.

As the ADF test suggests that the both series LSENSEX and LPOUND are AR(1). Hence it would be appropriate to check the co-integration between them. The table 9 shows the results of the Johansen's Co integration test. The value of the Trace Statistics is 5.67 and its associated P value is 0.73. The Maximum Eigen Statistics is 5.64 and its associated P value is 0.65. Both tests statistics cannot be rejected at 5 % level of significance. Hence it can be concluded that there is no co-integration between the Sensex and Pound.

Null Hypothesis (Ho): LSENSEX and LYEN Series are not co-integrated.

As the ADF test suggests that the both series LSENSEX and LYEN are AR(1). Hence it would be appropriate to check the co-integration between them. The table 10 shows the results of the Johansen's Co integration test. The value of the Trace Statistics is 11.60 and its associated P value is 0.17. The Maximum Eigen Statistics is 7.7 and its associated P value is 0.40. Both tests statistics cannot be rejected at 5 % level of significance. Hence it can be concluded that there is no co-integration between the Sensex and Yen.

CONCLUSION

This study examined the inter-linkage between stock price and exchange rate using Johansen's co-integration test framework. The analysis used the daily data over the period of 5 years from 2008 to 2015 which is obtained from RBI website and NSE & BSE website. The analysis revealed that stock market return in India does not have a significant long run relationship with exchange rate return as the stock index return and the return for exchange rate were not found co-integrated in any of the cases. The exchange rate movement was

not found significant in determining the stock market return.

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APPENDIX

Fig 1: Movement of the different Exchange Rate during the period of the study

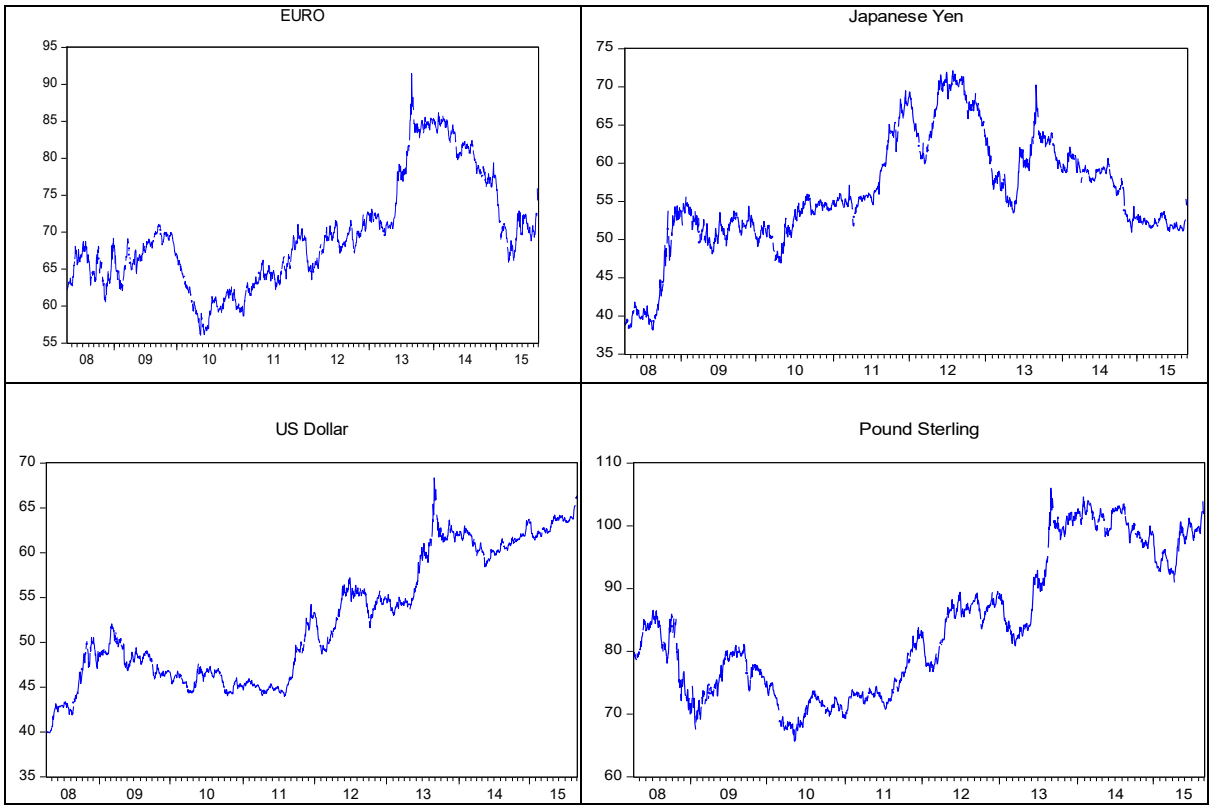

Fig2: Movement of the stock index during the period

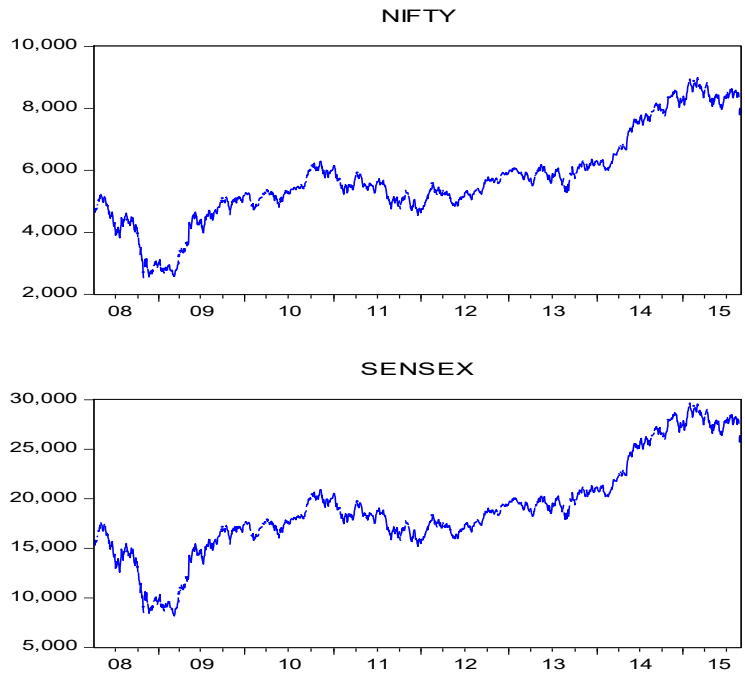

Table 1: Result of ADF Test.

Lag Length: 0 (Automatic - based on SIC, max lag = 24)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.106294	0.5414
Augmented Dickey-Fuller test statistic	-1.571548	0.4970
Augmented Dickey-Fuller test statistic	-1.045115	0.7389
Augmented Dickey-Fuller test statistic	-0.719899	0.8398
Augmented Dickey-Fuller test statistic	0.736452	0.8735
Augmented Dickey-Fuller test statistic	0.750045	0.8761

Table 2: ADF Test Result (First Difference)

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, max lag=24)		
	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-41.86311	0.0000
Augmented Dickey-Fuller test statistic	-41.09228	0.0000
Augmented Dickey-Fuller test statistic	-39.32284	0.0000
Augmented Dickey-Fuller test statistic	-41.61545	0.0000
Augmented Dickey-Fuller test statistic	-30.49261	0.0000
Augmented Dickey-Fuller test statistic	-43.20708	0.0001

Table 3: Co-integration Test Result of LDOLLAR LNIFTY

Included observations: 1772 after adjustments

Trend assumption: Linear deterministic trend

Series: LDOLLAR LNIFTY

Lags interval (in first differences): 1 to 4

Unrestricted Co-integration Rank Test (Trace)

Hypothesized		Trace	0.05	
None	0.004108	7.368923	15.49471	0.5351
At most 1	4.23E-05	0.074878	3.841466	0.7843

Trace test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.004108	7.294045	14.26460	0.4550
At most 1	4.23E-05	0.074878	3.841466	0.7843

Max-eigenvalue test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 4: Co-integration Test Result of LEURO LNIFTY

Included observations: 1772 after adjustments

Trend assumption: Linear deterministic trend

Series: LEURO LNIFTY

Lags interval (in first differences): 1 to 4

Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.002945	6.099520	15.49471	0.6838
At most 1	0.000493	0.873672	3.841466	0.3499

Trace test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.002945	5.225848	14.26460	0.7131
At most 1	0.000493	0.873672	3.841466	0.3499

Max-eigenvalue test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 5: Co-integration Test Result of LYEN LNIFTY

Included observations: 1772 after adjustments

Trend assumption: Linear deterministic trend

Series: LNIFTY LYEN

Lags interval (in first differences): 1 to 4

Unrestricted Co-integration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.004354	11.74419	15.49471	0.1696
At most 1 *	0.002262	4.012892	3.841466	0.0451

Trace test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.004354	7.731296	14.26460	0.4067
At most 1 *	0.002262	4.012892	3.841466	0.0451

Max-eigenvalue test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 6: Co-integration Test Result of LPOUND LNIFTY

Included observations: 1772 after adjustments

Trend assumption: Linear deterministic trend

Series: LPOUND LNIFTY

Lags interval (in first differences): 1 to 4

Unrestricted Co-integration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.003325	5.924816	15.49471	0.7044
At most 1	1.32E-05	0.023430	3.841466	0.8783

Trace test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.003325	5.901385	14.26460	0.6259
At most 1	1.32E-05	0.023430	3.841466	0.8783

Max-eigenvalue test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 7: Co-integration Test Result of LDOLLAR LSENSEX

Included observations: 1772 after adjustments

Trend assumption: Linear deterministic trend

Series: LDOLLAR LSENSEX

Lags interval (in first differences): 1 to 4

Unrestricted Co-integration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.004008	7.224906	15.49471	0.5517
At most 1	6.09E-05	0.107847	3.841466	0.7426

Trace test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.004008	7.117059	14.26460	0.4754
At most 1	6.09E-05	0.107847	3.841466	0.7426

Max-eigenvalue test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 8: Co-integration Test Result of LEURO LSENSEX

Included observations: 1772 after adjustments

Trend assumption: Linear deterministic trend

Series: LEURO LSENSEX

Lags interval (in first differences): 1 to 4

Unrestricted Co-integration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.003002	6.227325	15.49471	0.6687
At most 1	0.000507	0.899065	3.841466	0.3430

Trace test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.003002	5.328260	14.26460	0.7000
At most 1	0.000507	0.899065	3.841466	0.3430

Max-eigenvalue test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table 9: Co-integration Test Result of LPOUND LSENSEX

Included observations: 1772 after adjustments

Trend assumption: Linear deterministic trend

Series: LPOUND LSENSEX

Lags interval (in first differences): 1 to 4

Unrestricted Co-integration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.003182	5.679211	15.49471	0.7331
At most 1	1.82E-05	0.032295	3.841466	0.8573

Trace test indicates no co-integration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.003182	5.646916	14.26460	0.6588
At most 1	1.82E-05	0.032295	3.841466	0.8573

Max-eigenvalue test indicates no co-integration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 10: Co-integration Test Result of LYEN LSENSEX

Included observations: 1772 after adjustments
Trend assumption: Linear deterministic trend
Series: LYEN LSENSEX
Lags interval (in first differences): 1 to 4
Unrestricted Co-integration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.004341	11.60596	15.49471	0.1768
At most 1 *	0.002197	3.897620	3.841466	0.0483

Trace test indicates no co-integration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.004341	7.708341	14.26460	0.4091
At most 1 *	0.002197	3.897620	3.841466	0.0483

Max-eigenvalue test indicates no co-integration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values