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RESEARCH ARTICLE

TESTING FOR GRANGER CAUSALITY BETWEEN BSE SENSEX AND FOREX RESERVES: AN EMPIRICAL STUDY

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ABSTRACT

The investors carefully watch the performance of stock markets by observing the composite market index in general and BSE Sensex in particular before their investment. The Sensex (market index) acts as a yardstick to influence foreign investors to secure investments in the form of Forex Reserves. It provides a base for investors in forecasting future trends in the market. Hence, It is essential to understand whether Sensex causes Forex Reserves or otherwise to formulate suitable policies. The objective of the study is to investigate the casual relationship between Sensex and Forex Reserves. The empirical investigation was carried out based on monthly data ranging from July 1997 to Sept. 2015 covering 219 observations. The study has selected BSE Sensex of Indian stock market which may have influence on the Forex Reserves.Data for variables are collected from the database of the Indian economy maintained by Reserve Bank of India. Sensex data is obtained from the official website of the BSE India.com, yahoo finance .com. and other official websites. E-Views is used to analyze the data. Statistical tools used for the study is Descriptive statistic, Unit root test, Johansen Cointegration test and Granger causality test. The results of the study reveal that the BSE Sensex and Forex Reserves are cointegrated at first difference level. The BSE Sensex does Granger Cause Forex Reserves. The Granger causality study reveals that there is unidirectional causality between the BSE Sensex and Forex Reserves.

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INTRODUCTION

In the present scenario it is in fact hard to imagine a world without stock markets. Stock markets play a pivotal role in growing industries and commerce of a country that eventually affect the economy. The investors carefully watch the performance of stock markets by observing the composite market index in general and BSE Sensex before their investment. The Sensex (market index) acts as a yardstick to influence foreign investors to make investments in the form of Forex Reserves. It provides a base for investors in forecasting future trends in the market. It is believed that BSE Sensex play influential role in attracting Forex Currencies form the investors. Hence, It is essential to understand whether Sensex causes Forex Reserves or otherwise to formulate suitable policies. Importance of stock market in the economic development of a country and its impact on macroeconomic variable in general and Forex Reserves in particular cannot be denied. The macroeconomic variables like Forex Reserves are important indicator that affects economic development of the country. It is generally perceived that domestic economic variables play a seminal role in the overall performance of stock market. But in the era of globalization and integration of world economies the impact of global economic variables cannot be ignored.

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Objective

The main objective of the study is to investigate the casual relationship between Sensex and Forex Reserves.

MATERIALS AND METHODS

The empirical investigation was carried out based on monthly data ranging from july 1997 to Sept. 2015 which covers 219 observations. The study has selected BSE Sensex of Indian stock market which may have influence on the Forex Reserves. The empirical investigation considers BSE (Sensex) closing price as independent variable i.e. proxy for Indian stock market. Data for variables are collected from the database of the Indian economy maintained by Reserve Bank of India. Sensex data is obtained from the website of the stock exchanges yahoo finance .com. and other official websites. E-Views is used to analyze the data.

Hypotheses Testing

The hypothesis of this research is given below:

$H_0$1: Forex Reserves is normally distributed
$H_0$2: Sensex is normally distributed
$H_0$3: There is Group unit root of Forex Reserves and Sensex.
$H_0$4: There is no cointegration between BSE Sensex and Forex Reserves.
$H_0$5: BSE Sensex does not cause Forex Reserves.
$H_0$6: Forex Reserves does not cause BSE Sensex.

Descriptive Statistics

It describes then patterns and general trends of a dataset. It enables a reader to quickly understand and interpret the set of data that has been collected. This study uses measures of central tendency (Mean), measures of Variability (standard deviation, range, minimum and maximum), skewness and kurtosis.

Unit Root Test

The foundation of time series analysis is stationarity. A stationary process is a stochastic process whose joint probability distribution does not change when shifted in time or space. If the variable is not stationary, we can obtain a high regression although there is no meaningful relation between variables i.e. spurious regression between totally unrelated variables. Therefore, before estimating regression, augmented Dickey Fuller test (Hamilton, J., 1994) was conducted to check the stationarity of the data. The test for a unit root is conducted on the coefficient of yt-1 in the regression. Where Yt is the variable in period t, T denotes a time trend, is the difference operator, et is pure white noise error term disturbance with mean zero and variance deviation 2, k represents the no. of lags of the differences in the ADF equation and Yt 1 = (Yt-1 – Yt-2).

Co integration

Cointegration test is conducted after ADF test showing stationarity variables of Sensex and Forex Reserves. The cointegration test is to be done to check whether there is a long term relationship existing between BSE Sensex and Forex Reserves through Johansen Co-integration Test. The test results of Johansen cointegration indicate long term relationship between BSE Sensex and Forex Reserves Trace statistic and Max-Eigen Statistics.

Granger Causality Test

The **Granger causality test** is a statistical hypothesis test for determining whether one time series is useful in forecasting another, first proposed in 1969. Ordinarily, regressions reflect "mere" correlations, but Clive Granger argued that causality in economics could be tested for by measuring the ability to predict the future values of a time series using prior values of another time series. Since the question of "true causality" is deeply philosophical, and because of assuming that one thing preceding another can be used as a proof of causation, econometricians assert that the Granger test finds only "predictive causality".

Granger defined the causality relationship based on two principles:

1. The cause happens prior to its effect.
2. The cause has *unique* information about the future values of its effect.

Given these two assumptions about causality, Granger proposed to test the following hypothesis for identification of a causal effect of X on Y:

$$\mathbb{P}[Y(t+1) \in A|\mathcal{I}(t)] \neq \mathbb{P}[Y(t+1) \in A|\mathcal{I}_{-X}(t)],$$

Where $\mathbb{P}$ refers to probability, A is an arbitrary non-empty set, and $\mathcal{I}(t)$ and $\mathcal{I}_{-X}(t)$ respectively denote the information available as of time t in the entire universe, and that in the modified universe in which X is excluded. If the above hypothesis is accepted, we say that X Granger-causes Y.

A method for Granger causality has been developed that is not sensitive to deviations from the assumption that the error term is normally distributed. This method is especially useful in financial economics, since many financial variables are non-normally distributed. Recently, asymmetric causality testing has been suggested in the literature in order to separate the causal impact of positive changes from the negative ones. "If two or more time-series are cointegrated, then there must be Granger causality between them - either one-way or in both directions. However, the converse is not true."

A time series X is said to Granger-cause Y if it can be shown, usually through a series of t-tests and F-tests on lagged values of X (and with lagged values of Y also included), that those X values provide statistically significant information about future values of Y.

RESULTS AND DISCUSSION

Interpretation

The graph shows the movement of the Sensex and Forex Reserves. The red line indicates BSE Sensex and blue line shows Forex Reserves. The Sensex and Forex Reserves have upward trend. The graphs show the trends in the volatility of BSE Sensex are more than that of Forex Reserves. From a single glance, it is clear that the Sensex and Forex Reserves have some relationship in between. Table 1 depicts the mean of BSE Sensex for the period is 11636.36 and mean of Forex Reserves for the period is 8943.393. The high standard deviation implies the high volatility of the series.BSE Sensex has very high and significant variation from their mean as against BSE Sensex.

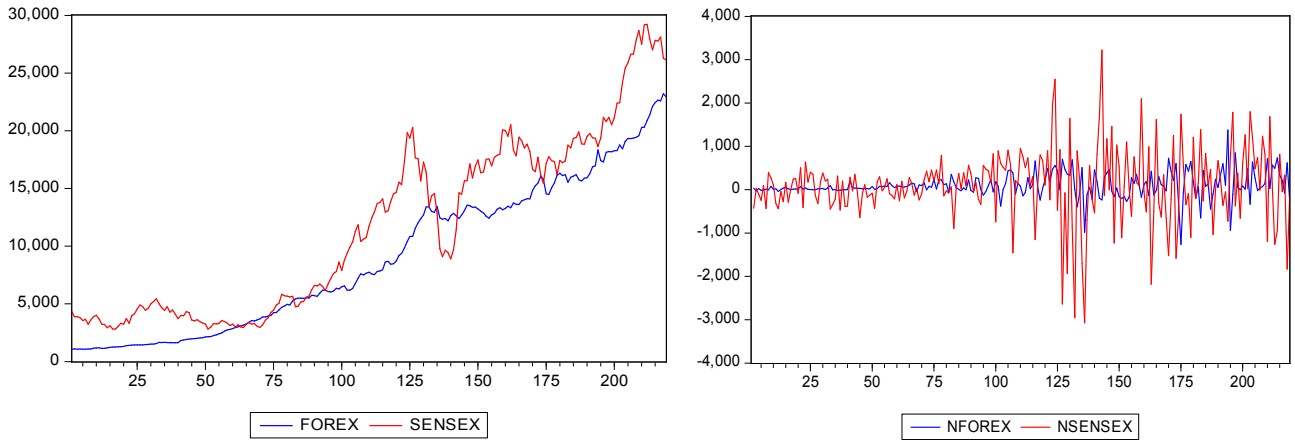

Chart 1. Trends of BSE Sensex and Forex Reserves and First difference of BSE Sensex and Forex Reserves

Table 1. Descriptive Statistics

Descriptive Statistics	Forex Reserves	Sensex
Mean	8943.393	11636.36
Median	7608.42	10370.24
Maximum	23199.1	29220.12
Minimum	1063.35	2810.66
Std. Dev.	6444.946	7722.476
Skewness	0.350737	0.470469
Kurtosis	1.852384	2.022253
Jarque-Bera	16.50793	16.80235
Probability	0.00026	0.000225
Sum	1958603	2548363
Sum Sq. Dev.	9.06E+09	1.30E+10
Observations	219	219

Table 2. Group Unit Root Test

Group unit root test: Summary				
Series: NFOREX RESERVES and NSENSEX				
Date: 11/15/15 Time: 10:17				
Sample: 1 208				
Exogenous variables: Individual effects				
Automatic selection of maximum lags				
Automatic lag length selection based on SIC: 2 to 6				
Newey-West automatic bandwidth selection and Bartlett kernel				
Method	Statistic	Prob.**	sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-9.5712	0	2	402
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-18.4466	0	2	402
ADF - Fisher Chi-square	189.462	0	2	402
PP - Fisher Chi-square	36.8414	0	2	410
** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.				

The positively skewed values for the variable imply that mean of the observation is more than median and BSE Sensex and Forex Reserves are positively skewed. Thus, there is no deviation from normal distribution. The value of kurtosis for the Forex Reserves (1.852384) and BSE Sensex (2.022253) are platykurtic distribution (i.e. <3) indicating that values are wide spread around the mean. leptokurtic distribution (i.e.>3) meaning that high probability for extreme values in the distribution. Jarque Bera test statistic measures the difference of the skewness and kurtosis of the data series from the normal distribution. Jarque-Bera statistic test the null hypothesis that data follow normal distribution.

By using probability values of Jarque- bera stastistics, null hypothesis normality is rejected for Forex Reserves and BSE Sensex at 5 percent level of significance.

Test of Unit root

ADF statistics is used for checking the stationality. If the caluculated absolute ADF test statistics is more than the critical values from fuller's table, then the series are stationary or integrated of order zero i.e. unit root do not exists. The unit root test results obtained through ADF test (with intercept) are presented in Table.2 It is clear from Table - 2 that all the

absolute test statistics values are more than the critical values therefore; the null hypotheses of non-stationarity are rejected. It is also clear from the P value that all the P values are less than 5 percent therefore the null hypotheses of unit root in the series are denied. Therefore the alternative hypotheses of stationarity are accepted for Forex Reserves and BSE Sensex at first difference.

Based on the cointegration tests, we conclude there is long term relationship between the BSE Sensex and Forex Reserves.

Granger Causality Test

Causality is the relationship between two variables, the first being cause and the second being effect.

Table 3. Johansen Co integration Test

Date: 11/14/15 Time: 08:48				
Sample (adjusted): 7 219				
Included observations: 213 after adjustments				
Series: NFOREX NSENSEX				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
None *	0.198273	47.07013	14.2646	0
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):				
NFOREX	NSENSEX			
-0.007121	0.000973			
-0.002453	-0.0024			
Unrestricted Adjustment Coefficients (alpha):				
D(NFOREX)	133.0938	-14.27743		
D(NSENSEX)	-66.1832	305.5316		
1 Cointegrating Equation(s):		Log likelihood	-3230.29	
Normalized cointegrating coefficients (standard error in parentheses)				
NFOREX	NSENSEX			
1	-0.13668			
	-0.05116			
Adjustment coefficients (standard error in parentheses)				
D(NFOREX)	-0.9477			
	-0.13527			
D(NSENSEX)	0.471261			
	-0.43694			

Table 4. Pair –wise Granger Causality Test

Pair-wise Granger Causality Tests			
Date: 11/14/15 Time: 09:09			
Sample: 1 219			
Lags: 2			
Null Hypothesis:	Obs.	F-Statistic	Prob.
NSENSEX does not Granger Cause NFOREX	219	9.8033	0.0000805
NFOREX does not Granger Cause NSENSEX		0.25031	0.7788

Johansen Co integration Test

The table 3 indicates the cointegrated or non cointegrated price status of BSE Sensex and Forex Reserves. The test results of Johansen cointegration represent the BSE Sensex and Forex Reserves are cointegrated priced over long term. There are two statistic results namely Cointegration Rank Trace statistic and Maximum Eigen value statistic Tests. Trace test indicates 2 cointegrating equations at the 0.05 level since its statistic a value is more than that of critical value and its prob. value is 0 which is less than 0.05. Hence, it denotes rejection of null hypothesis of no cointegration at the 0.05 level. Max-Eigen value test also denotes 2 cointegrating equations at the 0.05 level since their statistic values are also more than that of critical value and its prob. value is 0 and hence, it denies null hypothesis of number of cointegration.

There are two types of causality relationship between these variable, bidirectional causality and unidirectional causality. The relationship between these two variables should be either unidirectional or bidirectional. If F-statistic $\geq$ 3.84 then Alternate hypothesis is accepted. If F- statistic < 3.84 then H_o - Null hypothesis is accepted

Interpretation of Granger causality test E-views

Alternative hypothesis is accepted since its prob. is 0.00008 which is less than 0.05. Hence, Sensex causes Forex. Whereas, for null hypothesis 2, Null hypothesis is accepted which means Forex Reserves does not cause Sensex. Therefore, this proves cause and effect relationship is unidirectional and not bidirectional. Therefore, it appears that Granger causality runs one way from Sensex to Forex Reserves and not other way.

Conclusion

Identifying the link between the BSE Sensex and Forex Reserves is important for the investors and very much essential for establishing the policies of the nation. The present study addressed the question Sensex cause Forex Reserves and Forex Reserves cause Sensex. The empirical study was based on Unit Root Test, Cointegration Test and Granger Causality Test for a period from Jul. 1997 to Sept. 2015. The results of the study reveal that Sensex does Granger Cause Forex Reserves. The BSE Sensex and Forex Reserves are cointegrated. The granger causality study reveals that there is unidirectional causality between the BSE Sensex and Forex Reserves. The causality test reveals no contradictory findings If two or more time-series are cointegrated, then there **must be** Granger causality between them - either one-way or in both directions.

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