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Empirical Study on Interaction between Foreign Exchange Rate and Stock Market Indices Using Econometrics

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Abstract: ***India is one of the most prominent emerging country, sought to lead the globe in terms of growth. The leading indicators of the country namely the Sensex and the Nifty prove the very fact, by gaining new highs in the recent times. The policy implementation by the current government & the RBI, focuses more to ensure sustainable growth with lesser volatility. The foreign exchange rate seems to have stabilized from dropping to a low of Dollar-Rupee of Rs. 70. The measures taken by RBI justify the current move backed by the Government's policy of demonetization and attracting higher inflows. The various studies indicate that there is interaction among these macroeconomic variables. In this context, the study attempts to understand the linkages between the foreign flows and the Nifty in the Indian context. The relevant data was collected from secondary sources for a period of 15 years. The tools used for the analysis were Vector auto regression, Granger Causality and ARDL model. The findings suggest that the Pound inflows are highly significant in influencing the Nifty. It was observed that the Euro and the Yen as well influence the Nifty at 10% significance level.***

Keywords: ***Macro economic variables, Econometric Model, Stationarity, Vector auto regression, ARDL Model, Granger Causality.***

JEL Classification: B22, E44, E47, F31, G15, O11

1. INTRODUCTION

Stock exchange is a reliable barometer which helps to measure the economic condition of a country. Stock market is also known as mirror which reflects the economic condition of country. The volatility in stock exchange has an impact on the economy. Understanding the origin of stock market volatility is a topic of considerable interest to policy makers and financial analyst. Policy makers are interested in main determinants of volatility and its spill-over effects on real activities of the economy. On the other hand, financial analysts are interested in the direct effects, the volatility that exerts on pricing of securities and appropriate hedging in terms of derivatives. The most intimidating characteristics of the stock market is volatility, because it presents the most important opportunity for advantageous investing for those who understand it and have the patience and optimistic to take advantage of it. There are various macro-economic factors that cause the volatility in the stocks viz. the interest rate, inflation rate, economic policies, foreign and domestic institutional investments, foreign trade etc.

The economy of India had undergone significant policy shifts from the beginning of 1990's. The globalisation has led many Indian companies to expand their business in many foreign countries and many foreign companies to trade with India. The most vital liberalisation policy was lesser restrictions on foreign capital control. So, all the above reasons have made foreign institutional investments and foreign trade important factors to influence the economy. These have heightened the interest of MNCs in developing techniques and strategies for foreign exchange exposure management. The barometer of the economy, the Nifty has more influence by the foreign flows and the study focuses to understand the interaction between the foreign exchange rates and the Nifty.

2. REVIEW OF LITERATURE

Md. Lutfur Rahman and Jashim Uddin (2009) investigated the interactions between stock prices and exchange rates in three emerging countries such as Bangladesh, India and Pakistan. The empirical results of their study showed that there was no co integrating relationship between stock prices and exchange rates and then there was no way causal relationship between stock prices and exchange rates in the countries. They have concluded stating that stock prices do not influence exchange rates and past values of stock prices cannot be used to improve the forecast of future exchange rates

Maheenjamil and Naeem Ullah (2013) analysed the impact of US Dollar to Pakistan Rupee exchange rate on the stock market return in Pakistan by taking the monthly data of KSE 100 index data for a time period of 1998 to 2009. They have found that exchange rate had significant impact on stock market return by conducting VECM analysis which had shown that a relationship between the two variables exists in the short run in Pakistan. They had concluded by stating that in short run, market corrects itself to the changes in exchange rate to be in equilibrium

Abdul Rasheed Zubair (2013) estimated the causal relationship between stock market index and monetary indicators like exchange rate and money supply before and during the global financial crisis for Nigeria, using monthly data for the period 2001–2011. The results indicated absence of long-run relationship before and during the crisis and then presence of uni-directional causality before the crisis, while during the period of the crisis there was absence of causality between the variables. So he concluded stating that there is no existence of link between the exchange rate and stock market index for both the period in Nigeria during the period under study.

Rabia Najaf and Khakan Najaf (2016) analysed the relationship between Indian rupee-US dollar exchange rate and Nifty returns. By taking the data from period of October 2008, to march 2010, they had proved that exchange rate and Nifty returns are non-normally disturbed and there was negative relationship between Exchange rate and Nifty returns. Then they had done Granger causality test which had shown that there is unidirectional relationship between Indian rupee-US dollar exchange rate and Nifty returns. They had concluded by stating that if there was increase in the nifty returns then exchange rate will decline.

Oguzhan Ozcelebi and Nurtac Yildirim (2016) examined how exchange rate and stock prices interact in Eastern Europe? Their empirical findings imply that for all cases, the fluctuations in exchange rates may have a considerable role in the variation in stock markets, while variations in stock prices may have macroeconomic consequences by leading to changes in real exchange rates. They also found that the relationship between real exchange rates and stock prices in these countries may be induced by the monetary policy decisions and other domestic and foreign factors.

3. STATEMENT OF PROBLEM

Stock market plays a crucial role in development of a country and the stock market index is an economic barometer. There are various factors that influence stock market index of a country such as economic policies, political forces, performance of top most companies, major industries growth rate, foreign and domestic institutional investments, foreign trade. So the paper attempts to model the foreign exchange rates influences on the stock market index.

4. OBJECTIVES OF STUDY

- To identify the nature of movement between the Exchange rate and the stock market Indices.
- To explain the relationship between the Nifty & exchange rates
- To construct a model on the relationship Nifty & exchange rates
- To appraise the model in terms of causal relationship among the variables.

5. METHODOLOGY

The data for the research was collected through secondary sources. The monthly average of Rupee-US dollar exchange rate, Rupee- Euro exchange rate, Rupee- Pound exchange rate, Rupee-Yen exchange rates, the Nifty and Sensex were collected from January 2000 to July 2016.

6. STATIONARITY TEST

Stationarity means a statisticalproperty of time series whosemean, variance, autocorrelation, etc. are all constant over time. Stationarity can be defined in precise mathematical terms, but for our purpose we mean a flat looking series, without trend, constant variance over time, a constant autocorrelation structure over time and no periodic fluctuations. A stationary series is relatively easy to predict as you can simply predict that its statistical properties will be the same in the future as they have been in the past, so we can use this stationary series to predict future using past which is an important criterion to conduct further analysis.

A series is said to be (weakly or covariance) stationary if the mean and auto-covariance's of the series do not depend on time. ADF test can be specified with no drift and no trend; with trend and no drift; lastly with both trend and drift as follows.

$\Delta Yt = \delta\ Yt-1 + \sum \alpha i\ \Delta Yt-1 + Ut$ — No drift, no intercept

$\Delta Yt = \beta\ 0 + \delta\ Yt-1 + \sum \alpha i\ \Delta Yt-1 + Ut$ — Intercept, no drift term

$\Delta Yt = \beta\ 0 + \beta 1t + \delta\ Yt-1 + \sum \alpha i\ \Delta Yt-1 + Ut$ — With intercept and trend

Furthermore, Phillips-Perron unit root tests are used to reinforce the ADF. One advantage that the Phillips-Perron (PP) test has over the ADF test is that it is robust with respect

to unspecified autocorrelation and heteroscedasticity in the disturbance process of the test regression, Brooks (2000). Therefore, the PP test works well with financial time series. The two tests specify the Null hypothesis (H0) as that the time series has unit root, thus the time series is non-stationary against the Alternative Hypothesis (H1) that the time series has no unit root, thus a stationary time series:

H0: Time series has a unit root ($\delta = 1$)

H1: Time series has no unit root ($\delta \neq 1$)

7. CO INTEGRATION TEST

Co integrationis astatisticalproperty of a collection oftime seriesvariables. First, all of the series must be integrated of order 1. Next, if a linear combination of this collection is integrated of order zero, then the collection is said to be co-integrated. Co integration has become an important property in contemporary time series analysis as unit root processes have non-standard statistical properties, so that conventional econometric theory methods do not apply to them For instance, astock market indexand the price of its exchange ratesmove through time, each roughly following arandom walk. Testing the hypothesis that there is astatistically significantconnection between the stock market index and the exchange rate could now be done by testing for the existence of a co integrated combination of the two series.

8. LAG LENGTH CRITERIA TEST

This test was conducted to select the appropriate number of lags to be taken to create the Vector Auto regression model.

9. VECTOR AUTO REGRESSION(VAR)

Vector auto regression(VAR) is aneconometric modelused to capture the linear interdependencies among multipletime series. VAR models generalize the univariateautoregressive model(AR model) by allowing for more than one evolving variable. All variables in a VAR enter the model in the same way, each variable has an equation explaining its evolution based on its ownlagged values, the lagged values of the other model variables, and anerror term.

10. HETEROSKEDASTICITY TEST

Heteroskedasticity is the circumstance in which the variability of a variable is unequal across the range of values of a second variable that predicts it. Breusch-Pagan-Godfrey Test is used for heteroskedasticity for a linear regression model. According to this test estimated variance of the residuals from a regression are dependent on the values of the independent variables then there is heteroskedasticity.

11. NORMALITY TEST

Normality Test is used to determine whether sample data has been drawn from a normally distributed population or not.

Stability test (Cusum test) :

The CUSUM test is based on the cumulative sum of the recursive residuals. This option plots the cumulative sum together with the 5% critical lines. The test finds parameter instability if the cumulative sum goes outside the area between the two critical lines.

12. GRANGER CAUSALITY TEST

A correlation betweenvariables, however, does not automatically mean that the change in onevariableis the cause of the change in the values of the other variable.Causationindicates that one event is the result of the occurrence of the other event; i.e. there is acausalrelationship between the two events. So, causality means that the change in onevariableis the cause of the change in the values of the other variable.

13. DATA ANALYSIS AND INTERPRETATION:

Augmented Dickey Fuller test was used to test the stationarity of the variables. The results of ADF demonstrated the variables stationary at first difference. In case of the variables at level, the null hypothesis cannot be rejected as the p-values are greater than 5%. The Null is rejected in case of Ist difference.

Variables	P- values at Level	P- values at I st difference
Nifty	0.9508	0.0000
US dollar	0.9532	0.0000
Euro	0.5949	0.0000
Pound	0.3671	0.0000
Yen	0.7466	0.0000

14. TEST FOR COINTEGRATION

Date: 07/19/17 Time: 23:35				
Sample (adjusted): 2000M06 2016M07				
Included observations: 194 after adjustments				
Trend assumption: Linear deterministic trend				
Series: EURO NIFTY POUND USD YEN SENSEX				
Lags interval (in first differences): 1 to 4				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.106894	69.17755	95.75366	0.7493
At most 1	0.089466	47.24575	69.81889	0.7516
At most 2	0.068414	29.06322	47.85613	0.7653
At most 3	0.044400	15.31504	29.79707	0.7593
At most 4	0.025103	6.504446	15.49471	0.6359
At most 5	0.008072	1.572312	3.841466	0.2099
Trace test indicates no cointegration 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	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.106894	21.93180	40.07757	0.9194
At most 1	0.089466	18.18253	33.87687	0.8683
At most 2	0.068414	13.74818	27.58434	0.8396
At most 3	0.044400	8.810591	21.13162	0.8474
At most 4	0.025103	4.932134	14.26460	0.7504
At most 5	0.008072	1.572312	3.841466	0.2099
Max-eigenvalue test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

The Johansen co-integration test was used to check the co-integration of the variables at level, and it proved that, there is no-cointegration among the variables in both Trace statistics and the Max-Eigen value. The P-values of the variables were not significant to observe cointegration. Hence, we conclude that the variables are not cointegrated and Vector auto regression was used to find the relationship between the variables.

15. VECTOR AUTO REGRESSION

The estimation of VAR was done using stationary Ist difference of Nifty, USD, Euro, Pound, and, Yen. The results are as shown below.

System: UNTITLED				
Estimation Method: Least Squares				
Date: 07/18/17 Time: 11:32				
Sample: 2000M04 2016M07				
Included observations: 196				
Total system (balanced) observations 980				
	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.201356	0.090308	2.229652	0.0260
C(2)	-0.130575	0.095370	-1.369139	0.1713
C(3)	-45.74593	29.15567	-1.569023	0.1170
C(4)	-21.89090	29.14510	-0.751100	0.4528
C(5)	4.708243	16.52121	0.284982	0.7757
C(6)	-16.07997	16.68581	-0.963691	0.3355
C(7)	3.658148	14.26241	0.256489	0.7976
C(8)	33.87471	13.62868	2.485545	0.0131
C(9)	20.65342	15.80482	1.306780	0.1916
C(10)	-9.624298	15.89719	-0.605409	0.5451
C(11)	36.13540	17.22924	2.097330	0.0362
Observations: 196				
R-squared	0.101281	Mean dependent var		35.20383
Adjusted R-squared	0.052702	S.D. dependent var		228.8302
S.E. of regression	222.7187	Sum squared resid		9176670.
Durbin-Watson stat	1.933963			

Equation: DNIFTY = C(1)*DNIFTY(-1) + C(2)*DNIFTY(-2) + C(3)*DUSD(-1) + C(4)*DUSD(-2) + C(5)*DEURO(-1) + C(6)*DEURO(-2) + C(7)*DPOUND(-1) + C(8)*DPOUND(-2) + C(9)*DYEN(-1) + C(10)*DYEN(-2) + C(11)

The VAR estimates were significant with lagged values of Nifty & the Pound. The probability of C(1) and C(8) are less than 0.05 or 5% which infers that;

- DNIFTY(-1) i.e. previous period differenced nifty values and

- DPOUND (-2) i.e. differenced pound values of two lagged periods were significant in influencing the current nifty values. So, the model was created using these two variables.

ARDL Model:

DNIFTY c 0.20135550888*DNIFTY (-1) 33.8747095949*DPOUND(-2)

Dependent Variable: DNIFTY				
Method: Least Squares				
Date: 07/18/17 Time: 11:58				
Sample (adjusted): 2000M04 2016M07				
Included observations: 196 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	25.53674	16.04736	1.591335	0.1132
0.20135550888*DNIFTY(-1)	1.077336	0.345795	3.115530	0.0021
33.8747095949*DPOUND(-2)	0.553110	0.245882	2.249490	0.0256
R-squared	0.070415	Mean dependent var		35.20383
Adjusted R-squared	0.060782	S.D. dependent var		228.8302
S.E. of regression	221.7668	Akaike info criterion		13.65632
Sum squared resid	9491837.	Schwarz criterion		13.70649
Log likelihood	-1335.319	Hannan-Quinn criter.		13.67663
F-statistic	7.309795	Durbin-Watson stat		1.963003
Prob(F-statistic)	0.000871			

The model was observed significant from the P-value of the F-statistic (0.000871), No autocorrelation with DW Stat. of 1.96 and an R-squared value of 7%. The current value can be predicted by past Nifty value and the pound value with an co-efficient of determination of 7%.

The model was tested for Auto-correlation, heteroskedasticity, normality, and Stability.

Correlation test:

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.556876	Prob. F(2,191)	0.5739
Obs*R-squared	1.136282	Prob. Chi-Square(2)	0.5666

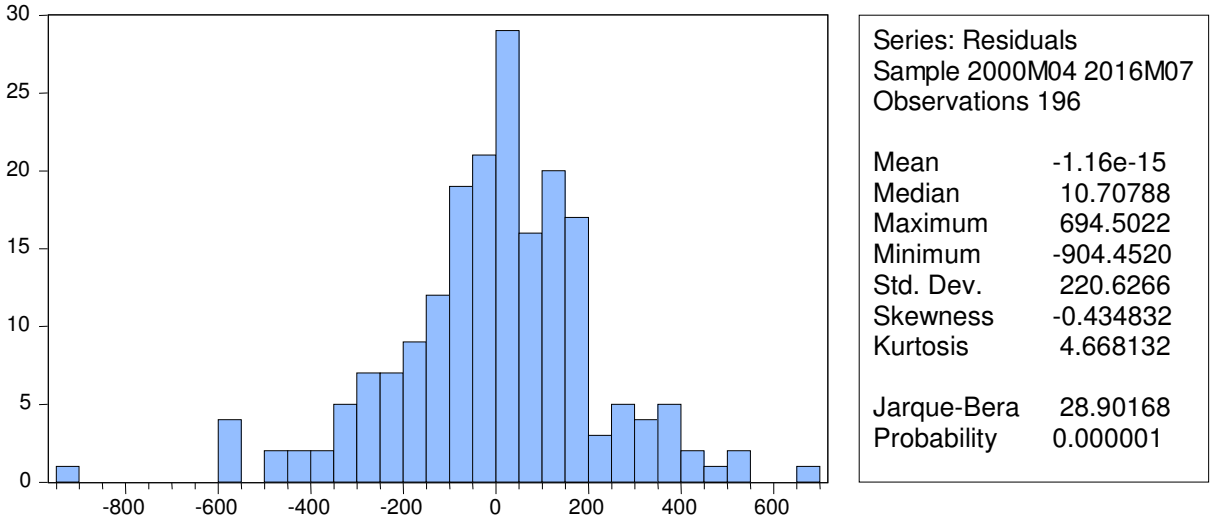
From the above result of the serial correlation test, the p-value of the chi square is more than 0.05 or 5% which is 56.66% and therefore we cannot reject the null hypothesis that there is no serial correlation in the residuals.

Heteroskedasticity test:

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.917739	Prob. F(2,193)	0.4012
Obs*R-squared	1.846449	Prob. Chi-Square(2)	0.3972
Scaled explained SS	3.283634	Prob. Chi-Square(2)	0.1936

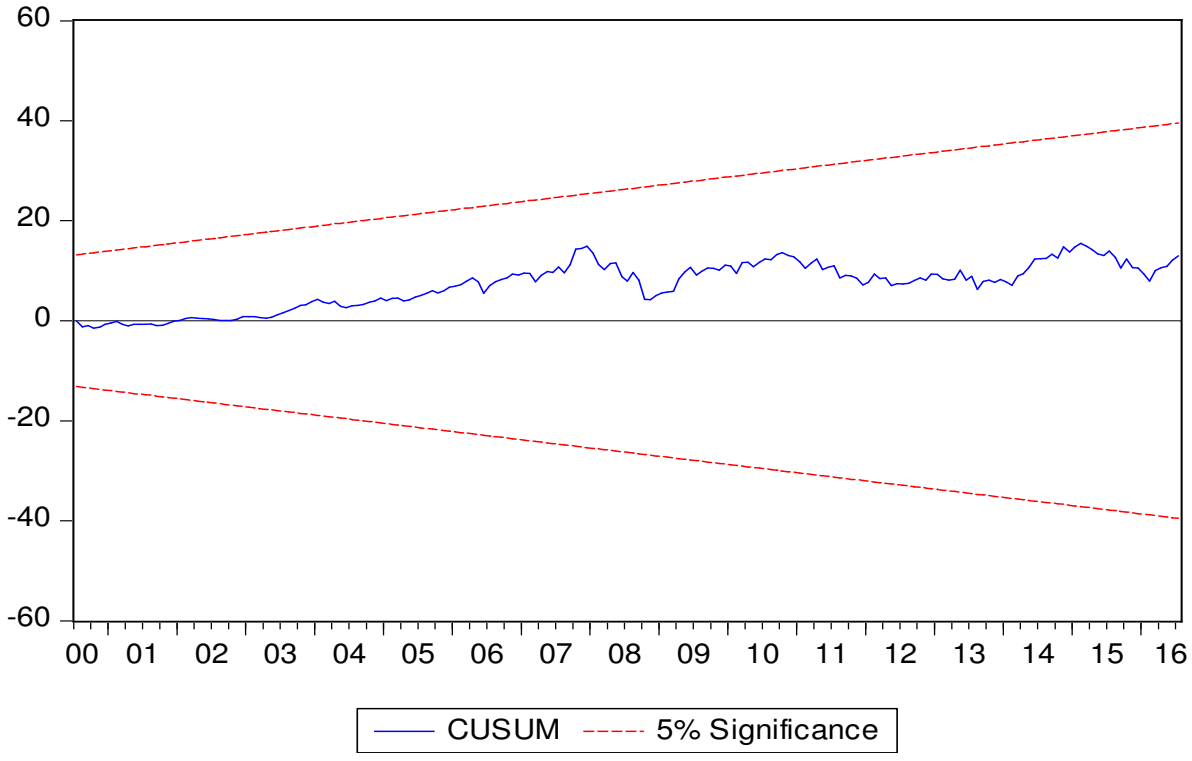
From the above, the p-value of the chi square with the observed R square is more than 0.05 or 5% that is 0.1936 or 19.36% thus the residuals are homoscedastic.

Normality test:



From the above, it was inferred from the P-value that the residuals are not normally distributed.

Stability test:



From the above graph, the blue line of the data is within the 5% significance lines. This infers that the model is stable.

Granger Causality test:

Pairwise Granger Causality Tests			
Date: 07/18/17 Time: 13:04			
Sample: 2000M01 2016M07			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DUSD does not Granger Cause DNIFTY	196	0.32303	0.7243
DNIFTY does not Granger Cause DUSD		1.16432	0.3143
DEURO does not Granger Cause DNIFTY	196	0.47021	0.6256
DNIFTY does not Granger Cause DEURO		2.75480	0.0662
DPOUND does not Granger Cause DNIFTY	196	2.14945	0.1194
DNIFTY does not Granger Cause DPOUND		6.35075	0.0021
DYEN does not Granger Cause DNIFTY	196	0.23580	0.7902
DNIFTY does not Granger Cause DYEN		0.19229	0.8252
DEURO does not Granger Cause DUSD	196	1.51757	0.2219
DUSD does not Granger Cause DEURO		0.19571	0.8224
DPOUND does not Granger Cause DUSD	196	0.75407	0.4718
DUSD does not Granger Cause DPOUND		0.50302	0.6055
DYEN does not Granger Cause DUSD	196	1.59824	0.2049
DUSD does not Granger Cause DYEN		1.74848	0.1768
DPOUND does not Granger Cause DEURO	196	0.45742	0.6336
DEURO does not Granger Cause DPOUND		0.18850	0.8284
DYEN does not Granger Cause DEURO	196	2.50317	0.0845
DEURO does not Granger Cause DYEN		0.61956	0.5393
DYEN does not Granger Cause DPOUND	196	2.55921	0.08
DPOUND does not Granger Cause DYEN		0.57925	0.5613

The results of pairwise Granger causality, suggests that Yen Granger causes the Euro & the Pound at 10% significance level, the Nifty Granger causes the Pound at 5% and the Euro at 10% level of significance respectively. The causality was observed to be unidirectional.

16. CONCLUSION

From the analysis, it can be concluded that nifty was influenced by its past values and pound values of two lagged periods and the other exchange rates were not significant in influencing the nifty value. The model which was created using the nifty past value and pound value was stable and the residuals were homoscedastic and not normally distributed. From the granger causality test it was found that the relationship that exists between nifty and pound was unidirectional.

17. LIMITATIONS

The secondary data collected for analysis is limited to 16years from 2000 to 2016. There was no information about exchange rates other than USD, Euro, Pound, and Yen. So, it was unable to see the impact of other country's currency exchange rate on Indian stock market. It was found that only pound was significant in influencing nifty, so the model was created using that exchange rate.

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