Effect of Demonetisation of on Indian High Denomination Currencies on Indian Stock Market and its Relationship with Foreign Exchange Rate

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Abstract: This study examines the impact of foreign exchange rate, i.e., US Dollar to Indian Rupee (USD/INR) on Indian Stock Market Index (Nifty 50) during demonetisation of high denomination Indian currencies. Daily rate of return of Foreign exchange rate (USD/INR) and Indian Stock Market Index (Nifty 50) were considered for the study. 'Dummy' variable was used to measure the effect of demonetisation during Nov/Dec 2016. The period of study was restricted to 243 days from 1st April 2016 to 31st March 2017. Study reveals that there was an upward trend observed in Indian Stock Market and Indian currency was strengthened with the decrease in Foreign exchange rate (USD/INR).

Key words: Exchange rate, Indian stock market, ARCH GARCH, Foreign exchange, strengthened, demonetisation

INTRODUCTION

November 8th 2016 when entire global was anxiously looking for Presidential election in US, Indian Prime Minister Narendra Modi announced that the high denomination notes of 500 and 1,000 would cease to be legal. The 50 days period was given to Indian population to exchange their old 500 and 1000 rupees notes with new currencies by depositing them into bank. It was a drastic monetary step in which a currency units states as a legal tender is declares invalid. This is done whenever there is a change of national currency, replacing the old unit with a new one. It aimed to wash-down the stock of black money supply and to remove the fake note out of economy (Law, 2013). After demonetization of Indian currency, rupee has become stronger against good number of currencies including US Dollar ($), Euro, Australian Dollar, Singapore Dollar, Japanese Yen, British Pound and had become weaker against few currencies viz., Russian Ruble and South African Rand. It was also observed that, Indian stock market also reacted positively with demonetisation.

Literature review: Demonetisation had effected the cash transaction as there were shortages of lower denomination currencies like 50 and 100. During demonetization payment became big problem. Many micro/tiny businesses were shut down and many days there was no payment for working class, especially, daily workers like painter, carpenter, plumber, electrician, this resulted in unemployment. Totally it disturbed the ordinary people and livelihood of weaker sections of society. According to Nikkei India, Manufacturing Purchasing Manager's Index (PMI) fell to from 52.3-49.6 in indicating a downturn in the overall manufacturing activity. Cash crunch has resulted in lower purchasing activity in turn leading to lower manufacturing output. Cash delivery business came to standstill. Real estate business and other sectors depended on cash transaction suffered loss. This reveals that all the sectors of Indian stock market affected because of demonetisation. Hence, the study on exploring the interaction between Indian stock Market and foreign exchange rate found optimal (Murthy et al., 2016).

One of the significant indicators of vigorous fluctuations in stock prices is volatility of stock market. Considerate volatility in stock markets is vital for the assessment of investment and leverage decisions as it has substantial impact on risk-averse investors. Exchange rate is one of the most important factor for any economic growth of any country, it has direct effect on international trade. Exchange rate can be best comprehended as just a benchmark for a country's cash supply. Due to the ban of 500 and 1000 denominator currency by the Indian government has impacted the exports in sectors like agriculture due to high number of cash transactions. This ban greatly impacted the growth of export-import EXIM trade. Financial economists, academicians and policy

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Fig. 2: Daily data and return of Nifty

Table 2: Unit root test of daily return of Nifty and Foreign exchange rate

Augmented Dickey-Fuller test statistics	NIFTY		USD/INR	
	t-statistics	Prob.	t-statistics	Prob.
Test critical values				
-	-15.2807	0.0000	-14.4027	0.0000
1% level	-3.4568		-3.45684	
5% level	-2.8730		-2.87309	
10% level	-2.5730		-2.57300	

Calculated from the data taken from NSE and Quandl.com.com website for a selected period using e-Views Software

Table 3: Results of estimated regression model NIFTY = $C_1 + C_2$*USD_INR+e ----- (1)

Variables	Name of the variable	Estimated coefficient	SE of coefficient	T-statistic	Probability
Constant	C1	0.065626	0.047851	1.371449	0.1715
USD_INR	C2	-0.893770*	0.164304	-5.439741	0.0000

R^2, 0.109356; Akaike info criterion, 2.259136; F-statistic, 29.59078; Schwarz criterion, 2.287885; Prob. (F-statistic), 0.000000*; Durbin-Watson statistic, 2.066633*; Significant at 1%

Wasiuzzaman, 2011). It depicts that the trend was almost stationary from 150-185 days and then there is continuous upward trend in the Indian Market. Return on Stock market was found stationery (Kamble and Honrao, 2014).

From Fig. 2 analysis it was found that, during 150-185 days, the Indian Stock Market had shown sensitiveness indicating that 'demonetisation of higher denomination currency' has made a greater impact on stock market. In order to identify and measure this effect, we has used another variable named as 'Dummy'.

Model: We have used three variables such as Indian Stock Market Index (Nifty 50), United States Dollar (USD) and Dummy variable in 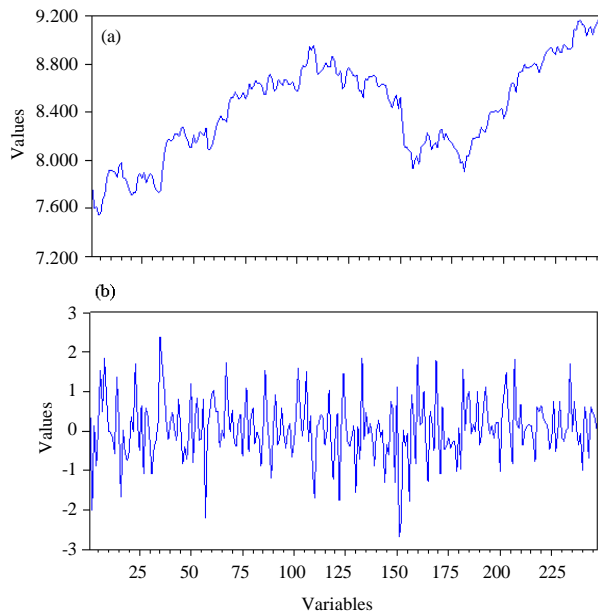this model. Here our data for dummy is from 9/11/2016 to 31/12/2017. Here we have used dummy variable (Dummy) to capture the effect of Demonetisation on Indian Stock market. Here, Dummy = 0, prior to demonetisation period 1/4/2016 to 8/11/2016) and after demonetisation period (1/1/2017 to 31/03/2017) while Dummy = 1 during demonetisation period (9/11/2017 to 31/12/2017).

If the Dummy variable is found significant and positive, demonetisation of high denomination Indian Currency has a positive impact on Nifty along with the foreign exchange rate of two currencies (Amatyakul and Chintrakarn, 2012).

Unit root test (stationary test): We expect that time series data should stationary to run Auto-regressive models at

levels. Hence, Stationery test for different data series were conducted through Augmented Dickey Fuller Test (ADF). The results of ADF shown in Table 2.

The ADF statistic value for Nifty is -15.2807, USD/INR is -14.4027 and the associated one-sided p-value (for a test with 243 observations) is 0.00 for all the variables. Test Critical values at the 1, 5 and 10% levels are shown in Table 2. It was found that, the t-statistics is less than the critical values meaning that variables does not have unit root and is desirable at level.

Regression model: The regression estimation with the variables viz., retun on Indian Stock Market (Nifty) and US Dollar (USD-IND) are shown in Eq. 1. Mean equation:

$$NIFTY = C_1 + C_2 * USD\_INR + e \quad (1)$$

Where:
Nifty = Return on stock market return, C_1= constant
USD_INR = Return on Exchange rate of US dollar
e = Residual. Here we have taken return on daily data of 243 days

The result of estimated regression equation is shown in Table 3. The test of significance was done by t-statistics. T-statistic is used to examine the hypothesis that the estimated coefficient is equal to zero or not. p-value is used to interpret the t-statistic. When the p-value is less than or equal to 5% (0.05), then the independent variable is significant to influence the dependent variable. F-statistics reported in the regression output is from a test of the hypothesis that all of the slope of the coefficients in a regression are zero. F-test is a joint test which can be highly significant, even if t-statistics are insignificant for the variables. Means independent variables should be jointly significant to influence dependent variable. If the
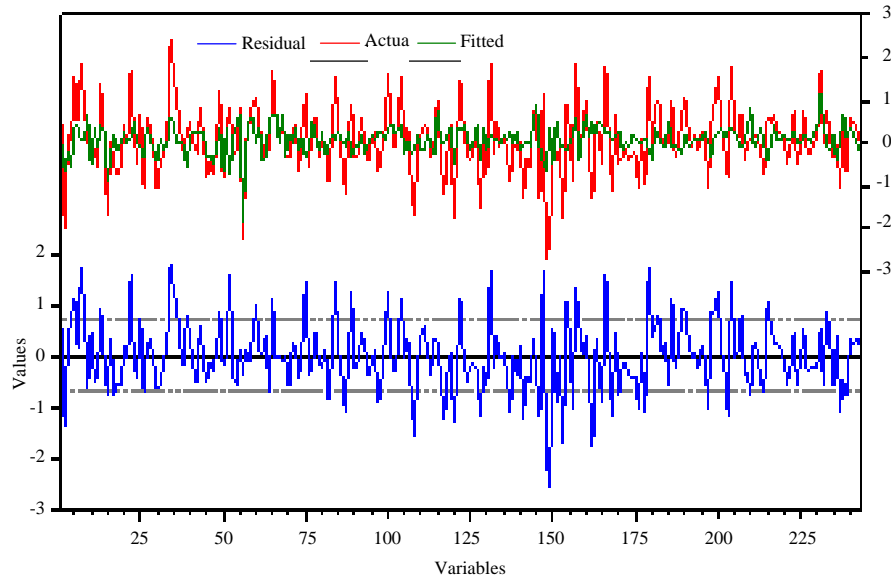
Fig. 3: Residual data graph

p-value is less than the significant level of testing, reject the null hypothesis that all slope coefficients are equal to zero.

Arch test: In order to fit ARCH/GARCH Model we should run the regression model to see that the residuals should be stationery. The graphical representation of residual data are shown in Fig. 3.

It is found that periods of low volatility followed by periods of low volatility and periods of high volatility is followed by periods of high volatility for a continued period indicating volatility clustering. When this is observed for the residuals, then we can justify to run ARCH family model. This can further investigated by adopting ARCH test.

Heteroskedasticity LM test will be conducted with the following Hypothesis. Null: there is no ARCH affect. Alternative; there is ARCH effect (Table 4).

It is found that probability of Chi-square is 0.0219 which is <5% meaning that we can reject null hypothesis and we can accept alternative hypothesis. So, we can run the ARCH/GARCH Model.

Development of GARCH (1, 1) Model: The development of General GARCH (1.1) Model consists of two equations viz., Mean equation and variance equation. Mean Equation is represented by:

$$NIFTY = C_1 + C_2 * USD\_INR + e \qquad (1)$$

Table 4: Heteroskedasticity test

Variables	Values
F-Statistics	5.3231
Probability F(1.240)	0.0219*
Obs.* R^2	5.2510
Prob. Chi-square	0.0219*

*Significant at 1%

and variance equation is represented by:

$$GARCH = C3 + C4 * (RESID(-1))2 + \\ C5 * GARCH(-1) + C_6 * DUMMY + e \qquad (2)$$

Where:

GARCH	=	Residual variance (error term) derived from the mean (Eq. 1). It is also known as present/current day's variance or volatility of Stock Market Return (NIFTY) (Olweny and Omondi, 2011)
$(RESID(-1))^2$	=	Previous period's residual square obtained from Eq. 1 and is known as Lag/previous day's return information regarding volatility. It is known as ARCH term
GARCH (-1)	=	Lag/Previous day's variance residual or volatility of Stock Market Return (NIFTY). Term is known as GARCH
DUMMY	=	Variable to represent the effect of demonetisation

Results discussion of GARCH (1, 1) Model: The study has been done with Nifty as dependent variable, USD/INR as exogenous variable in mean equation and DUMMY as exogenous variable in variance equation

Table 5: Results of GARCH (1,1) Model

NIFTY = C_1+C_2*USD_INR+e----- (1)

GARCH = C_3+C_4*(RESID (-1))^2+C_5*GARCH (-1)+

C_6*DUMMY+e ---- (2)

Variables	Name of the variable	Estimated coefficient	SE of coefficient	Z-statistic	Probability
Constant	C1	0.1301	0.0444	2.9317	0.0034
USD_INR	C2	-0.7500*	0.1312	-5.7156	0.0000
Variance equation with normal gaussian distribution					
Constant	C3	0.7221*	0.1194	6.0474	0.0000
(RESID (-1))^2	C4	-0.0555	0.0344	-1.6142	0.1065
GARCH (-1)	C5	-0.5574*	0.1895	-2.9402	0.0033
DUMMY	C6	1.2325*	0.2215	5.5645	0.0000

R^2, 0.109356; Akaike info criterion, 2.259136; Durbin-Watson statistic, 2.066633; Schwarz criterion, 2.287885; *Significant at 1%

Table 6: Results of GARCH (1,1) Model

NIFTY = C_1+C_2*USD_INR+e----- (1)

GARCH = C_3+C_4*(RESID (-1))^2+C_5*GARCH (-1)+

C_6*DUMMY+e ---- (2)

Variables	Name of the variable	Estimated coefficient	SE of coefficient	Z-statistic	Probability
Constant	C1	0.1091	0.0414	2.6320	0.0085
USD_INR	C2	-0.6705*	0.1313	-5.1064	0.0000
Variance equation with normal generalised error distribution					
Constant	C3	0.7030*	0.1495	4.7012	0.0000
(RESID (-1))^2	C4	-0.0592	0.0357	-1.6583	0.0972
GARCH (-1)	C5	-0.5285*	0.2266	-2.3321	0.0197
DUMMY	C6	1.2531*	0.3154	3.9723	0.0001
GED parameter		1.4108*	0.2275	6.2011	0.0000

R^2, 0.0997; Akaike info criterion, 2.1775; Durbin-Watson statistic, 2.0323; Schwarz criterion, 2.2781*; Significant at 1%

Table 7: Results of GARCH (1,1) Model

NIFTY = C_1+C_2*USD_INR+e----- (1)

GARCH = C_3+C_4*(RESID (-1))^2+C_5*GARCH (-1)+

C_6*DUMMY+e ---- (2)

Variables	Name of the variable	Estimated coefficient	SE of coefficient	Z-statistic	Probability
Constant	C1	0.1130	0.04313	2.6204	0.0088
USD_INR	C2	-0.6855*	0.12790	-5.3590	0.0000
Variance equation with students't distribution					
Constant	C3	0.6868*	0.17100	4.0157	0.0001
(RESID (-1))^2	C4	-0.0595	0.03228	-1.8438	0.0652
GARCH (-1)	C5	-0.4876*	0.21440	-2.2738	0.0230
DUMMY	C6	1.3162*	0.51130	2.5793	0.0101
T-Dist. DOF		7.7117	6.10210	1.2647	0.2059

R^2, 0.10000; Akaike info criterion, 2.1909; Durbin-Watson statistic, 2.0329; Schwarz criterion, 2.2916*; Significant at 1%

(Bucevska, 2013). Three types of distribution viz., Normal Gaussian, Generalised Error and Student's t distribution with were used in this study. The results were shown in Table 5-7.

Normal gaussian distribution: Here, Coefficients of Return on exchange rate USD/INR (-0.7500) is found significant meaning that the return on exchange rate can influence the volatility of Nifty. GARCH term is found to be significant with the coefficient of -0.55574. It means that lag period/previous day Nifty's return volatility (C_5 in Eq. 2) can influence today's Nifty's volatility of return. In addition DUMMY variable also found highly significant at 1% with 1.2325. It means that Volatility of Nifty return is influenced by GARCH, DUMMY factor and the exchange rates.

Generalised error distribution assumption: Here, Coefficients of Return on exchange rate USD/INR (-0.6705) is found significant meaning that the return on exchange rate can influence the volatility of Nifty. GARCH term is found to be significant with the coefficient of -0.5285. It means that lag period/ previous day Nifty's return volatility (C_5 in Eq. 2) can influence today's Nifty's volatility of Return. In addition DUMMY variable also found highly significant at 1% with 1.2531. It means that Volatility of Nifty Return is influenced by GARCH, DUMMY factor and the exchange rates.

Student's t distribution: Here, coefficients of return on exchange rate USD/INR (-0.6855) is found significant meaning that the return on exchange rate can influence the volatility of Nifty. GARCH term is found to be significant with the coefficient of -0.4876. It means that lag period/ previous day Nifty's return volatility (C_5 in Eq. 2) can influence today's Nifty's volatility of Return. In addition DUMMY variable also found highly significant at 1% with 1.3162. It means that Volatility of Nifty Return is influenced by GARCH, DUMMY factor and the exchange rates.

Residual diagnostic test for GARCH (1, 1) model: Residual diagnostic was conducted for GARCH (1, 1) Model to select the desirable model to measure the volatility of stock market return with the effect of demonetisation (Ali *et al.*, 2015).

Testing for serial correlation: Estimated equation should be examined for the evidence of serial correlation by applying Correlogram square residual (Q test) test. Following are the assumptions of the test.

- Null: there is no serial correlation in the residual or error term
- Alternative: there is serial correlation

Q-statistics are insignificant in all distribution with large p>0.05, we accept null hypothesis indicating that there is no serial correlation in the residuals (Table 8).

Heteroskedasticity lm test: This ARCH test is to check whether residuals are auto correlated. Following are hypothesis.

Table 8: Correlogram of squared residual

Lag	Normal gaussian distribution		Generalised error distribution		Student's t distribution	
	Q-stats	Probability	Q-stats	Probability	Q-stats	Probability
1	0.1302	0.718	0.1831	0.669	0.2261	0.634
2	1.8980	0.387	2.1954	0.334	2.4098	0.300
3	3.0285	0.387	4.4167	0.220	4.8498	0.183
4	5.5086	0.239	8.3494	0.080	8.7262	0.068
5	7.1555	0.209	8.8900	0.114	9.2951	0.098

Table 9: ARCH test

Factors	Normal gaussian distribution	Generalised error distribution	Student's distribution
F-statistics	0.5858	0.9195	0.9414
Probability F(1.240)	0.4448*	0.3386*	0.3329*
Obs.* R^2	0.5893	0.9236	0.9455
Prob. Chi-square	0.4427*	0.3365*	0.3308**

Significant at 1%

Table 10: Normality test

Factors	Normal gaussian distribution	Generalised error distribution	Student's distribution
Jarque-bera statistics	2.5962	2.6088	2.5963
Probability	0.2730*	0.2713*	0.2731*
Skewness	0.1229	0.0785	0.0932
Kurtosis	3.4427	3.4826	3.4706*

Significant at 1%

- Null: there is No ARCH Effect
- Alternative: there is ARCH effect

It is found that probability of Chi-square is more than 5% meaning that we can accept null hypothesis which says that there is no ARCH effect (Table 9).

Normality test: Residual Diagnostics/Histogram-Normality Test describes shows descriptive statistics and a histogram of the residuals. Jarque-Bera statistic is the component to diagnose whether the residuals are normally distributed or not. If the standardized residuals are normally distributed, the Jarque-Bera statistic should not be significant (Table 10).

- Null: residuals are normally distributed
- Alternative: residuals are normal

The probability of Jaqua-Bera is more than 5%. Null hypothesis is rejected for all distribution. It indicates that residuals are normal which is desirable.

Model selection: After residual diagnostic check, it was found that GARCH (1, 1) Model with all the distribution found satisfactory with Q-test for serial correlation, ARCH-test for Heteroskedasticity and normality test with Jarque-Bera statistics. Hence, all the models are accepted. Hence, desirable model will be generalised error distribution with lowest AIC value of 2.1775.

CONCLUSION

Modeling and forecasting the volatility of return on stock market has become an important field of empirical research in finance. This is because volatility is considered as an important concept in many economic and financial applications. This study attempts to explore the interaction between Exchange rates and Indian Stock Market during demonetisation of Indian currency. The volatility of the Indian Stock Market returns have been modeled by using Generalized Autoregressive Conditional Heteroscedastic (GARCH) Models that captures most common stylized facts about exchange returns such as volatility clustering and leverage effect, following three residual distributions viz., normal, Student's t-distribution and Generalised Error distribution. The model is used for capturing the symmetry effect. The study used the USD/INR exchange rates data for the period 1st April 2016 to 31st March 2017 as exogenous variable and dummy variable was used to measure the impact of demonetisation. On the basis of observed results, the following are the conclusions.

Daily returns are charecterised by these models with strong confirmation. The exchange rate USD/INR showed a significant movement from normality and there exists a conditional heteroscedasticity in the residuals series. (Tripathy and Rahman, 2013). Descriptive statistics for the USD/INR exchange rates shows existence of negative skewness and low kurtosis. The results of the ARCH-LM test conducted point out significant presence of ARCH effect in the residuals as well as volatility clustering effect. All models were found satisfactory in all the diagnostic tests and Generalised Error Distribution model is desirable to select as best model with lowest Akaike Information Criteria 4 (Gokbulut and Pekkaya, 2014).

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