THE EFFECT OF CURRENCY FUTURES TRADING ON INDIAN CURRENCY MARKET

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ABSTRACT

In this paper, we have examined the impact of the introduction of currency futures in Indian currency market by using data on daily closing prices on exchange rates of USDINR from 30 August 2004 to 31 August 2012 by dividing it into two parts i.e. pre & post derivatives and similarly taken data on daily closing prices on exchange rate of GBPINR, EURINR & YENINR from 2 January 2006 to 31 December 2013 in a GARCH (1, 1) framework capturing heteroscedasticity in currency pairs return series. Graphs show volatility clustering. The result of the ARCH-LM test confirms the presence of ARCH effect in all the return series. GARCH (1, 1) gives us good fit to the daily currency pair return series. Both a_1 *and* b_1 *are statistically significant. The sum of* a_1 *and* b_1 *is very close to unity except in the case of POSTEURINR implying shocks to the conditional variance is highly persistent. Thus, overall the derivatives has positive impact on GBPINR, EURINR & YENINR but have negative impact on USDINR as* $(a_1 + b_1)$ *has increased in case of USDINR and decreased in all other cases.*

Keywords

Currency Futures, Volatility, GARCH (1, 1), Heteroscedasticity, Persistence

Introduction

In India, trading in derivatives started in June 2000 with the launch of futures contracts in the BSE Sensex and the S&P CNX Nifty Index on the Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) respectively. Options trading commenced in June 2001 in the Indian market, respectively. Since then, the futures and options (F&O) segment has been growing continuously in terms of new products, contracts, traded volume & value. At present, the NSE has established itself as the market leader in this segment in India, with more than 99% market share. NSE was the first exchange to have received an in-principle approval from SEBI for setting up currency derivative segment. The exchange launched its currency futures trading platform on 29thAugust, 2008. Currencies futures on USD-INR were introduced for trading and subsequently the Indian rupee was allowed to trade against other currencies, Such as euro, pound sterling and the Japanese yen. Currency Options was introduced on October 29, 2010. Compared to other financial markets, FX markets have unique features in terms of their structure, composition, effects of change in technology & regulations. Indian FX markets offer an interesting case study of the process of market development. The average daily turnover has increased

drastically after the introduction of futures in currency market. In 2008-09, average daily turnover was ₹ 1167.43 Cr. which was increased to ₹ 7427.53 Cr in 2009-10, ₹ 13,854.57 in 2010-11 and similarly in subsequent years. After the introduction of futures trading, there has been discussion over the impact of futures on underlying spot market. A number of researches have been taken in this area with two different arguments and debate got intensified on the negative or positive impact of futures trading on the underlying market volatility.

In one way, futures market increases market volatility since it attracts uninformed traders because of their degree of leverage with respect to cash market traders and on the other way futures market reduces spot market volatility since futures market plays an important role in price discovery, increases market depth and enhances efficiency. It is also used for hedging which reduces the risk and increase liquidity in the market which stabilizes market.

Volatility is a measure of variability in the price of an asset. Volatility is associated with unpredictability and uncertainty about the price. It is difficult to estimate about the future trend of volatility in market because it is affected by a large number of factors including political instability, economic fundamentals, government decisions, corporate performance, international markets etc. However, by calculating historical volatility a prediction can be assumed about the future trend in the volatility. Traditionally volatility is measured using a constant one period variance. A new class of stochastic process called autoregressive conditional heteroscedasticity (ARCH) was introduced by Robert F. Engle in 1982 after which many extensions of that model were developed.

This research is to observe and analyse the effect of introduction of currency futures on spot market for exchange rate and attempts to find out whether introduction of currency futures has increased the volatility in spot market of forex or not.

To analyse the relationship between the futures trading and the volatility, the Generalized Autoregressive Conditional Heteroscedastic (GARCH) family of statistical techniques is utilized which is one of the key econometric technique employed in most of the previous studies. The paper tries to determine whether the introduction of futures market affect the volatility of underlying spot market positively or negatively.

The next section presents a brief review of the theoretical literature and of the main results of previous empirical studies. Section 4 is related to objectives & Hypotheses of the paper, thereafter Section 5 give details about the study period &data set. Section 6 describes about research methodology used in the paper. Section 7 shows the empirical results of this study and Section 8 concludes the paper.

Literature Review

There are three different and opposing arguments exist in the literature about the impact of the introduction of futures trading into the underlying spot markets. Several studies are undertaken to examine the effect of Index futures on the volatility of stock market.

Edwards (1988), Harris (1989), Lasttch (1991), Chan et. al. (1992), Rahman (2000), Sathya Swaroop Debasish (2009) use data from various stock markets and conclude that there is no change on the volatility of these markets before and after introduction of futures.Some scholars like Bessermbinder and Senguin (1992) , Robinson (1993) , Kumar, Sarin and Shastri (1995) , Thenmozhi (2002) , Nath (2003), find that there is a decrease in the volatility while some researchers like Hung, Lee and So (2003) , Bae , Kwon and Park (2004) , Rao (2007) find that the reverse is true. All of them have used data from different markets in different countries.

The first group of researchers supports the argument that futures trading increase the volatility of the underlying market and so destabilize the market. In this argument, following are the prominent researchers:-

Cox (1976) argued that the main cause of destabilization of the underlying spot market is the presence of uninformed traders in the derivatives market.

Finglewski (1981) supports the same argument by stating that a lower level of information of futures participants compared to that of cash market traders results in increased spot market volatility.

Clifton (1985) observed an increase of volatility in the currency spot market after the introduction of futures by using data from chicago's International Monetary Market.

Stein (1987) develops a model in which prices are determined by the interaction between hedgers and informed speculators. If the speculators observe a noisy but informative signal, the hedgers react to the noise in the speculative trades, producing an increase in volatility.

Antoniou and Holmes (1995) suggested an increased volatility following the introduction of the FTSE100 index futures contract for the London Stock Exchange.

Bologna and Cavallo (2002) investigated the effect of the introduction of stock index futures on volatility of the Italian stock exchange by employing GARCH techniques. They concluded that the introduction of the stock index futures trading has led to diminish the stock market volatility, due to the increased impact on recent news and reduced effect of the uncertainty originating from the old news.

Bandivadekar & Ghosh (2003) found a decline in volatility of Nifty and BSE Sensex after futures introduction.

Ryoo and Graham Smith (2003) studied the impact of introduction of KOSPI 200 futures on Korean stock market using data for the period from 1 September 1993 to December 1998. Using GARCH models they concluded that futures trading increase the speed at which information impounded into the spot market prices, reduces the persistent of the information and increase the spot market volatility.

Mazouz, Khelifa, and Michael Bowe (2006), investigated the impact of LIFFE's introduction of individual equity futures

contracts on the risk characteristics of the underlying stocks trading on the LSE. He did not found any evidence that futures innovation impacts on either the systematic risk or the permanent component of the residual variance of returns.

Drimpets and Sariannidis (2007), studied the effect of the introduction of the futures and options to FTSE/ ASE 20 Index on volatility of underlying and found that there is a reduction in spot market volatility after introduction on stock index futures trading.

The second group of researchers supports the argument that futures trading decrease the volatility of the underlying market and not destabilize the market. In this argument, following are the prominent researchers:-

Danthine (1978) argue that the futures market improves market depth and reduce volatility because the cost to informed traders of responding to mispricing is reduced.

Glen and Jorion (1993) examined the utility of currency futures/forwards and concluded that currency risk can be minimized through futures/forward hedging.

Butterworth (2000) also argued that introduction of the derivative trading leads to more complete market enhancing the information flow. Derivatives trading bring more information to the market and allows for quicker disseminations of the information. The transfer of the speculative activity from spot to futures market decreases the spot market volatility.

Vipual (2006) studied the volatility of NSE 50 index before and after introduction of Nifty futures trading and found a decline in volatility of Nifty index each year from 1998 and 2004.

Drimbetas et al. (2007) investigated the impact of the introduction of futures trading on stock index into the Green stock market and showed that the introduction of derivatives had induced a reduction of the conditional volatility of the underlying market.

Chen, H., Han, Q., Li, Y., & Wu, K. (2013), investigated the effect of introducing index futures trading on the spot price volatility in the Chinese stock market. They provide empirical evidence that the introduction of index futures trading significantly reduces the volatility of the Chinese stock market, which is robust to different model selection criteria and various prediction approaches.

Shu, C., He, D., & Cheng, X. (2015). in their paper " One currency, two markets: the renminbi's growing influence in Asia-Pacific " first to provide evidence that the offshore market, the CNH, plays an important role in addition to the onshore market, the CNY, as a channel by which the renminbi can influence currencies in Asia-Pacific. Confirming evidence from previous studies, movements of Asian currencies are found to be affected by those of the onshore renminbi market.

Objectives of the Study

Our main objective is to examine the following issues in respect of the Indian currency market:

1) To examine the impact of futures trading on return of currency pair series.

2) To examine the impact of introduction of futures trading on the volatility of the currency pairs USDINR, GBPINR, EURINR & YENINR.

3) To examine the nature of volatility before and after introduction of futures in USDINR, GBPINR, EURINR & YENINR.

4) To study the stabilizing effect of derivatives in Indian currency market.

Hypotheses of the Study

1) The data of return series is normally distributed.

2) There is no significant change in mean return of currency after introduction of derivatives.

3) The currency pair returns series of USDINR, GBPINR, EURINR & YENINR is non- stationary or possess a unit root.

4) There is no presence of heteroscedasticity in residuals of return series of currency pairs.

5) There is no impact of derivatives trading in currency market volatility.

Study Period and Database

The formal trading in currency futures contracts in USDINR began from 29th August 2008. Analysis is undertaken with the use of data for the period 4 years prior to through 4 years after the introduction of futures trading. Thus the data ranges from September 2004 to August 2012 for USDINR of spot market whereas trading in GBP, Euro & Yen started after January 2010, so in these cases data is taken from January 2010 to December 2013. In case of USDINR, the cut-off date is 29th August 2008 whereas in cases of GBPINR, EURINR & JPYINR. The cut-off date is 1st January 2010. The historical exchange rates time series data have been collected from the website of RBI. Daily closing data was used to find out the impact of futures trading on currency market volatility. The dataset comprises of time series data on currency pairs as mentioned above. The data in case of USDINR consists of total of 1945 observations whereas in cases of GBPINR, EURINR & JPYINR consists of 1944 observations.

In order to study the impact of derivatives on currency market volatility, the whole study period in all cases data is divided into two parts, first part as pre- derivatives period and second part as post-derivatives period. In case of USDINR, pre-derivatives period starts from 30 August 2004 to 28 August 2008, a total of 979 observations and post – derivatives period starts from 1st September 2008 to 31 August 2012, a total of 964 observations whereas in cases of GBPINR, EURINR & JPYINR, pre-derivatives period starts from 02 January 2006 to 31 December 2009, a total of 967 observations and post-derivatives period starts from 01 January 2010 to 31 December 2013, a total of 976 observations. All the data have been taken from NSE India website.

Research Methodology

Statistical Tools

Statistical tools such as mean, standard deviation, skewness, kurtosis, Jarque-bera test for normality & t-test for comparison of means.

Econometric Techniques

In the study, return (R_t) on which volatility has been estimated, is defined as :

$$R_t = \ln (P_t / P_{t-1}) * 100 \qquad (1)$$

Where R_t is continuous daily return at time t, computed in the logarithmic first difference, where Pt is the closing value of exchange rate at the end of the day.

Stationarity of all the return series has been checked using the ADF test (1979) statistic. We have graphically plotted the daily return series over time by which volatility clustering, if any, can be checked. To test the null hypothesis of normality, Jarque-Bera (JB) statistic has been applied. In the past studies findings of heteroscedasticity in time series data are well documented. According to past studies, tendency in financial data for volatility clustering can be well captured in a GARCH framework. Therefore, we also have modelled the time-varying conditional variance in our study as a GARCH process. This paper focuses mainly on aspect whether the nature of volatility has changed after the introduction of futures contracts or not. For this, we divide the sample period into sub-periods (namely, pre-futures and post-futures periods), using the cut-off date. We separately fit a GARCH model for each period.

To check the appropriateness of the GARCH type model for a given dataset, we have performed the ARCH LM test (Engle, 1982) which is a Lagrange Multiplier (LM) test for detecting the presence of ARCH effect in the residuals.

From the past studies, we find the GARCH (1.1) model as the most suitable for our study. The impact of derivative introduction in the currency market is examined in the study by modelling various return series in a GARCH(1,1) process. Therefore, we estimate the following conditional mean equation:

$$R_{t,\,cur} = \alpha_0 + \alpha_1 R_{t-1,\,cur} + \varepsilon_t \qquad \varepsilon_1 \sim N(0, h_t) \qquad (2)$$

Where $R_{t,cur}$ and $R_{t-1,cur}$ are daily return and lagged daily return of currency return series, respectively. The residual ε_t in equation (2) is assumed to be distributed N (0, h_t) where conditional variance h_t is represented as :

$$h_t = \alpha_0 + \alpha_1 \Sigma^2_{t-1} + \beta_1 h_{t-1} \qquad (3)$$

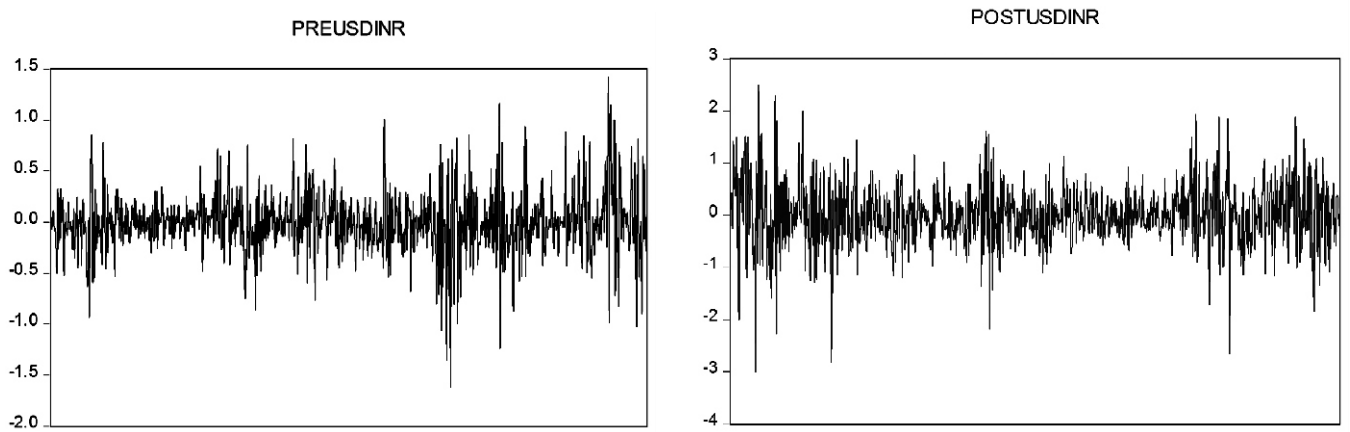
α_1 represents the news coefficient and β_1 represents a persistence coefficient . If the value of GARCH lag coefficient β_1 is significantly large, the volatility is persistent in nature, whereas a large value of GARCH error coefficient α_1 indicates quite intensive reaction of volatility to market movements. If the value of $\alpha_1+\beta_1$ is close to unity, a shock at time t will persist for many future periods implying a long memory. For the GARCH model to be well specified, it is necessary that both α_1 and β_1 are non-negative. Following the onset of futures trading, an increase in α_1 would suggest that news is impounded into prices more rapidly, and a decrease in β_1 would suggest that old news has a less persistent effect on price changes. Conversely, a reduction in α_1 would suggest that news is being impounded into prices more slowly, and an increase in β_1 would suggest greater persistence. Hence, the GARCH framework enables changes in both the level and structure of volatility to be detected.

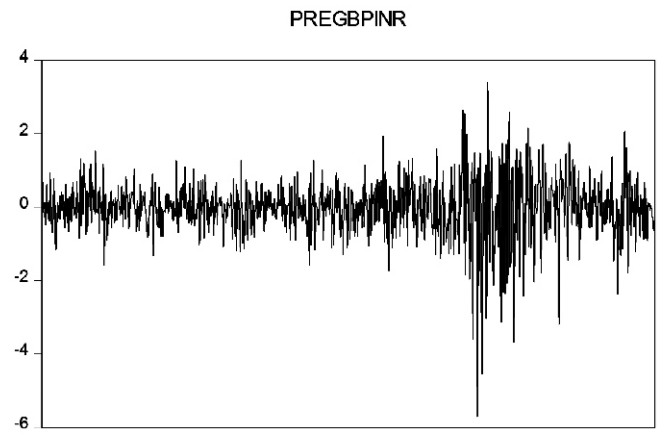
Data Analysis and Findings

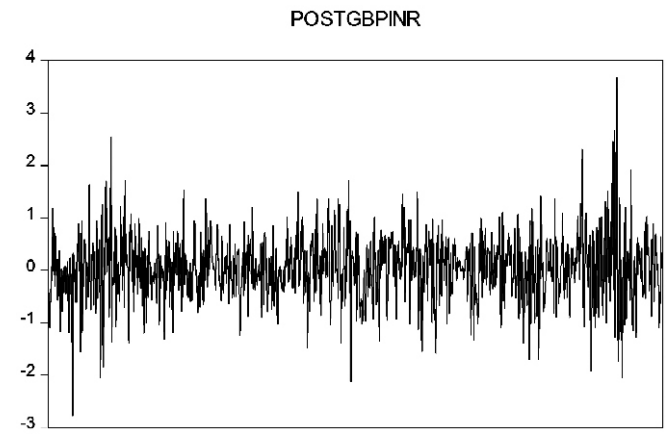
Graphs

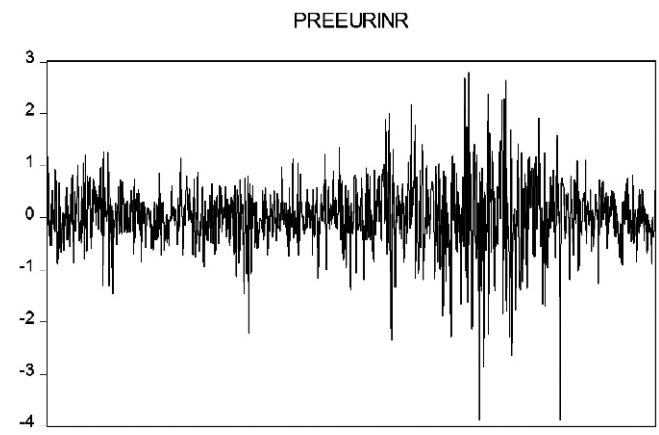
The visual inspection of the plot of daily return series of various currencies as shown in Graph 1 reveals that returns continuously fluctuate around mean value that is close to zero. The movements are in both positive and negative territories and large fluctuations tend to cluster together separated by periods of relatively low fluctuations showing volatility clustering. The fluctuations have decreased in all currencies pair post derivatives except USDINR.

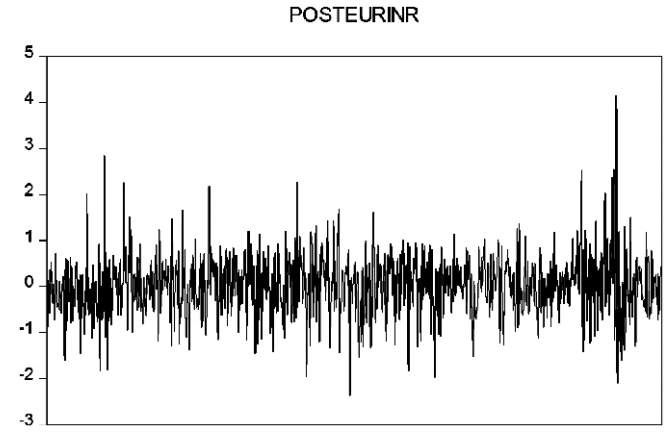
Graph 1

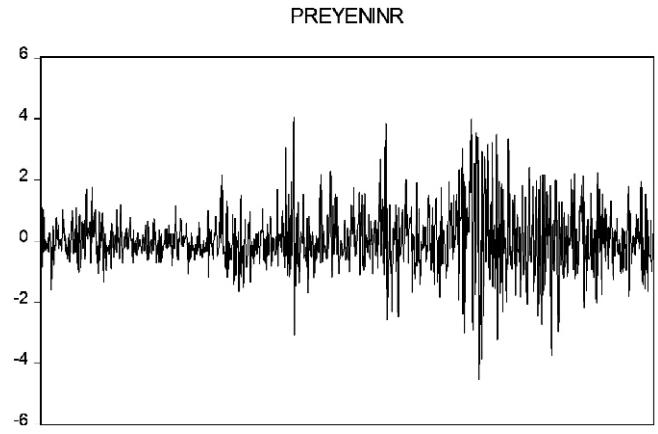


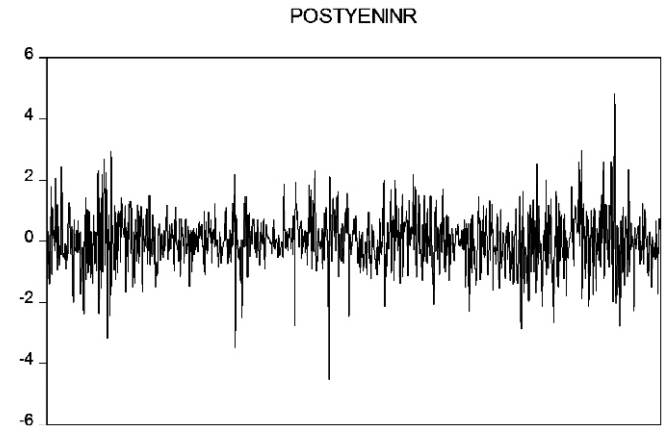












Descriptive Statistics

The descriptive statistics on all return series of PREUSDINR, POSTUSDINR, PREGBPINR, POSTGBPINR, PREEURINR, POSTEURINR, PREJPYINR & POSTJPYINR are summarized in Table 1. Mean and standard deviations of all the return series are presented in Table 1. The mean return has increased post derivative in all currencies pair except YENINR but not significantly and standard deviation has declined in all the return series except USDINR post derivative. The coefficient of skewness for all the return series is observed to be different from zero which indicates that return distributions are not symmetric. The return series of PREUSDINR, POSTGBPINR, POSTEURINR & PREYENINR are positively skewed whereas return series of POSTUSDINR, PREGBPINR, PREEURINR, POSTYENINR are negatively skewed. The coefficient of kurtosis of the return series has mixed pattern, PREUSDINR is mesokurtic, PREGBPINR & PREEURINR are leptokurtic whereas all the others are platykurtic but all indicates a "heavy tailed" distribution. These observed skewness and kurtosis values indicate that the distribution of daily return series of all the selected currencies is non-normal. The JB normality test also supports this non-normality of return distributions as we find from Table 1 that the estimated values of JB statistic of all the return series are statistically significant at 5% level. Thus, null hypothesis that the data follow normal distribution is rejected.

Table 1: Descriptive Statistics

Variable	*Period*	*Mean*	*Standard Deviation*	*Kurtosis*	*Skewness*	*JB Probability*	
						t-statistics	*p-value*
PREUSDINR	30-Aug-04 to 28-Aug-08	-0.010	0.316	2.934	0.050	340.89	0.00000
POSTUSDINR	01-Sep-08 to 31-Aug-2012	0.024	0.612	2.160	-0.110	186.07	0.00000
PREGBPINR	02-Jan-06 to 31-Dec-09	-0.004	0.775	6.244	-0.907	1676.84	0.00000
POSTGBPINR	01-Jan-10 to 31-Dec-2013	0.030	0.645	2.167	0.174	192.98	0.00000
PREEURINR	02-Jan-06 to 31-Dec-09	0.024	0.682	3.962	-0.425	658.90	0.00000
POSTEURINR	01-Jan-10 to 31-Dec-2013	0.025	0.675	2.411	0.350	261.02	0.00000
PREYENINR	02-Jan-06 to 31-Dec-09	0.030	1.007	2.288	0.288	222.87	0.00000
POSTYENINR	01-Jan-10 to 31-Dec-2013	0.019	0.909	2.080	-0.032	179.18	0.00000

Table 2: t-tests (Differences of Mean)

Variable	*Period*	*Mean*	*P(T<=t)2-tail*	*t-values*	*t critical*	*Inferences*
PREUSDINR	30-Aug-04 to 28-Aug-08	-0.010	0.1344	-1.498	-1.962	Null Hypothesis Accepted
POSTUSDINR	01-Sep-08 to 31-Aug-2012	0.024				
PREGBPINR	02-Jan-06 to 31-Dec-09	-0.004	0.2929	-1.052	-1.962	Null Hypothesis Accepted
POSTGBPINR	01-Jan-10 to 31-Dec-2013	0.030				
PREEURINR	02-Jan-06 to 31-Dec-09	0.024	0.9756	-0.030	-1.962	Null Hypothesis Accepted
POSTEURINR	01-Jan-10 to 31-Dec-2013	0.025				
PREYENINR	02-Jan-06 to 31-Dec-09	0.030	0.7948	0.2601	1.962	Null Hypothesis Accepted
POSTYENINR	01-Jan-10 to 31-Dec-2013	0.019				

The null hypothesis "There is no significant change in mean return of currency series after introduction of derivatives" is accepted". From the table 2, it is concluded that null hypothesis is accepted. Thus we found that there is no significant change in mean return of currency series after introduction of derivatives.

Test of Stationary Series (Unit Root test)

A unit root test tests whether a time series variable is non-stationary and possesses a unit root. The null hypothesis is generally defined as the presence of a unit root and the alternative hypothesis is either it has stationarity, trend stationarity or explosive root depending on the test used. Each time series is subject to a check for stationarity. The Dickey-Fuller test is employed separately to analyse all the return series of PREUSDINR, POSTUSDINR, PREGBPINR, POSTGBPINR, PREEURINR, POSTEURINR, and PREJPYINR & POSTJPYINR. The unit root hypothesis (i.e. that the series is non-stationary) is found false in all the return series so all the return series are stationary. Table 3 reports the result of the unit root tests.

Test of Stationary Series (Unit root test at Level)

Particular	**UNIT ROOT TESTSAugmented Dickey Fuller Test**				
	Test Statistic	*Critical Value (1%)*	*Critical Value (5%)*	*Critical Value (10%)*	*Inference*
PREUSDINR	-29.88	-3.43	-2.86	-2.56	Rejected
POSTUSDINR	-30.56	-3.43	-2.86	-2.56	Rejected
PREGBPINR	-24.10	-3.43	-2.86	-2.56	Rejected
POSTGBPINR	-29.45	-3.43	-2.86	-2.56	Rejected
PREEURINR	-31.98	-3.43	-2.86	-2.56	Rejected
POSTEURINR	-28.62	-3.43	-2.86	-2.56	Rejected
PREYENINR	-32.05	-3.43	-2.86	-2.56	Rejected
POSTYENINR	-31.33	-3.43	-2.86	-2.56	Rejected

* Data calculated through E-Views 9

Heteroscedasticity Test

The LM test is applied for determination of presence of "ARCH effect" in the residual of the estimated model, the result of which is presented in Table 4. From Table 4, we find that both the *F*- statistic and ARCH-LM statistic are statistically significant at 5% level for all the return indices (PREUSDINR, POSTUSDINR, PREGBPINR, POSTGBPINR, PREEURINR, POSTEURINR, PREYENINR & POSTYENINR) thereby rejecting the null hypothesis of no heteroscedasticity. The result of the ARCH-LM test confirms the presence of ARCH effect in all return series which is also consistent with the graphical presentation of the return series showing volatility clustering.

Table 4: Results of the ARCH LM Test on various return series of Currencies Pair

Particulars	*Prob. Chi Square (1)*	*Prob.(F)*	*Inference*
PREUSDINR	0.0983	0.0985	P(F) > P(Chi-Square)
POSTUSDINR	0.9791	0.9792	P(F) > P(Chi-Square)
PREGBPINR	0.1420	0.1423	P(F) > P(Chi-Square)
POSTGBPINR	0.8787	0.8788	P(F) > P(Chi-Square)
PREEURINR	0.3907	0.3912	P(F) > P(Chi-Square)
POSTEURINR	0.7569	0.7572	P(F) > P(Chi-Square)
PREYENINR	0.0852	0.0853	P(F) > P(Chi-Square)
POSTYENINR	0.1745	0.1748	P(F) > P(Chi-Square)

Note: ARCH LM Statistic (at lag 1) is the LM test statistic for examining the presence of ARCH effect in the residuals of the estimated model. If the value of ARCH LM statistic is greater than the critical value from the Chi-square distribution, the null hypothesis of no heteroscedasticity is rejected.

GARCH Analysis

The results of the fitted GARCH (1, 1) model (Equation 2) to daily currency pair's series are presented in Table 5. All the coefficients in the mean and variance equations are found to be significant at 1% level. Significant F-statistic implies that there is heteroscedasticity in return variance. So, there is return volatility throughout the period. Further $(\alpha_1 + \beta_1) <$ implies that there is no unit root and the series concerned is stationary. Hence, GARCH (1, 1) gives us good fit to the daily currency pair return series. Both α_1 are β_1 highly statistically significant. The sum of α_1 is β_1 very close to unity except in the case of POSTEURINR implying shocks to the conditional variance is highly persistent. The results in Table 5 shows that there has been a decrease in ARCH term of USDINR & GBPINR whereas an increase in ARCH term of EURINR & YENINR in the post derivative period as compared to pre derivative period. Thus new news impounded into prices more rapidly in EURINR & YENINR after introduction of futures. The GARCH term has increased only in case of USDINR post derivative and decreased in cases of GBPINR, EURINR & YENINR, thus these having less persistent effect on price changes. Thus, overall the derivatives has positive impact on GBPINR, EURINR & YENINR but have negative impact on USDINR $(\alpha_1 + \beta_1)$ as has increased in case of USDINR and decreased in all other cases.

Table 5: Volatility estimates before and after the introduction of Currency Futures

Particulars	*Intercept* (α_0)	*ARCH* (α_1)	*GARCH* (β_1)	$(\alpha_1 + \beta_1)$
PREUSDINR	0.006489(0.0000)	0.289195 (0.0000)	0.671334 (0.0000)	0.960529(0.0000)
POSTUSDINR	0.010790 (0.0025)	0.161380 (0.0000)	0.817942 (0.0000)	0.979322(0.0000)
PREGBPINR	0.005550 (0.0024)	0.072514 (0.0000)	0.917576 (0.0000)	0.990090 (0.0000)
POSTGBPINR	0.018215 (0.0041)	0.066243 (0.0000)	0.888952 (0.0000)	0.955195 (0.0000)
PREEURINR	0.002770 (0.0206)	0.056146 (0.0000)	0.938071 (0.0000)	0.994217 (0.0000)
POSTEURINR	0.065814 (0.0054)	0.107612 (0.0000)	0.745549 (0.0000)	0.853161 (0.0000)
PREYENINR	0.007922 (0.0126)	0.094618 (0.0000)	0.900596 (0.0000)	0.995214 (0.0000)
POSTYENINR	0.043792 (0.0001)	0.113910 (0.0000)	0.837436 (0.0000)	0.951346 (0.0000)

Conclusion

In this paper, we have tried to examine the impact of the introduction of currency futures on underlying asset volatility in Indian context by using data on daily closing prices on exchange rates of USDINR from 30 August 2004 to 31 August 2012 by dividing it into two parts i.e. pre & post introduction and similarly taken data on daily closing prices on exchange rate of GBPINR, EURINR & YENINR from 2 January 2006 to 31 December 2013 in a GARCH (1, 1) framework capturing heteroscedasticity in currency pairs return series. Graphs show

volatility clustering. The fluctuations have decreased in all currencies pair post derivatives except USDINR. The mean return has increased post derivative in all currencies pair except YENINR but not significantly. The data follow non-normal distribution in all return series. The unit root hypothesis (i.e. that the series is non-stationary) is found false in all the return series so all the return series are stationary. The result of the ARCH-LM test confirms the presence of ARCH effect in all return series which is also consistent with the graphical presentation of the return series showing volatility clustering. GARCH (1, 1) gives us good fit to the daily currency pair return series. Both α_1 and β_1 are highly statistically significant. The sum of α_1 and β_1 is very close to unity except in the case of POSTEURINR implying shocks to the conditional variance is highly persistent. Thus, overall the derivatives has positive impact on GBPINR, EURINR & YENINR but have negative impact on USDINR ($\alpha_1 + \beta_1$) as has increased in case of USDINR and decreased in all other cases.

However, the study has not considered high-frequency data for the volatility analysis and the conclusions are based only on the analysis of currency pair series. Further scope of research may also examine the asymmetric nature of volatility of forex market using the E-GARCH models.

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