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Impact of Currency Futures Issuance on Foreign Exchange Rate Volatility in India

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Abstract: This article examines the effect of currency futures on foreign exchange rate volatility in India focusing on USD-INR, EUR-INR, GBP-INR and JPY-INR. For the period from February 2002 to February 2020, the daily exchange rate values of all the four currencies against the Indian rupee (INR) were collected. The Augmented Dicky Fuller (ADF) test of the unit root was performed to check the stationarity of the time series data utilized in the study. After verifying the presence of heteroskedasticity with the ARCH LM test, GARCH (1, 1) modelling is employed to assess the impact of the launch of currency futures on the volatility of India's foreign exchange rate. The findings clearly depict that presence of volatility persistence is there for USD-INR, GBP-INR, EUR-INR, and JPY-INR. The volatility of returns of exchange rate before and after currency futures was discovered to be different as it is higher in pre futures period for USD-INR, and GBP-INR whereas for EUR-INR and JPY-INR it is higher in post futures period.The major implication is that when constructing hedging strategies, investors must account for volatility persistence between currency futures and spot markets.

1. Introduction

New information about the market has an effect on financial market trading. The current study is an attempt to detect the effect of currency futures on the underlying currency spot market. It is intended to examine the shift in volatility and information in the time period of post derivatives. This paper presents a discussion of results about the influence of the inception of the currency futures market in India. The focus of the current research is on the result of the inception of currency futures on foreign exchange rate volatility in the Indian stock market concerning USD-INR, JPY-INR, GBP-INR

and EUR-INR. Currency derivatives first appeared in July 2008, when currency futures for the US dollar were introduced. These were later extended to other key currencies such as the euro, pound and yen. Currency derivative securities trading in India has developed significantly since its introduction in 2008,no. of contracts climbed from 3,26,72,768 in 2008 to 71,83,33,857 contracts in 2022. Such significant growth in such a short period of time is worthy of notice. Because of their huge trading volume, we look at currency and foreign exchange rate volatility as well as the underlying spot markets. As a result, these products are expected to represent the Indian futures and spot markets' scheme of volatility interaction mechanisms. We make two contributions in this regard. Firstly, we examine the broadly networked currency futures markets, the patterns of volatility and shock propagation markets by using pairs of currencies USDINR, GBPINR, EURINR and JPYINR. The variance dynamics of financial time-series data with a high frequency have been simulated since Engle's debut in 1982, and later generalization by Bollerslev. It's becoming more common to use an ARCH specification (1986).

As a result, for estimating the mean and conditional variance in the stated return series, the GARCH (1,1) model is used. Another contribution relates to the markets in which we specify, it includes all currency pairs in the field of currency futures in India. Along with it, Nifty returns are taken as an independent variable. In the previous studies, the data period used was quite limited, however, our extended data, which spans nearly 18 years, is thought to be sufficient to capture the dynamics of volatility interaction; as a result, this study should throw more insight into the correlation among the currency futures and foreign exchange rate volatility. The literature about the derivative has a different effect on the underlying spot market shows that Derivatives' effect on the underlying cash markets differs by country and that various observations have been made at different times. One set of academics feels that futures and options products increase the underlying market's speculative and volatile nature by introducing some degree of instability (Figlewski, 1981; Ross, 1989; Stein, 1987). Contrary to popular belief, certain studies show that information moves rapidly between futures and cash markets, resulting in increased total capital market efficiency. The futures market also plays an important job in discovery of price in the equity market, as well as maintaining prices in both the futures and spot markets (Danthine, 1978; Bologna and Cavallo, 2002). Furthermore, the uniqueness of the financial system of India necessitates a special study, as the generalizations made about industrialized countries may not hold true in this case. Furthermore, in India, futures, particularly currency futures, are considered tender. Given that the Indian economy is growing and opening up and incorporating with other major economies across the world, and that the government recognizes the significance of foreign commerce and thus foreign exchange, this type of research is critical.

2. Review of Literature

2.1. Currency Derivatives

The currency derivatives are used by investors for hedging their foreign exchange rate risk (Tebogo, 2012). Guru (2009) analyzed the forex derivatives market in India. Rising foreign currency turnover and growth in foreign investment give rise to the use of currency futures. Currency derivatives are mainly used for hedging purposes, arbitrage purposes and price discovery. Speculation is the least

preferred objective of currency derivatives. Guru (2010) by using the USD-INR currency pair analyzed how trading of currency futures impacted volatility and spot exchange rate returns. The futures market proved as a driver of the spot market because the futures market has more informational content compared to the spot market. To manage the currency exchange rate risk various strategies are used. Currency derivatives are one of the most suitable currency risk management tools (Pandey, 2014; Sivakumar and Sarkar, 2008). In a study, Mittal (2012) concluded that the issuance of derivatives products for hedging of foreign exchange rate risk has enabled the integration of the national economy with the world economy.

The Indian currency derivatives market is growing at a swift phase both in terms of volume and trading since currency futures and options were introduced in India (Pallavi, 2015; Mahanta, 2012). Similarly, Guru (2009) explored the recently launched currency futures market in India and its growth and global trends in the forex derivatives market. Exchange-traded currency derivatives were increased as compared to OTC derivatives. USD-INR was the most traded currency pair at the initial stage (Rajkumar and Rani, 2012). Furthermore, some researchers explored the growth and development of the Indian currency futures market and analyzed that there was increased exchange rate volatility of USD-INR during conventional and non-conventional trading hours (Chakravarty and Parveen, 2010). The currency forward market plays a major role in determining foreign exchange spot rates and minimizing the risk associated with it (Srikanth *et al*., 2012).Currency derivatives are useful to achieve stability in the earnings in foreign exchange market (Tebogo, 2012). Furthermore, Kadyan (2014) analyzed the Indian rupee role as an international currency. It was concluded from the study that Indian rupees were not an international currency at the time of the study. The Indian rupee has high volatility and its chances of becoming an international currency are still so far.

In a study, Pandey (2014) analyzed currency risk management by using currency derivatives tools. The study explained the transaction, translation and economic exposure. Currency derivatives were proved as a successful tool for risk hedging involved in the foreign exchange market. The monthly turnover of currency derivatives at NSE during February 2018 rose at 5,06,671 crore from 1,57,554 crores in December 2011. The Currency futures and options average daily turnover reached Rs. 16778.20 crore in 2015 (Pallavi, 2015). In a study some new features like the addition of late-night hours, options and various products in different currencies, cross currencies were also suggested (Chakravarty and Parveen, 2010).

2.1.1. Currency Futures

In the Indian market study of foreign exchange rate volatility and currency derivatives influence on foreign exchange rate volatility is more important because it is still in the developing stage. There is excessive volatile market in the currency market and the starter of currency futures affect the volatility of EUR-INR (Gupta, 2017). Pandey (2011) analyzed that in terms of open interest and contracts traded at MCX and NSE currency futures were developed at a rapid phase because it was proved as a good deal to hedge the risk. Volatility, trading volume and depth of the market are related to each other in the currency futures market. Similarly, Guru (2010) considered that there is no existence of cause-and-effect relationship between currency future volume, open interest and volatility of the spot market.

Results also presented that the effect of volatility in the futures market on the spot market can be said below. Also tells that return in the forward market affect volatility of return in the future market. As volatility increases, it brings high trading in hedging instruments. And when it decreases it brings low trading.

Many variables influence the foreign exchange derivatives market (Pavaskar and Kala, 2013). Chatrath *et al.* (1996) discovered a positive connection between volatility in daily exchange rate changes of the Japanese Yen, British Pound, Canadian dollar, Deutsche Mark, and Swiss Franc and the level of trading activity of futures in these currencies. Similarly, some other studies also found a positive association among currency derivatives and the volatility of foreign exchange rates while some of them found no relationship between these factors (Sahu, 2012; Rastogi, 2011). While some studies evidenced that volatility has decreased after currency futures were launched in India. In a study, Nath and Pacheco (2018) explored India's currency futures market. There is also the effect of good news on spot exchange rate return as it causes more volatility (Kumar, 2015; Thenmozhi and Thomas, 2007). Futures and spot markets both have an impact on each other in some way (Thenmozhi and Thomas, 2007).

In India, volatilities in the exchange rate of various foremost currencies (US Dollar, Euro etc.) instigate volatility in the daily exchange rate value of the Indian Rupee (Sahoo, 2012). Studies concerning the currency futures marketplace's effect on the foreign exchange rate volatility provide mixed results for various nations. Some of the studies found evidence that the issuance of currency futures brings high instability in the foreign exchange market while some other research found no effect on foreign exchange rate volatility (Sharma, 2011). The starter of currency derivatives brings efficiency to the market as they are helpful in hedging and speculation purposes because the currency exchange rate is harder to predict for market participants (Liu, 2007; Tornell and Yuan, 2012). Sriram and Senthil (2013) found that the Spot market reacts to new information quicker as compared to the futures market and because of unidirectional causation in the foreign exchange market spot causes the futures.

By examining the short-term causal correlation amidst futures market return and the spot market return of JPY-INR traded in India it was found that there was a unidirectional cause and effect relationship between these two markets (Raghu and Shanmugam, 2013). There is also the bi-directional association between currency spot and futures market. The futures market has a very large impact on the spot market (Bhat and Suresh, 2014; Yaganti *et al.*, 2015). In the case of the following currencies - USD, EURO, GBP and JPY, the relationship among the spot market and the futures market was analyzed by using an error correction model. It was found that the futures market come out as the leading market (Kharbanda and Singh, 2017). In a study, a bidirectional causal association was also found between volume and returns (Mittal and Kumar, 2016). Similarly, in a study effect of currency derivatives on foreign exchange rate volatility of Pound sterling was examined and it was found that trading of currency futures in India has reduced the foreign exchange rate volatility. Futures contracts are reflected as an impartial forecaster of variations in the spot rate for the USD-INR (Kumar and Truck, 2014). Pre futures period has a consistent shock of volatilities having ARCH and GARCH effect as compared to moderate ARCH effect in the post-introduction period (Kumar *et al.*, 2015). There is also the effect of recent news on currency derivatives as well as the previous day's effect starts reducing.

It was also indicated that in the after-currency futures period currency futures trading lessens the volatility of JPY-INR and GBP-INR and increases the volatility of EURO INR during the post currency period (Sakthivel *et al.*, 2017a). (Sakthivel *et al.*, 2017b), Furthermore, Kumar (2017) examined the coexistent and causative association between return, volatility and trading volume of currency future market for these currency pairs USD-INR, EUR-INR, GBP-INR and JPY-INR. A positive relationship was found between currency future return and trading volume. Exchange-traded currency derivatives were increased as compared to OTC derivatives. USD-INR was the most traded currency pair during the time of the study (Rajkumar and Rani, 2012). In a study, it was found that Currency futures have a poorer hedging efficacy than OTC forwards (Mohanraju, 2014). When there are no directly available currencies in the market then cross hedging is also used by various firms (Chang and Wong, 2003).

3. Objectives and Hypothesis of the Study

3.1. Objectives of the Study

The main objectives of the study are:

- To investigating the effect of the issuance of currency futures in the Indian currency derivatives market as well as to know about the efficiency of the market.
- To assess spot foreign currency market volatilities for pre-and post-future eras and to compare the spot foreign exchange market's stability and depth throughout both times.

3.2. Hypothesis of the Study

The following research hypothesis is framed and tested for analyzing the above-mentioned issues.

H_{01}: The issue of currency futures has an effect on foreign exchange market volatility in India.

4. Research Methodology

4.1. Data

Data has been collected for the time series that is recorded in the form of the currency derivatives market. For investigating the effect of currency futures on foreign exchange rate volatility in India, four currency pairs are selected in the study those are USD-INR, GBP-INR, JPY-INR and EUR-INR. The choice of these currency pairs is based on the availability of data as there are only four currency pairs issued in India in the futures market. Daily closing prices for pre futures introduction as well as after futures issuance are collected for tracing the trend of volatility changes after currency futures. In the study, the official websites of NSE and RBI are used for collecting data related to currency futures and spot prices. To assess the influence of currency futures on foreign exchange rate volatility data sample period is selected as 18 years of data from February 2002 to February 2020.

After that, it is split into two sub-period pre futures time periods spanning from February 2002 to August 2008 for USD-INR and February 2002 to October 2010 for EUR-INR, GBP-INR and JPY-INR (Kumar, 2015). In the case of post futures, August 2008 to February 2020 for USD-INR whereas

EUR-INR, GBP-INR and JPY-INR data spans from October 2010 to February 2020. Because currency futures are one of several drivers of the degree of fluctuation in the spot exchange rate, the study also utilized the CNX Nifty's daily closing values for the same time period to separate the influence of Exchange rate volatility is influenced by currency futures and a variety of other factors. As an independent variable, the CNX Nifty's lagged value has been used in the mean return equation for this reason (Kumar, 2015; Sahu, 2012).Daily return data series is chosen for the study. It has been obtained by continuously compounding logarithmic returns, as follows:

Rt = Log (Pt / Pt-1)

Here, Pt=Price at time t (Natural log value), Pt-1 = price at time t-1(Natural Log value)

4.2. Research Methodology

4.2.1. Stationarity Testing

For econometric modelling, it is necessary for data to be stationary. To determine if the series is cohesive, it needs to be checked for constant mean and variance. For the data, there is a unit root in the time series, according to the null hypothesis. To investigate whether the Currency pairs USD-INR, GBP-INR, EUR-INR, and JPY-INR time series are stationary, the null hypothesis in the ADF test is that the series has a unit root. The ADF test is used to find the unit root in a series of the raw data for the period of pre and post phase as well as the whole sample. The ADF test is applied at a level with intercept and trend, where alternative hypotheses got accepted. The Akaike Information Criteria are used to estimate the lag duration for ADF testing (AIC).

4.2.2. Volatility

4.2.2.1. Currency Futures

For investigative the effect of the issuance of currency futures and options on foreign exchange rate volatility; the first difference has been used. As it is the foremost requirement for the application of further volatility-based models. Furthermore, the ARCH-LM test is applied to know about the presence of volatility clustering in the time series. It is resulted that the p-value is less than 0.05, the null hypothesis of the arch test, that there is no impact of the arch, is rejected, proving the presence of volatility clustering. Hence, the significance of the ARCH LM test suggests the existence of volatility clustering in the error term. After that to examine empirically the effect of the issuance of currency futures and options in the Indian stock market on foreign exchange rate volatility standard generalized Autoregressive Conditional Heteroskedasticity (GARCH) model is applied. Returns on the Nifty are used as an independent variable (Kumar, 2015, Sahu, 2012).

The arch term's coefficient is indicated by α, which is employed in the variance equation and reflects the impact of yesterday's news (error) on today's volatility. Along with this, the coefficient of GARCH denoted by β reflects the persistence of volatility. In case, the b coefficient is higher than volatility persistence would be on the higher term. Another condition included in the GARCH model is that the entire addition of mutually coefficients of arch and GARCH term should not exceed 1. It

shows the volatility is decaying and the rate of decaying is 1 – (α+β), also representing a stationary process (Gujrati, 2009). The GARCH model's general mean equation is as follows:

$$Y_t = \delta + \beta_1 Y_{t-1} + \beta_1 r\_nifty_{t-1} + \varepsilon_t$$

where Y_t represents the currencies, r_nifty_{t-i} represents the previous day nifty return and ε_t is error term assuming that the data set is normally distributed with a constant mean and time varying variance (h_t).

The variance equation of the GARCH model is as follows:

$$h_t = \partial_0 + \sum_{i=1}^{p} \varphi_i h_{t-i} + \sum_{j=1}^{q} \zeta_j u_{j-i}^2$$

where h_t is representing by the conditional variance constituted of its own lag and the squared errors lagged values. $\Sigma_{i=1}^{p} \varphi_i$ represents the effect of GARCH term which captures the persistence of volatility in short run while $\Sigma_{j=1}^{q} \zeta_j$ is the ARCH term captures the previous day news effect. Long run persistence of volatility is determined by summing up the coefficients of ARCH and the GARCH term.

Further the models are also tested for the stability by conducted diagnostic testing. ARCH test has been conducted to examine the presence of heteroscedasticity in the residuals of the model.

5. Results and Discussion

Unit root test results pre-futures, and post-futures and for the full sample period are provided in tables 1, 2 and 3. Because the value for the ADF test is not less than 0.01 at the level, the null hypothesis is not rejected, which specifies that the series for all the periods is not stationary at the level (Phillips, 1987). By continuing the same process for the first difference it is interpreted that as the P-value is less than the significant value, we reject the null hypothesis and accept the alternative hypothesis. This inculcates that the first difference is that it does not have a unit root. Thus, by taking the first difference all the series become stationary and integrated into the first order. The non-stationary data null hypothesis is rejected for all series at a 5% level of significance, according to the ADF test results.

Table 1: Unit Root Test for Whole Sample

Series	*ADF Test*			
	At level Form With Trend & Intercept		*AT 1st difference With Only Intercept*	
	t-Statistic	*Prob.**	*t-Statistic*	*Prob.**
USD_INR	-2.156	0.514	-31.195	0
EURO_INR	-3.209	0.083	-65.133	0.0001
GBP_INR	-2.537	0.310	-64.720	0.0001
YEN_INR	-2.447	0.355	-67.903	0.0001
CNX_NIFTY	-3.214	0.082	-61.776	0.0001

Source: Authors' Own Compilation

Notes: The Test Equation include drift and trend terms at level, for First Difference Only Drift is included. The lag order in the ADF Test Equation based on SIC equation. *and ** At 5% and 1%, respectively, indicate significance.

Table 2: Unit Root Test for Pre-Introduction of Futures in India

Series	*ADF Test*			
	At level Form With Trend & Intercept		*AT 1st difference With Only Intercept*	
	t-Statistic	*Prob.**	*t-Statistic*	*Prob.**
USD_INR	-1.213	0.907	-29.949	0
EURO_INR	-2.942	0.149	-46.042	0.0001
GBP_INR	-2.586	0.287	-44.586	0.0001
YEN_INR	-1.514	0.825	-46.897	0.0001
CNX_NIFTY	-2.216	0.480	-41.238	0

Source: Authors' Own Compilation

Notes: The Test Equation include drift and trend terms at level, for First Difference Only Drift is included. The lag order in the ADF Test Equation based on SIC equation. *and ** At 5% and 1%, respectively, indicate significance.

Table 3: Unit Root Test for Post Introduction of Futures in India

Series	*ADF Test*			
	At level Form With Trend & Intercept		*AT 1st difference With Only Intercept*	
	t-Statistic	*Prob.**	*t-Statistic*	*Prob.**
USD_INR	-2.411	0.374	-52.657	0.0001
EURO_INR	-2.075	0.559	-46.772	0.0001
GBP_INR	-1.661	0.768	-47.083	0.0001
YEN_INR	-2.350	0.406	-49.618	0.0001
CNX_NIFTY	-2.962	0.143	-45.963	0.0001

Source: Authors' Own Compilation

Notes: The Test Equation includes drift and trend terms at level, for First Difference Only Drift are included. The lag order in the ADF Test Equation based on SIC equation. *and ** At 5% and 1%, respectively, indicate significance.

Figure 1 indicates the analysis of volatility of GARCH variance series versus Return series. Table 4 represents the outcomes of the heteroskedasticity based Model GARCH (1,1) for USD/INR for the full sample period, pre futures and post futures. GARCH model conclusions for USD/INR are contained in column 3 whole period while column 4 is for pre futures and column 6 for post future in table 4. As shown in the Table 4, the mean equation indicates that in the case of USD/INR, the previous day return and the error are helpful in predicting the current day return because the AR(1)is significant for

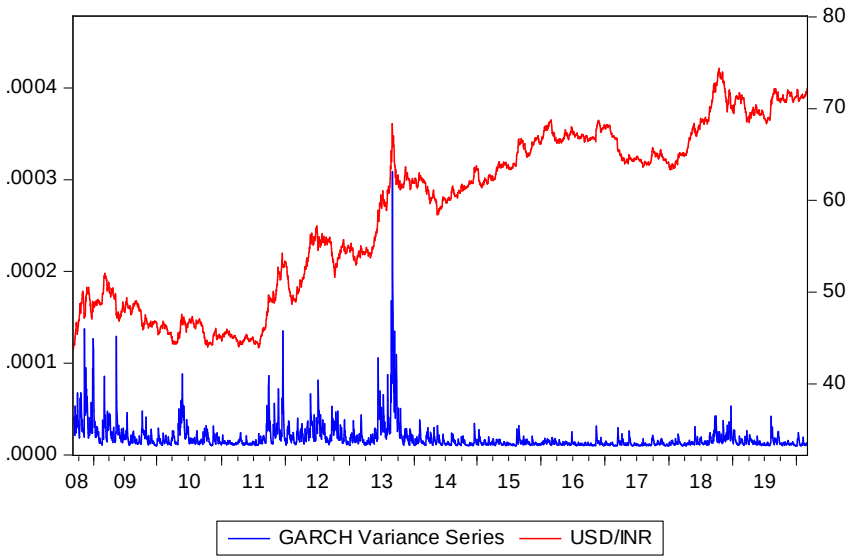

Figure 1: GARCH Variance Series versus Return Series

Source: Authors' Own Compilation

the whole period and pre futures however not for the post futures whereas MA(1) is significant in post futures only. In the case of post futures, the AR term is not significant, implying no influence of previous day return on the current day returns. Further, the previous day's nifty return insignificant and negative in all three scenarios, for the whole period (-0.011), pre futures (-0.007) and post futures(-0.065) implying a negative influence on the current day USDINR returns for three-time horizons.

In the empirical analysis, the essential conditional volatility clustering for the GARCH model is also checked by the ARCH test. Since the null hypotheses of the ARCH LM test suggest the significant volatility clustering in both series. Therefore, the GARCH model has been applied. The model of GARCH (1,1)is best suited for the whole period and pre futures and GARCH (1,1) is found best for post futures period on the basis of the bottom values of AIC and SIC. Results of the model can be seen from Table 4, pervious day news is significantly influencing the current day volatility as the coefficient of ARCH term is significant for both the series at 1% and 5% level. Volatility persistent is also high as the coefficient of GARCH term is significant at 5% and further, there as on of volatility is persistence because the sum of coefficients of GARCH term is greater than the ARCH term. Additionally, the addition of ARCH and GARCH term is less than the 1 implying that the volatility is decaying.

The diagnostic testing is conducted to inspect the stability of the estimates. The results of diagnostic test indicates that the model is not suffering from autocorrelation problem as the Durbin-Watson statistic value is approx. 2 for these three-time period of USD-INR .Furthermore, as the p-value of the ARCH test with two lags is not significant, the null hypothesis that there is no ARCH effect is not rejected, implying that the ARCH effect is no longer present in the error term.

Table 4: GARCH on USD-INR

Equation	*Coefficient*	*Whole Period*	*Pre-Future*	*Post - Future*
Mean Equation	C	0.000(0.000)***	-0.012(0.000)***	0.000(0.127)
	DNSE(-1)	-0.011(0.000)***	-0.007(0.004)***	-0.065(0.000)***
	AR(1)	-0.041(0.011)**	-0.051(0.070)*	0.270(0.136)
	MA(1)	-	-	-0.351(0.044)**
	Break (28 Apr 2008)	0.000(0.006)***	-	-
Variance Equation	C	0.000(0.040)**	0.001(0.003)***	0.000(0.000)***
	RESID (-1)^2	0.204(0.000)***	0.448(0.000)***	0.150(0.000)***
	GARCH(-1)	0.407(0.000)***	0.325(0.003)***	0.600(0.000)***
	GARCH(-2)	0.419(0.000)***	0.337(0.000)***	-
	T-DIST. DOF	5.738(0.000)***	4.186(0.000)***	20(0.000)***
	AIC	-8.679	-0.475	-8.043
	SIC	-8.666	-0.448	-8.026
	DW	1.927	1.856	1.949
Diagnostic test	ARCH 1	0.000	0.326	0.868
	ARCH 2	0.794	0.325	0.004

Notes: P- Values are provided in the parenthesis. ***,**,* indicating the significant at 1%, 5% & 10% level of significance respectively. D1 represents the Dummy variable for respective dates.

Source: Authors' Own Compilation

Table 5: GARCH on EURO-INR

Equation	*Coefficient*	*Whole Period*	*Pre-Future*	*Post – Future*
Mean Equation	C	0.013(0.095)*	0.025(0.575)	0.009(0.429)
	DNSE(-1)	-0.044(0.000)***	-0.032(0.118)	-0.086(0.000)***
	AR(1)	-0.309(0.350)	-	-
	AR(2)	-	-0.004(0.951)	-
	MA(1)	0.311(0.348)	0.005(0.937)	0.034(0.086)*
	D1(22 Oct 2008)	-	-0.003(0.981)	-
	D2(17 May 2004)	-	-0.018(0.929)	-
	D3(28 Aug. 2013)	-	-	3.813(0.736)
	D4(10 Nov. 2016)	-	-	-3.265(0.688)
Variance Equation	C	0.008(0.001)***	0.422(0.118)	0.006(0.005)***
	RESID(-1)^2	0.069(0.000)***	0.150(0.141)	0.046(0.000)***

contd. table 5

Equation	*Coefficient*	*Whole Period*	*Pre-Future*	*Post – Future*
	GARCH(-1)	0.571(0.046)**	0.600(0.012)**	0.937(0.000)***
	GARCH(-2)	0.340(0.210)	-	-
	T-DIST. DOF	8.609(0.000)***	20(0.233)	7.469(0.000)***
	AIC	1.737	2.326	1.658
	SIC	1.751	2.354	1.679
	DW	2.008	2.112	1.974
Diagnostic Test	ARCH 1	-0.445	-0.268	-0.109
	ARCH 2	-0.444	-0.268	-0.793

Notes: P- Values are provided in the parenthesis. ***,**,* indicating the significant at 1%, 5% & 10% level of significance respectively. D1, D2, D3 & D4 represents the Dummy variable for respective dates.

Source: Authors' Own Compilation

Table 5 represents the outcomes of the GARCH Model for EUR-INR for the full-time period, pre futures and post futures. The outcomes for EUR-INR are contained in column 3 whole period while column 4 is for pre futures and column 6 for post future in table 5. As shown in the Table 5, the mean equation indicates that in the case of EUR/INR, the previous day return and the error are not helpful in predicting the current day return because the AR(1,2)is not significant for the whole period and pre futures however not for the post futures whereas MA(1) is significant only in post futures at 10% level of significance. In the case of post futures, the AR term is not significant, implying no influence of previous day return on the current day returns. Further, the previous day's nifty return is significant and negative in all three scenarios, for the whole period (-0.044), pre futures (-0.032) and post futures (-0.086) implying a negative influence on the current day EURINR returns for three-time horizons. In the empirical analysis, the essential conditional volatility clustering for the GARCH model is also checked by the ARCH test. Since the null hypotheses of the ARCH LM test suggest the significant volatility clustering in both series. Therefore, the GARCH model has been applied.

The GARCH (1,2) model is best suited for the whole period and GARCH(1,1) is found best for times before and beyond the currency futures on the basis of the lowest values of AIC and SIC. Table 5 displays the model's results, previous day news is significantly influencing the current day volatility as the coefficient of ARCH term is significant for both the series at 1% and 5% level. Volatility persistent is also high as the coefficient of the GARCH term is significant at 5% and further, the reason for the volatility is persistence because the sum of coefficients of the GARCH term is greater than the ARCH term. Additionally, the addition of ARCH and GARCH terms is less than 1 implying that the volatility is decaying.

Diagnostic testing is conducted to examine the stability of the estimates. The results of the diagnostic test indicate that the model is not suffering from an autocorrelation problem as the Durbin-Watson statistic value is approx. 2 for these three-time periods of EUR-INR. Furthermore, the null hypothesis of the ARCH test that there is no ARCH effect is not get rejected thus suggesting that

there is no ARCH effect left in the error term as the p-value of the ARCH test with 2 lags is not significant.

Table 6: GARCH on GBP-INR

Equation	*Coefficient*	*Whole Period*	*Pre-Future*	*Post - Future*
Mean equation	C	0.012(0.138)	0.013(0.276)	0.039(0.262)
	DNSE(-1)	-0.030(0.000)***	-0.017(0.029)**	-0.064(0.037)**
	AR(1)	0.011(0.477)	-0.003(0.896)	-
	D1(29 Aug. 2013)	-	-	-0.040(0.084)*
Variance Equation	C	0.010(0.000)***	0.006(0.002)***	0.027(0.003)***
	RESID(-1)^2	0.052(0.000)***	0.057(0.000)***	0.049(0.000)***
	GARCH(-1)	0.922(0.000)***	0.928(0.000)***	0.874(0.000)***
	T-DIST. DOF	7.993(0.000)***	11.289(0.000)***	6.981(0.000)***
	AIC	1.74	1.721	1.745
	SIC	1.75	1.741	1.762
	DW	1.989	2.006	1.943
Diagnostic test	ARCH 1	0.685	0.389	0.88
	ARCH 2	0.685	0.388	0.633

Notes: P- Values are provided in the parenthesis. ***,**,* indicating the significant at 1%, 5% & 10% level of significance respectively. D1 represents the Dummy variable for respective dates.

Source: Authors' Own Compilation

Table 6 represents the outcomes of the GARCH Model for GBPINR for the whole period, for times before and beyond the currency futures issuance. The outcomes for GBPINR are contained in column 3 reflect the whole period while column 4 is for pre futures and column 6 for post futures in table 6. As shown in Table 6, the mean equation indicates that in the case of GBPINR, the previous day return and the error are not helpful in predicting the current day return because the AR term is not significant, implying no influence of the previous day return on the current day returns. Further, the previous day's nifty return is significant and negative in all three scenarios, for the whole period (-0.030), pre futures (-0.017) and post futures (-0.064) implying a negative influence on the current day GBPINR returns for three-time horizons. In the empirical analysis, the essential conditional volatility clustering for the GARCH model is also checked by the ARCH test.

Since the null hypotheses of the ARCH LM test suggest the significant volatility clustering in both series. Therefore, the GARCH model has been applied. The GARCH (1,2) model is best suited for the whole period and GARCH (1,1) is found best for time period before and beyond the future on the basis of the lowest values of AIC and SIC. Table 6 displays the model's results, pervious day news is significantly influencing the current day volatility as the coefficient of ARCH term is significant for

both the series at 1% and 5% levels. Volatility persistent is also high as the coefficient of the GARCH term is significant at 5% and further, the reason for the volatility is persistence because the sum of coefficients of the GARCH term is greater than the term of ARCH model. Additionally, the addition of ARCH and GARCH terms is less than 1 implying that the volatility is decaying.

Diagnostic testing is conducted to examine the stability of the estimates. The results of the diagnostic test indicate that the model is not suffering from an autocorrelation problem as the Durbin-Watson statistic value is approx. 2 for these three time periods of GBPINR. Furthermore, as the p-value of the ARCH test with two lags is not significant, the null hypothesis that there is no ARCH effect is not rejected, implying that there is no ARCH effect remaining in the error term.

Table 7: GARCH on JPY-INR

Equation	*Coefficient*	*Whole Period*	*Pre-Future*	*Post - Future*
Mean equation	C	0.006(0.737)	-0.011(0.366)	0.011(0.330)
	DNSE(-1)	-0.060(0.0)***	-0.041(0)***	-0.208(0)***
	AR(1)		-0.060(0.012)**	-0.054(0.007)***
	AR(2)	-0.613(0.001)***		
	MA(2)	0.610(0.001)***		
	D1(18 mar 2011)	5.814(0.982)		-3.623(0.644)
	D2(29 Aug. 2013)	-5.828(0.982)		
	D3(22 Aug. 2013)	0.002(0.927)		
Variance Equation	C	0.009(0)***	0.011(0.005)***	0.009(0.002)***
	RESID(-1)^2	0.077(0)***	0.130(0)***	0.066(0)***
	GARCH(-1)	0.910(0)***	0.299(0.065)*	0.917(0)***
	GARCH(-2)	-	0.556(0)***	-
	T-DIST. DOF	6.404(0)***	6.732(0)***	7.099(0)***
	AIC	2.077	2.079	2.009
	SIC	2.093	2.102	2.028
	DW	2.096	2.034	1.998
Diagnostic test	ARCH 1	0.153	0.182	0.137
	ARCH 2	0.153	0.182	0.843

Notes: P- Values are provided in the parenthesis. ***,**,* indicating the significant at 1%, 5% & 10% level of significance respectively. D1 represents the Dummy variable for respective dates.

Source: Authors' Own Compilation

Table 7 represents the outcomes of the GARCH Model for JPY-INR for the full-time period, pre future and post future. The outcomes for JPY-INR are contained in column 3 whole period while column 4 is for pre futures and column 6 for post future in table 7. As shown in Table 7, the mean

equation indicates that in the case of JPY-INR, the previous day return and the error are not helpful in predicting the current day return because the AR(1) is significant for the pre futures and post futures and AR(2) is significant for whole period whereas MA(2) is significant in whole period at 1% level of significance. Further, the previous day's nifty return is significant and negative in all three scenarios, for the whole period (-0.060), pre futures (-0.041) and post futures (-0.208) implying a negative influence on the current day JPYINR returns for three-time horizons. In the empirical analysis, the essential conditional volatility clustering for the GARCH model is also checked by the ARCH test. Since the null hypotheses of the ARCH LM test suggest the significant volatility clustering in both series. Therefore, the GARCH model has been applied.

The GARCH (1,2) model is best suited for pre futures and GARCH (1,1) is found best on the basis of the lowest AIC and SIC values for the entire time and the post-futures period. Outcomes of the model can be seen in Table 7, previous day news is significantly influencing the current day volatility as the coefficient of ARCH term is significant for both the series at 1% and 5% levels. Volatility persistent is also high as the coefficient of the GARCH term is significant at 5% and further, the reason for the volatility is persistence because the sum of coefficients of the GARCH term is greater than the ARCH term. Additionally, the addition of ARCH and GARCH terms is less than 1 implying that the volatility is decaying.

Diagnostic testing is conducted to examine the stability of the estimates. The diagnostic test's results indicate that the model is not suffering from an autocorrelation problem as the Durbin-Watson statistic value is approx. 2 for these three-time periods of YEN-INR. Furthermore, as the p-value of the ARCH test with two lags is not significant, there is no ARCH impact, according to the null hypothesis is not rejected, implying that there is no presence of ARCH effect remaining in the error term.

6. Summary and Conclusion

The impact of the issuance of Currency futures as traded on the Indian stock exchange. is investigated in this article on the particular currency pairs USD/INR, GBP/INR, EURO/INR, and JPYINR foreign exchange rate volatility. So as to investigate the volatility before and after the issuance of currency futures in India the timeline is segregated into two phases, pre futures and post futures. Besides this NSE data have been collected as an independent variable. After confirming stationarity first data has been tested for the presence of volatility clustering by using the ARCH LM test. Its results clearly specified a significant arch effect in the data series. The volatility of the currency derivatives market is influenced by fluctuations in spot prices before and after the futures market's creation. The study's conclusions clarify that development in currency derivatives market effects significantly spot market. The results conclude that the majority of the data comes from the prior day's volatility for USDINR, GBPINR, EURINR and JPYINR. Recent information has a minor impact on volatility. Furthermore, In the case of GBPINR, JPYINR and USDINR persistence are greater in pre futures period whereas for EURINR it is higher in post futures period (Rastogi, 2011; Sahu, 2012; Kumar, 2015).

Currency futures have made the Indian foreign market more dynamical and durable in terms of volatility, with movements lasting longer in the post-future period. Through the current study better

regulatory framework can be planned. Prior to and following the implementation of currency futures, the ARCH and GARCH coefficients of trading for all currency pairs how that the persistent and clustering effect of old news is higher. The implication is that in the currency futures market, both hedging and speculative actions tend to set out each other's net influence on spot currency market volatility. By using these estimates regulatory authorities, as well as policymakers, can forecast the formerly unanticipated newly launched currency pairs in the field of the currency derivatives market. That will be effective for sustainable development.

7. Managerial Implications

Through the current study better regulatory framework can be planned. By using these estimates regulatory authorities, as well as policymakers, can forecast the formerly unanticipated newly launched currency pairs in the field of the currency derivatives market. That will be effective for sustainable development. It is beneficial when the policy shift of introducing exchange-traded currency futures has been welcomed, there are still several issues that need to be solved in order to improve market efficiency for hedgers, traders, and market makers in the currency spot and futures markets. Our findings support the rising interconnectedness between worldwide financial markets and Indian markets, implying that diversification has become a bit more challenging endeavour as the world has gotten more global. However, because these currency derivatives products are publicly available information, investors may use them as part of their knowledge set and measure educated traders' predictions.

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