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A Study Of Currency Market Volatility In India During Its Pre And Post Derivative Period

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Abstract

The paper is aimed at examining the impact of introduction of currency derivatives on exchange rate volatility of Pound. The data used in this paper comprises of daily exchange rate of Pound in terms of Indian rupees for the sample period April 2006 to December 2013. To explore the time series properties Unit Root Test and ARCH LM test have been employed and to study the impact on underlying volatility GARCH (1, 1) model has been employed. The results indicate that the introduction of currency futures trading has helped in reducing the exchange rate volatility of the foreign exchange market in India. Further, the results are also indicative of the fact that the importance of recent

ISSN: 2348 9510
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Volume 1, Issue 6, September 2014

news on spot market volatility has decreased and the persistence effect of old news has declined with the introduction of currency futures trading.

Keywords: Currency Futures, Exchange Rate, Forex Market, GARCH, Volatility.

Introduction

During the early 1990s, India entered on a series of structural reforms in the foreign exchange market. The movement away from pegged exchange rate regime to partially floated in 1992 and fully floated in 1993 was influential in developing a market-determined exchange rate of the rupee and was a significant step in the progress towards total current account convertibility.

In order to advance Indian foreign exchange market to international standards, a well developed foreign exchange derivative market was essential which started in 2008.

The exchange rate policy does not aim at a fixed target or a pre-announced target or a band but is supported by the ability of Reserve Bank to interfere in the markets, if and when necessary, only to smoothen any unnecessary volatilities or disorderly market behavior, while allowing the underlying demand and supply conditions to determine the exchange rate movements over a period in an orderly manner.

Currency futures trading in INR-USD started on August 29, 2008, till January 2010, exchange rate futures was available only for INR-USD. Exchange-traded currency futures have now been expanded to the Euro, Pound and Yen pairing. At the time of introduction of currency futures in India, it was thought that the currency futures market in India would make a prominent contribution towards improving the list of options available for currency risk management.

International experience of the emerging markets with the introduction of currency futures is a mixed one. In several cases, the volatility is found to be reduced following the constitution of currency futures market, though empirical evidence to the contrary also exists. The transaction volumes in currency futures in these countries have remained too small to put any significant upward pressure on exchange rate volatility. Also, there is no

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Volume 1, Issue 6, September 2014

clear evidence to prove that futures contracts traded on exchanges result in increased volatility in the prices for the underlying commodity. In the light of the above, it will be interesting to observe and analyze the effect of introduction of currency futures on spot market for exchange rate. This research looks into this aspect and attempts to find out whether introduction of currency futures and currency future trading activity in INR-GBP has increased due to the volatility in spot market or not.

The fig-1 below shows the volatility of Pound Log Return over the period 2006-2009 and 2010-2013 respectively

Fig. 1

ISSN: 2348 9510
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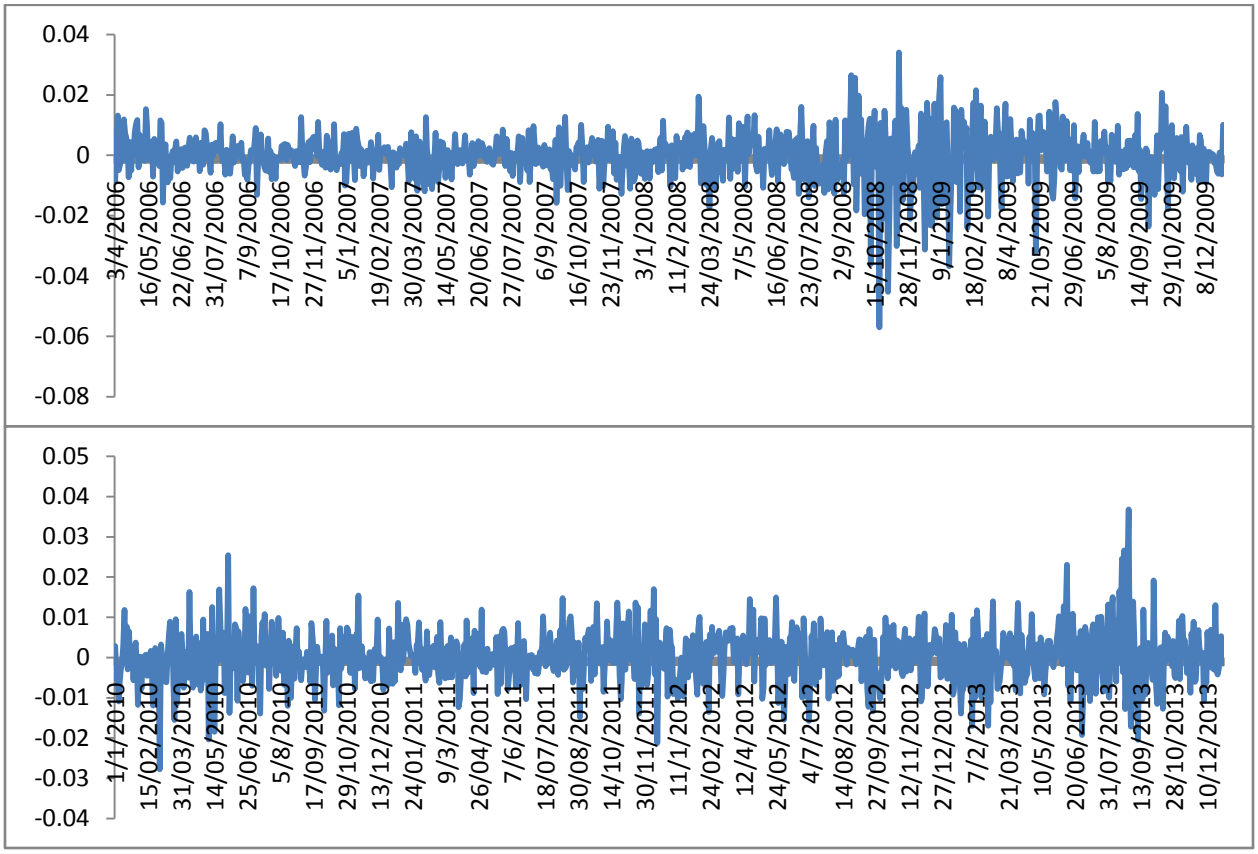
Volume 1, Issue 6, September 2014



Literature Review

Figlewaski (1981) argued that speculation in the derivatives market is transmitted to the underlying spot markets. The speculation produces a net loss with a few speculators gaining and others loosing, in that way it destabilizes the market. Uninformed speculative traders increase price volatility by interjecting noise to a market with limited liquidity. The inflow and existence of the speculators in the derivatives market produces destabilization forces, which creates uninvited bubbles.

Ross (1989) assumed that there exist economies that are devoid of arbitrage and proceeds to provide a condition under which the no arbitrage situation will be sustained. It implies

ISSN: 2348 9510
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Volume 1, Issue 6, September 2014

that the variance of the price change will be equal to the rate of information flow. The implication of this is that the volatility of the asset price will increase as the rate of information flow increases. Thus, if derivatives market increases the flow of information, the volatility of the spot price must change in the absence of arbitrage opportunity.

In contrast, **Danthine (1978)** argued that the futures markets improved market depth and reduced volatility because the cost to informed traders of responding to mispricing is reduced.

Kumar and Seppi (1992) and Jarrow (1992) studied the impact of currency derivatives on spot market volatility and found that speculative trading executed by big players in the derivatives market increases the volatility in the spot exchange rate. Hence, currency futures trading increases the spot market volatility.

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

Chatrath, Ramchander and Song (1996) analyzed the impact of currency futures trading on spot exchange rate volatility by establishing relationship between level of currency futures trading and the volatility in the spot rates of the British pound, Japanese yen, Canadian dollar, Deutsche mark and Swiss franc. They concluded that there exists a causal relationship between currency futures trading volume and exchange rate volatility and also found that the trading activity in currency futures has a positive impact on conditional volatility in the exchange rate changes. Further, futures trading activity has declined on the day following increased volatility in spot exchange rates.

Shastri, Sultan and Tandon (1996) investigated the effect of the introduction of options on the volatility of currency markets and concluded that options contracts complete and stabilize the spot currency markets.

Jochum and Kodres (1998) examined the impact of the introduction of the futures market to the spot currency markets, and report varying results depending on the market

ISSN: 2348 9510
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Volume 1, Issue 6, September 2014

they studied. For Mexico, they find that the introduction of currency futures help reduce the volatility of the spot currency market, while for Hungary and Brazil, they find no discernible impacts.

Adrangi and Chatrath (1998) determined the impact of currency futures commitments and found that the overall growth in currency futures commitments has not caused exchange rates to be more volatile. However, increase in the participation of large speculators and small traders do destabilize the markets.

Butterworth (2000) also argued that introduction of the derivative trading leads to more complete market enhancing the information flow. Derivatives market allows for new positions and extended investment sets and enables to take position at lower cost. 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.

Bologna and Cavallo (2002) argued that the speculation in the derivatives market also leads to stabilization of the spot prices. Since derivatives are characterized by high degree informational efficiency, the effect of the stabilization permits to the spot market. The profitable speculation stabilizes the spot price because informed speculators tend to buy when the price is low pushing it up and sell when the price is high causing it to fall. These opposing forces constantly check the price swings and guide the price towards to the mean level. Uninformed speculators are not successful and are eliminated from the market. This profitable speculation in the derivatives market leads to a decrease in spot price volatility.

The abovementioned fact has provided impetus to explore the influence of currency derivatives in the context of emerging markets which in turn, necessitates further

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 6, September 2014

empirical investigation on the impact of currency futures trading on spot exchange rate volatility.

Objectives of the study

The study has been made to fulfill the following objectives:

1. The estimate the level of volatility prevailing in the Indian currency market.
2. To examine whether volatility is stationary or it has changed over time.
3. To examine whether the introduction of derivatives been really successful in reducing the volatility in the currency market.

Hypotheses of the Study

H_{01}: there is no volatility in the Indian Currency Market.

H_{02}: there is no significant change in level of currency market volatility after introduction of derivatives.

H_{03}: derivatives introduction has not been successful in reducing the volatility.

Methodology and Techniques

The methodology used in the study of volatility is briefly described on the following points:

i. Data and Sample
ii. Normality Test of the Data
iii. Stationarity Test on the Data
iv. Presence of Heteroscedasticity Test

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 6, September 2014

v. Development of Volatility Models for Estimation of Volatility

Data Collection

The historical currency values time series data have been collected from the official website of Reserve Bank of India i.e. www.rbi.org.in . Daily closing currency values will be used to find the impact of derivatives trading on currency market volatility.

The data set comprises of time series data on currency pair of GBPINR. The data analyzed for a span of 8 years starting from1st April, 2006 - 31st December, 2013 coving a total observations of 908 during Pre-Derivative Period and 972 in Post Derivative Period respectively. Eight years will be quite a good span of time to study the impact of any policy implication. In order to study the impact of derivatives on currency market volatility, the whole study period for GBPINR has been bifurcated as follows:

Pre derivatives period: 1st April 2006 – 31st December 2009

Post Derivatives period: 1st January 2010 – 31st December 2013

Derivatives trading started in Indian markets on 28th August 2008 with the launch of futures contract of USDINR at NSE. The full set of currency derivatives products was only available after January 2010 i.e. for GBPINR, JPYINR and EURINR.

Thus **January 2010** has been used as cutoff date to study the impact of introduction of derivatives on volatility.

Daily rate of return is calculated by taking natural logarithm of the ratio of present day index level with the previous day index level. The return series over the period of study (Yt) constitutes the time series currency market data for the purpose of the study.

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 6, September 2014

Normality Test

The Data distribution is said to be normal if its skewness is zero and kurtosis is three. The descriptive statistics like mean, standard deviation skewness and kurtosis of the return data over the period study for GBPINR. The normality test of the descriptive statistics is carried on by using an asymptotic Jarque-Bera (1981) test statistic. The formula of Jarque-Bera (JB) statistics is stated below:

$$JB\ Statistics = T\left(\frac{S^2}{6} + \frac{(K-3)^2}{24}\right)$$

T = No. of observations

S = Skewness coefficient

K = Kurtosis coefficient

JB test of normality is the test of the joint null hypothesis if S & K are 'O' and 3, respectively.

Stationarity Test on the Data

Before estimating the models, the unit root properties for the time series data have been tested individually for entire currency sets using Graphical method & ADF test statistic. Graphical method gives a visual estimate of the stationarity of the series which has been confirmed by ADF test statistic. Augmented Dickey fuller test is given by the following equation:

$$ADF = \alpha\Delta y_{t-1} + x'_t\delta + e_t$$

Where α & δ are parameters to be estimated & e_t is white noise error term

The ADF tests the following hypothesis:

H_0: α =0 (series has a unit root)

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 6, September 2014

H_1: α <0 (series does not have a unit root) and is evaluated using t ratio.

Presence of Heteroscedasticity Test

This is a Lagrange multiplier (LM) test for autoregressive conditional heteroskedasticity (ARCH) in the residuals. It tests the null hypothesis that there is no ARCH effect up to order q in the residuals. After we run the usual ARMA model (mean equation), we obtain the residuals. To test for any ARCH effects the residuals are regressed upon their own values by using the following equation:

$$e_t^2 = \beta_0 + \left(\sum_{i=}^{q} \beta_i \, e_{t-1}^2\right) + v_t$$

Where, e = residual

ARCH LM test approximates chi square distribution with q degrees of freedom.

LM ~ χ_q (chi-square with d.f. q).

The null hypothesis of no ARCH effects is rejected if LM > critical values.

Development of Volatility Models for Estimation of Volatility

The GARCH model

GARCH models explain variance by two distributed lags, one on past squared residuals to capture high frequency effects or news about volatility from the previous period measured as the lag of the squared residual from mean equation, and second on lagged values of variance itself to capture long term influences. In the GARCH (1, 1) model, the variance expected at any given data is a combination of long run variance and the variance expected for the last period, adjusted to take into account the size of the last periods observed shock.

GARCH (1, 1) model is given as:

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 6, September 2014

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \, \varepsilon_{t-1}^2 + \sum_{j=1}^{p} \beta_i \, \sigma_{t-1}^2$$

Parameter constraints:

$\alpha_0 > 0$

$\alpha_1 > 0$

$\beta \geq 0$

and $\alpha_1 + \beta < 1$

Where q represents the lags of the moving average terms and p representing the lags of the autoregressive terms. The above parameter constraints have been discussed for p=1. GARCH Framework helps to detect variations in both level & structure of volatility where alpha (ARCH coefficient) shows the impact of current news on volatility; GARCH coefficient shows the impact of old news on volatility indicating the persistence of previous information. The sum of both ARCH & GARCH coefficient shows the persistence in volatility i.e. the speed at which old shocks to the return die out. A straightforward interpretation of the estimated coefficients of the GARCH equation is that the constant term α_0 is the long-term average volatility, i.e. conditional variance, whereas e_t and σ_t^2 represent how volatility is affected by current and past information, respectively.

Analysis of the Results

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 6, September 2014

Analysis of Descriptive Statistics

The Table-1 presents the descriptive statistics in the form of mean, standard deviation, skewness and kurtosis of both Sensex and Nifty returns over pre-derivative, post-derivative and whole period of study.

Table No.1
Descriptive Statistics GBPINR

Period	Mean	Std Dev	Skewness	Kurtosis	JB Test
Pre-Derivative	-0.0000399	0.007924	-0.89868	8.95122	1460.55 (0.00)
Post-Derivative	0.000315978	0.006445	0.175609	5.14998	192.20 (0.00)
Whole	0.000144188	0.007197	-0.52799	8.10486	5127.55 (0.00)

Normality Test

The standard deviation of return during the post-derivative period is less than that of the pre-derivative period for GBPINR this may lead to the fact that there has been a marginal decrease in volatility after the introduction of currency futures trading in the Indian foreign exchange market. It is also observed from the above table that the value of JB Statistic is highly significant at any significance level. This clearly states the presence of non-normality in the return data of exchange rate returns, which is inconsonance with the documented financial literature.

Stationarity Test

Table – 2 below shows the ADF test of stationarity. It is seen that the values of t-statistics of GBPINR during all the periods are statistically significant at 1% significance level. The test thus confirms that all the series under study are stationary.

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 6, September 2014

Table No. 2
The ADF test statistics value for GBPINR

				Test Critical Value		
Period	No. of observations	ADF Test	P value	1%	5%	10%
		t-Statistics		t-Statistics	t-Statistics	t-Statistics
Whole	1878	-51.302	0.000	-3.430	-2.860	-2.570
Pre-Derivative	906	-30.301	0.000	-3.430	-2.860	-2.570
Post-Derivative	971	-29.409	0.000	-3.430	-2.860	-2.570

Test for Heteroscedasticity

ARCH LM Test	lag (p)	chi^2	df	Prob > chi2
Pre	1	10.139	1	0.0015
Post	1	16.962	1	0.0000
Whole	1	24.934	1	0.0000
H0: no ARCH effects vs. H1: ARCH(p) disturbance				

The Lagrange Multiplier (LM) test for no ARCH effect of exchange rate returns is having the values for whole period, pre derivative period and post derivative period being statistically significant with a zero probability, implying that there is a significant ARCH effect in exchange rate returns. All these results indicate that exchange rate returns series is heteroscedastic. The presence of heteroscedasticity in the exchange rate series calls for the use of ARCH family of models to study volatility.

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 6, September 2014

GARCH Analysis

Table No. 3
GARCH (1, 1) Analysis

	Intercept (α_0)	ARCH (α_1)	GARCH (β_1)	$\alpha_1+\beta_1$
Pre-Derivative	0.000000535 (0.004)	0.0706682 (0.000)	0.9196048 (0.000)	0.990273 (0.000)
Post-Derivative	0.00000185 (0.006)	0.0627179 (0.000)	0.891517 (0.000)	0.9542349 (0.000)
Whole	0.000000809 (0.000)	0.0659267 (0.000)	0.916784 (0.000)	0.9827107 (0.000)

To examine the level of volatility prevailing in the Indian currency market, GARCH (1,1) equation has generated the values for different parameters. These parameter values have been found to be significant as p value is zero for the constant, the ARCH term & the GARCH term. The level of volatility in the Indian currency market has been examined using unconditional variance using the formula:

$$Var\ \varepsilon_t = \frac{\alpha_0}{1 - (\alpha_1 + \beta_1)}$$

Thus various values generated using GARCH (1,1) has been put into the above equation and the level of volatility has been estimated. The result derived is 0.0000468. Level of volatility prevailing in the currency market has been found to be: 0.0000468 (approx 0) which is less than 0.05.

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 6, September 2014

So, we **Reject the Hypothesis H_{01}** that there is no volatility in the Indian currency market

The results in Table 3 show that the there has been a decrease in ARCH term in the post derivatives period as compared to pre derivatives period i.e. from 0.0706682 to 0.0627179 and the GARCH term has also shown a decrease from 0.9196048 to 0.891517. This shows that that the impact of recent news and of old news on volatility has declined. The sum of ARCH & GARCH term has decreased i.e. the persistence of volatility has decreased in the post derivative period. Thus we can say that markets have become efficient after index introduction of derivatives.

So, we **Reject the Hypothesis** that:

H_{02} there is no significant change in level of currency market volatility after introduction of derivatives and

H_{03} derivatives introduction has not been successful in reducing the volatility

Conclusion

The volatility in Indian currency market exhibits the characteristics with respect to the stylized features like autocorrelation, volatility clustering, asymmetry and persistence in its daily return. The impact of financial derivatives on the volatility of exchange rate of GBPINR is significant under GARCH (1, 1) model. It was found that volatility prevailing in the Indian currency market and it is due to the derivatives, the daily volatility during post derivative period is low in comparison to pre-derivative and whole period. The Indian currency market data is non-normal and stationary.

ISSN: 2348 9510
International Journal Of Core Engineering & Management (IJCEM)
Volume 1, Issue 6, September 2014

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Volume 1, Issue 6, September 2014

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