Market Efficiency and Volatility Spill over in Spot & Futures Currency Market (w.r.t $ and ₹)

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Abstract- *The present study has analysed the long term relationship between spot and future prices of currency (dollar) for the period of study between 01/06/2009 and 10/07/2013. The spot and future prices of the currency is found to have long term relationship which is supported by the existence of an error correction mechanism called arbitrage. The error correction mechanism restores the equilibrium relationship whenever disequilibrium takes place between the two markets. It is the spot price which corrects the disequilibrium in the market. The study also finds the presence of unidirectional causality in the currency market wherein the spot causes the future. Using Impulse response function,it is found that significant and higher response of future price to the spot price shocks of dollar and also Volatility spill over was from the spot price to the future price whereas, there was no evidence of volatility spill over from future to spot price.*

Keywords- *arbitrage; volatility spill over; error correction mechanism; impulse response.*

1. INTRODUCTION

Globalization and financial sector reforms in India have ushered in a sea change in the financial architecture of the economy. In the contemporary scenario, the activities in the financial markets and their relationships with the real sector have assumed significant importance. Since the inception of the financial sector reforms in the beginning of 1990's through liberalisation, privatisation and globalisation, the implementation of various reform measures have brought in a dramatic change in the functioning of the financial sector of the economy. Floating exchange rate was implemented in India in 1991 and the implementation of the same facilitated greater volume of trade thus resulting in high volatility in equity as well as forex market. This increased the markets' exposure to economic and financial risks. The regulator's decision to permit Foreign Institutional Investors to invest in stock market and permitting FDI (Foreign Direct Investments) gave a boost to the inflow of foreign exchange and increased volatility in the stock markets. Also, the movement away from pegged exchange rate regime to partially floated in 1992 and fully floated in 1993 was instrumental in developing a market-determined exchange rate of the rupee and was a significant step in the progress towards total current account convertibility. The country is also moving towards full convertibility of rupee on capital account and it is imperative that a foreign exchange derivative market is set up for better price discovery of the underlying asset (i.e, currency) and curb volatility in the movement of a pair of currency. Currency futures trading in INR-US$ started on August 29, 2008. Till January2010, exchange rate futures were available only for US $ vis-à-vis Indian Rupee. 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 notable contribution towards improving the menu 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 clear evidence to prove that futures contracts traded on exchanges result in increased volatility in the prices for the underlying asset. The rupee has already depreciated by 20% in the last one year thanks to the policies of the U.S in terms of easing out quantitative restrictions thus making it attractive for the investors' to invest in the U.S market. The volume and the open interest position in the currency derivative market have been low since its introduction in India and it has become important to understand the relationship between spot and futures market.

2. REVIEW OF LITERATURE

The following are the review of earlier studies

Chatrath et al., (1996) explicitly examined the relationship between level of currency futures trading and the volatility in the spot rates of the British pound, Canadian dollar, Japanese yen, Swiss franc and Deutsche mark. The researchers provide strong evidence on the causality between futures trading volume exchange rate volatility, as it is found out that the trading activity in futures has a positive impact on conditional volatility in the exchange rate changes, with a weaker feedback from the exchange rate fluctuations to the futures volatility.

Bhargava et al., (2007) focused on trading in futures on four currencies over the time period of 1982-2000. The authors found evidence that day traders and speculators destabilize the market for futures. According to them, it is inconclusive whether hedgers stabilize or destabilize the market

Gallo Giampiero et al., (2008) examined the volatility spillovers, interdependence and co – movements between markets and found that volatility in one market reacts to innovations in other markets as a result of financial integration. The research study employed Multi – Chain Markov Switching Model (MCMS, Otarnto 2005) to study the market characterizations by relying on the definitions of spillover, interdependence and co – movements. The model is estimated on the weekly high – low range of five Asian markets assuming a central (but not necessarily dominant) role for Hong Kong. The results showed plausible market characterizations over the long run with a spillover from Hong Kong to Korea and Thailand, interdependence with Malaysia and co – movement with Singapore.

Rosenberg et al., (2009) studied the relationship between intraday exchange rate movements in cash and futures are examined during 1996 and 2006 in Chicago Mercantile Exchange. Interestingly, in 1996, futures price changes mostly led those in the cash market; while in 2006, the direction of influence was largely reversed. The authors believe this change primarily reflects increased transparency of the cash FX market.

Guru (2010). Exchange traded currency futures in the Indian Rupee-Dollar currency pair, have recently been introduced in the country last year. The paper empirically tested the impact of currency futures trading on volatility and returns of underlying spot exchange rates. The informational advantage in exchange traded currency futures contracts relative to OTC contract is also tested. Results indicate that both speculative and hedging activities in the futures market for currency have no influence on the volatility in the underlying exchange markets. The returns in futures markets are seen to be driving the returns in spot markets, indicating the information advantage of the futures markets. Further, results indicate that the information content of futures markets is higher than that of forward markets.

Sakthivel et al., (2010) investigated the impact of introduction of index futures trading on volatility of Nifty. The study employed GARCH (1, 1) model to capture the time varying nature of the volatility and volatility clustering phenomena using daily closing price of the Nifty. The results showed that after introduction of the futures trading reduced stock market volatility, due to increase market efficiency. The study also examined futures trading changes structure of spot market volatility using GARCH model. The study observed that there is a changes structure in spot market volatility after introduction futures trading. Specifically, there is evidence that the increased impact on recent news and reduced effect of the uncertainty originating from the old news. The study concluded that the introduction of the derivatives contract improved the market efficiency and reduced the asymmetric information.

Debasish S. S. (2011) investigated the effect of futures trading on the volatility and operating efficiency of the underlying Indian stock market by taking a sample of selected individual stocks. The study examined whether the index futures trading in India has caused a significant change in spot price volatility of the underlying stocks and how the index futures trading has affected market/trading efficiency in the Indian futures and stock markets. The study employed event study approach to test whether the introduction of index futures trading has resulted in significant change in volatility and efficiency of the stock returns. The study indicated that the introduction of Nifty index futures trading in India is associated with both reduction in spot price volatility and reduced trading efficiency in the underlying stock market. The study suggested that there is a trade-off between gains and costs associated with the introduction of derivatives trading at least on a short-term perspective.

Nair. (2011) examined the impact of introduction of derivatives trading on the underlying spot market volatility of seventy two scrips using symmetric and asymmetric GARCH methods. The research study indicated the existence of asymmetric response to new information. Further, the results indicate an increase in the efficiency of processing new information. Overall, the study found that there is a strong evidence of a reduction of volatility after the introduction of derivatives trading.

Sharma (2011).This paper has focussed at the relation between volatility in the exchange rate in the spot market and trading activity in the currency futures. The results

show that there is a two-way causality between the volatility in the spot exchange rate and the trading activity in the currency futures market.

Sahu (2012) in his paper aimed at examining the impact of currency futures on exchange rate volatility of EURO after the introduction of currency futures trading in India. The data used in this paper comprises of daily exchange rate of EURO in terms of Indian rupees for the sample period January 02, 2008 to December 31, 2011. To explore the time series properties, Unit Root Test and ARCH LM test have been employed and to study the impact on underlying volatility, GJR GARCH (1, 1) model has been employed. The results indicate that the introduction of currency futures trading has had no impact on the spot exchange rate volatility of the foreign exchange market in India. Further, the results are also indicative of the fact that the importance of recent news on spot market volatility has increased and the persistence effect of old news has declined with the introduction of currency futures trading.

3. OBJECTIVES

The objective of the study is to analyse the lead-lag relationship between the level of spot and futures trading in the currency market. The study also analyses the volatility spill over effect between spot and futures market.

4. DATA AND METHODOLOGY

The study is based on the secondary data. The data for spot and futures exchange rate details are collected from www.mcxindia.com. The period of study is from 01-06-2009 to 01-07-2013.

4.1 Statistical Tools

The following statistical tools are employed for the present study. The tests namely JB test, , Unit root test, Johansen's Co integration test, Block Exogeneity Test(Wald Test) and GARCH(1,1) test were conducted using E-views software (version 7). A brief explanation about various statistical tools are given below-

4.2 Normality Test

The Jarque-Bera (JB) test [Gujarati (2003)] is used to test whether stock returns and exchange rates individually follow the normal probability distribution. The JB test of normality is an asymptotic, or large-sample, test. This test computes the skewness and kurtosis measures and uses the following test statistic:

$$JB = n [S2 /6 + (K-3)2 /24]$$

Where n = sample size, S = skewness coefficient, and K = kurtosis coefficient. For a normally distributed variable, S = 0 and K = 3. Therefore, the JB test of normality is a test of the joint hypothesis that S and K are 0 and 3 respectively.

To analyse the pattern of distribution of data skeweness and kurtosis have been calculated. Zero skewness implies symmetry in the distribution whereas kurtosis indicates the extent to which probability is concentrated in the centre and especially at the tail of the distribution. Kurtosis measures the peakedness of a distribution relative to the normal distribution. A distribution with equal kurtosis as normal distribution is called 'mesokurtic'; a distribution with small tails is called 'platykurtic' and a distribution with a large tail is called 'leptokurtic'.

4.3 Unit Root Test (Stationarity Test)

Empirical work based on time series data assumes that the underlying time series is stationary. Broadly speaking a data series is said to be stationary if its mean and variance are constant (non-changing) over time and the value of covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed [Gujarati (2003)].A unit root test has been applied to check whether a series is stationary or not. Stationarity condition has been tested using Augmented Dickey Fuller (ADF).

4.4 Augmented Dickey–Fuller (ADF) Test

Augmented Dickey-Fuller (ADF) test has been carried out which is the modified version of Dickey-Fuller (DF) test. ADF makes a parametric correction in the original DF test for higher-order correlation by assuming that the series follows an AR (p) process. The ADF approach controls for higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression. The Augmented Dickey-Fuller test specification used here is as follows:

$$Yt = b_0 + \beta\Delta Yt\text{-}1 + \mu 1\, \Delta Yt\text{-}1 + \mu 2\, \Delta Yt\text{-}2 + \ldots.. + \mu p\, \Delta Yt\text{-}p + et$$

Yt represents time series to be tested, b_0 is the intercept term, β is the coefficient of interest in the unit root test, μi is the parameter of the augmented lagged first difference of Yt to represent the pth-order autoregressive process, and et is the white noise error term.

4.5 The Johansen's Co integration test is used to test the presence of long term equilibrium relationship between the spot and future market of the currencies. The Vector Error Correction Model (VECM) is used to analyse the whether error correction mechanism takes place if some disturbance comes in the equilibrium relationship. The Block Exogeneity test is applied to analyse the short term causality relationship between spot and futures market of the currencies.

4.6 The volatility spillover between the spot and future prices of the currency is analyzed using GARCH (1,1) method. GARCH (1,1) technique were developed independently by Bollerslev (1986) & Taylor (1986). GARCH model allows the conditional variance to be dependent upon previous own lags, so that the conditional variance eq in simplest case is now

$$\sigma_t^2 = \alpha_o + \alpha_1 u_{t-1}^2 + \beta \sigma_{t-1}^2 \ldots \quad \ldots \text{eq (2)}$$

This is a GARCH (1,1) model. σ^2_t is known as *conditional variance* since it is a one- period ahead estimate for the variance calculated based on any past info thought relevant. In the above mentioned eq 2, one more exogenous variable is included, the square of the lagged error terms of other variable, estimated with the help of ARMA forecasting models. The new equation can be represented as

$$\sigma_t^2 = \alpha_0 + \alpha_1 \mu_{t-1}^2 + \beta_1 \sigma_{t-1}^2 + \beta_2 \epsilon_{t-1}^2$$
$$\ldots\ldots\ldots \text{ eq (3)}$$

Where, the last term represents the square of the lagged error terms of other variable.

5. ANALYSIS AND INTERPRETATION

Table I

Descriptive Statistics

Particulars	Spot Price ₹	Future Price ₹
Mean	49.06	49.60
Median	47.00	48.09
Maximum	60.588	60.57
Minimum	43.94	44.27
Standard Deviation	4.23	4.11
Skewness	0.63	0.49
Kurtosis	1.95	1.83
Jarque Bera	103.72	89.30
Probability	0.00	0.00

Table I shows the descriptive statistics of daily closing spot and future price of dollar in terms of rupees for the period selected for the study. It can be seen that the closing price in case of spot price varies from 43.94 to 60.58 thereby stating that there is wide fluctuation in the daily closing spot price. Similarly, the closing price of futures varies from 44.27 to 60.57 respectively. The mean return for the entire period is 49.06 for spot and 49.60 for the future.. Skewness is positive (0.636) for spot and future (0.49) indicating a relatively long right tail compared to the left one. Kurtosis with 1.93 for spot and 1.83 for futures indicates short tails and the distribution is platykurtic'. The findings are similar to the existing literature and with a high Jarque-Bera statistic, it can be confirmed that the returns series is not normally distributed.

It is a fact that many financial time series data are random walk or non-stationary time series and contains unit root. Test of unit root in the spot and future currency prices of dollar is essential as the presence of unit root may give invalid inferences in the analysis. ADF (Augmented Dickey-Fuller Test) is the popular test for unit root testing of time series.

Table II shows the results of ADF test and the results indicate that both (spot and future) series are non stationary at level but becomes stationary at their first difference and is statistically significant.

Table II
ADF Unit Root Test for Spot Price (SP) and Future Price (FP)

Particulars	't' Value (SP)	Probability(SP)	't' Value (FP)	Probability (FP)
At level	0.3056	0.978	0.1374	0.968
At first difference	-29.456	0.00	-33.702	0.00

In derivatives market the future prices of the currency can be derived from the spot prices, due to which a theoretical relationship is supposed to exist between the spot and future prices of the currency. This existence of long term equilibrium relationship between the spot and future prices of the currency can be tested using co integration test.

The co integration test was introduced by Granger (1981, 1983) and Engle and Granger (1987) to explain stationary equilibrium relationship among the non-stationary variables. The co integration test is useful in analyzing the presence of a stationary linear combination among the non-stationary variables of the same order. If such combination is found, an equilibrium relationship said to exists between the variables. The Johansen co integration test is applied in the research study between the spot and future closing prices of the currency .The result of the Johansen's Co-Integration Test are shown in table III. The trace statistics for the calculated Eigen value is more than

the table value and hence the null hypothesis of no co integration is rejected. The results are similar for the future prices of dollar and hence the result indicates the presence of long term relationship between the spot and future closing prices of dollar. Hence the long term equilibrium relationship also exists between the spot and future closing prices of the currency.

Table III
Johansen's Co-Integration Test on spot and future prices of Dollar

Co integration Between	Lag length selected	Co integration test using	No. of Co integrating Equations (CEs)	Eigen Value	Statistic	Critical value at 5%	Probability**
Daily Spot Closing and Daily Future Closing of Dollar	1 to 4 (in first difference of 2 series)	Trace test	H_0: r=0 (None)	0.222	50.328	15.495	0.000
			H_1: r ≤ 1 (At most 1)	0.000	0.973	3.841	0.324
		Max-Eigen Value test	H_0: r=0 (None)	0.022	49.354	14.265	0.000
			H_1: r ≤ 1 (At most 1)	0.000	0.973	3.841	0.324

Trace test indicates 1 Co integrating equation at 5% level of significance
Max-eigen test indicates 1 Co integrating equation at 5% level of significance
Denotes rejection of null hypothesis at 5% level of significance
**Mackinnon et.al.(1999) estimated p values

The equilibrium relationship between the non-stationary variables is used to construct an Error Correction Model (ECM). An error correction model is a statistical specification of economic dynamics through which the pull and push forces restore the equilibrium relationship whenever a disequilibrium takes place. In currency market, the future prices can be estimated using deterministic models. According to these models the future prices of the currency should be equal to the spot prices plus cost of carry. Any difference between the theoretical and actual prices of the currency may lead to arbitrage opportunities in the market. These arbitrage opportunities help in correcting the disequilibrium between the spot and future prices of the currency in the market. The results of the Error Correction model are shown in table IV for both the commodities

Table IV
Error Correction Model Result for Future and Spot price of Dollar

Exchanges	Variables	Δ(Spot)		Δ(Future)	
		Coefficient	t value	Coefficient	t value
Dollar	Equilibrium Error	0.0316	4.34	0.002	0.304
	ΔSpot(-1)	0.00073	0.002	0.125	3.28
	ΔFuture(-1)	0.05	1.73	-0.014	3.28
	Constant	0.013	1.34	0.015	1.33

The results indicate that the correction of equilibrium error is higher in the case of spot price and is statistically significant when compared to the future price. It shows that the spot price corrects the disequilibrium between the spot and the future prices. Also, the change in the future value of currency is determined by the lagged value of spot price and future price. However, the influence is positive in the case of lagged value of spot price.

Table V represents the results of the Block Exogeneity Wald Test in vector error correction model for the currency dollar. The Block Exogeneity test is applied to analyse the short term causality relationship between spot

and futures market of the currencies. The results indicate unidirectional causality (from spot to future) in the case of dollar.

Table V
VEC Grangers Causality/ Block Exogeneity Wald Test for Dollar

Dependent Variable	Excluded	Dollar	
		Chi Square Statistic	P Value
Δ(Spot)	Δ(Future)	4.315	0.113
Δ(Future)	Δ(Spot)	10.9266	0.0042

Variance decomposition explains the percentage of forecasting error that can be explained with the help of variances in its previous behavior as well as the behavior of other series. The results of variance decomposition of spot and future prices of the currency dollar for ten lags are shown in table VI. The results indicate that the forecasting error in spot price is mainly explained by the lagged values of the spot series whereas the forecasting error of future price is explained by the lagged values of spot price series. The rate of variance decomposition is higher in the case of future series when compared to the spot series. Therefore, it can be concluded that the spot series is exogenous in nature

.Table VI
Variance Decomposition Index for Spot Price and Future Price

	Dollar			
Period	Variance Decomposition of Spot		Variance Decomposition of Future	
	SP	FP	SP	FP
1	100	0.00	4.89	95.10
2	99.51	0.43	7.71	92.28
3	98.79	1.2	8.17	91.82
4	98.29	1.7	8.31	91.74
5	97.79	2.2	8.25	91.68
6	97.26	2.73	8.31	91.67
7	96.68	3.33	8.32	91.69
8	96.06	3.39	8.30	91.73
9	95.44	4.55	8.22	91.77
10	94.77	5.22	8.16	91.83

The impulse response explains the responsiveness of the endogenous variable in the system to shocks to each of the other endogenous variables. So, for each endogenous variable in the system, a unit shock is applied to the error, and the effects over time are noted. Figure I shows the pair wise impulse response relations between the spot and future prices of dollar. The results indicate the significant

and higher response of future price to the spot price shocks of dollar.

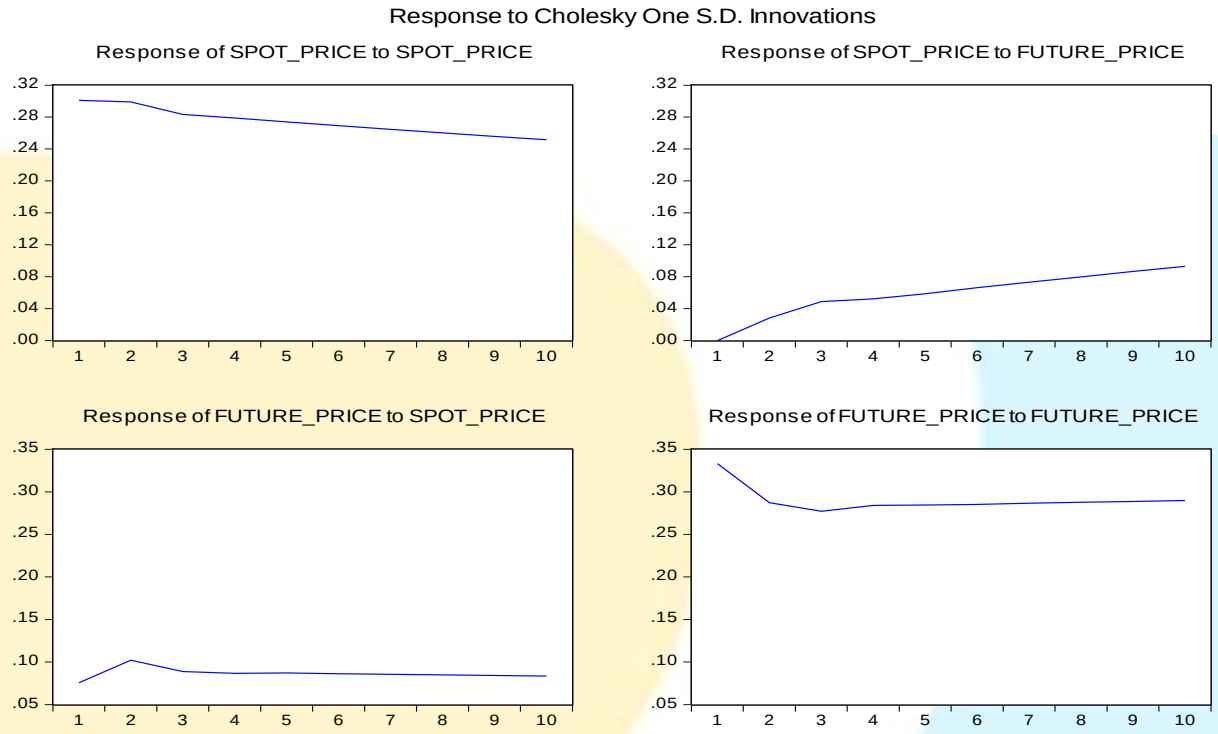

Figure I
Impulse Response Function of Dollar

The future market of the currencies is featured with low volume of trade with better liquidity and high margin requirements and the presence of reasonable number of participants including traders, speculators and arbitrageurs. Due to this reason the future markets of the currencies are supposed to be less efficient as compared to spot market. Hence when new information about the currency comes into the market, the participants responds to the information and involves in rebalancing their positions in the portfolios according to their perception about the current implications of the news. In such a case the spot market is very fast to respond to the news as compared to the future market. In this system the volatility lying in the currency prices is also a major concern for the participants. The purpose of this study is also to analyze the impact of volatility in one series on the future volatility in other series. This impact is known as volatility spillover in the literature.

Table VII shows the volatility spill over effect from spot to future market. The results indicate that the existence of volatility spill over in case of dollar from spot price to future price as indicated by the z statistics (2.24) in table VII.

Table VII
Volatility Spill over effect from Spot Market to Future Market

Dependent Variable: Future Price Method: ML – ARCH (Marquardt) - Normal distribution				
Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
C	50.57	15.30	3.30	0.009
AR(1)	0.995	0.07	57.5	0.00

MA(1)	-0.011	0.62	-0.018	0.985
Variance Equation				
C	0.761	0.34	2.192	0.028
Residual Term	-0.77	0.039	1.94	.051
GARCH Term	0.02	.004	5.91	0.00
Squared lagged residual in spot price of dollar	0.529	0.023	2.24	0.024

Table VIII shows the volatility spill over effect from future to spot market. The results indicate that there is no existence of volatility spill over in case of dollar from future price to spot price as indicated by the z statistics (-0.0986) in table VIII.

Table VIII
Volatility Spill over effect from Future Market to Spot Market

Dependent Variable: Spot Price Method: ML – ARCH (Marquardt) - Normal distribution				
Mean Equation				
	Coefficient	Std. Error	z-Statistic	Prob.
C	48.77	19.81	2.46	0.013
AR(1)	0.96	0.15	6.45	0.00
MA(1)	0.32	1.02	0.31	0.75
Variance Equation				
C	9.21	5.39	1.70	0.08
Residual Term	-0.49	0.21	-2.29	0.021
GARCH Term	-0.35	0.79	-0.44	0.65
Squared lagged residual in future price of dollar	-0.83	0.85	-0.98	0.32

6. CONCLUSION

The spot and future prices of the currency is found to have long term relationship which is supported by the existence of an error correction mechanism called arbitrage. The error correction mechanism restores the equilibrium relationship whenever disequilibrium takes place between the two markets. In the present study, it is the spot price which corrects the disequilibrium in the market. The study also finds the presence of unidirectional causality in the currency market wherein the spot causes the future. Variance decomposition explains the percentage of forecasting error that can be explained with the help of variances in its previous behavior as well as the behavior of other series. The results indicate that the forecasting error in spot price is mainly explained by the lagged values of the spot series whereas the forecasting error of future price is explained by the lagged values of spot price series. The rate of variance decomposition is higher in the case of future series when compared to the spot series. The spot price of the currency was found to be exogenous in nature. The study also found significant and higher response of future price to the spot price shocks of dollar. The future market of the currencies is featured with low volume of

trade with better liquidity and high margin requirements and the presence of reasonable number of participants including traders, speculators and arbitrageurs. Due to this reason the future markets of the currencies are supposed to be less efficient as compared to spot market. Hence when new information about the currency comes into the market, the participants responds to the information and involves in rebalancing their positions in the portfolios according to their perception about the current implications of the news. In such a case the spot market is very fast to respond to the news as compared to the future market. Volatility spill over was from the spot price to the future price whereas, there was no evidence of volatility spill over from future to spot price.

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