

Impact of Arbitrage Opportunities on Currency Futures Market in India

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ABSTRACT

Arbitrage opportunity comes into picture as a result of market inefficiencies and it gives a mechanism to ensure that prices do not deviate substantially. Hence, the impact of arbitrage opportunities has to be analyzed with reference to the pace of adjustment towards equilibrium and efficiency of spot and futures currency market in India i.e. long run relationship between futures and spot market. The impact of arbitrage opportunities need to be studied with respect to speed of adjustment towards equilibrium as well as market efficiency of spot and futures foreign currency market in India. The primary Objective of this research is to study the impact of arbitrage opportunities on currency futures in India. The present study employs Descriptive Research Design. The daily closing spot and future rupee exchange rate of Indian Rupee against USD, Pound, Euro and Yen is used for estimating the volatility. Time period of the study is 5 years starting from February, 2014 to March, 2019. Total number of observations was 1,247 in total. The exchange rate time series data has been collected from RBI database and currency future data was collected from National stock Exchange. To study the impact of arbitrage opportunities Unit Root Analysis of data, Johansen's Cointegration Test and Vector Error correction Granger causality Tests were employed. The study concludes that in the short

run arbitrage possibility in the future market impact the currency spot market and leads the spot market to the long run equilibrium.

1. INTRODUCTION

The futures and spot market prices are related by arbitrage. Like any other futures contracts, the fundamental no-arbitrage equation for forex futures can be determined. Since foreign currencies can be carried, futures prices can be easily determined by cash-and-carry arbitrage. In the cases of shares or bond portfolios, the assets provide returns in the form of interest or dividend. Similarly in the case of foreign currencies, the return assumes the form of interest on the foreign currency. Hence, cash and carry arbitrage with foreign currencies is also known as covered interest arbitrage. This can be supplementary interpreted as an arbitrage of a real futures contract against a synthetic futures position. This highlights the point that if derivatives are not available they could be synthetically created.

It is confirmed in the earlier researches that if the spot and future markets are cointegrated then it can be interpreted as long term equilibrium and it is specified that there are no noteworthy arbitrage opportunities in the long run. Long run equilibrium is achieved by correcting the short run disequilibrium in the market. Arbitrage opportunity comes into picture as a result of market inefficiencies and it gives a mechanism to ensure that prices do not deviate substantially. Hence, the impact of arbitrage opportunities has to be analyzed with reference to the pace of adjustment towards equilibrium and efficiency of spot and futures currency market in India i.e. long run relationship between futures and spot market.

2. REVIEW OF LITERATURE

Roll R., E. Schwartz, A. Subrahmanyam (2010) studied the cost-effectiveness of local currency traders in futures markets. It was established that traders found profit while trading in currency futures and profit was positively correlated to the trading volumes. Buhler and Kempf (2010) are of the opinion that when the equilibrium conditions persist,

opportunity for long and short arbitrage exists. Tse (2012) analysed the cross-market herging of investors and speculators in the dollar, francs, pound and yen futures markets from 1992 to 2010. Mishra Kannan and Mishra (2012) studied the long run relationship between the currency future prices and currency spot prices for USD/INR pair. Results show that there is a long term relationship between variables. Yadav and Pope (2012) analysed the relationship between spot and futures traded in Turkish Exchanges. The results showed a long run relationship between currency spot and futures market. In both short run and the long run A two-way causality was found. Suvanam and Jalan (2013) studied the price discovery and spillovers in spot and futures prices of four currencies. It's found out that Volatility spillovers are stronger from futures to spot in short-run while reverse is found in the long-run. Gromb and Vayanos (2013) examined the causality between price, volume and open interest with respect to four futures currency pairs Using Granger Causality Test. There was a bidirectional causality between futures prices and spot prices in EUROINR, GBPINR, JPYINR whereas unidirectional causality in USDINR. Sundaresan (2013) investigated the price discovery in the Indian stock market. The results pointed a long-run relationship between the stock futures and spot market. Nagel (2013) analyzed the market efficiency of the Indian commodity market. It was noted that futures market lead the spot market and enhance the efficiency of market. Mackinlay and Ramaswamy (2014) studied the exchange rate volatility in Indian spot and future market. The result of Johansen's Cointegration test proved that there is no long-term relationship between exchange rates of Indian rupee. Shah (2015) importantly analysed the pricing models for the currency futures market in India. Results of the study shows that the currency futures market in India is very inefficient and a long run relationship could be established between currency futures and currency spot market.

3. STATEMENT OF THE PROBLEM

A lot of research has taken place in the international market to understand the aspects of currency futures trading i.e. futures prices Arbitrage profit, existence of arbitrage opportunities etc. In foreign currency market, the theoretical future prices can be anticipated using deterministic models. Based on these models the future prices of the foreign currency should be equal to the spot prices and cost of carrying. Any difference in

the theoretical and actual prices of the foreign currency may result in arbitrage opportunities. Arbitrage opportunities results in correcting the disequilibrium between spot and future prices of the currency. This aspect is not covered in the most of the Indian studies. Therefore, the impact of arbitrage opportunities need to be studied with respect to speed of adjustment towards equilibrium as well as market efficiency of spot and futures foreign currency market in India. The present study is an attempt to fill this important gap.

4. OBJECTIVES AND METHODOLOGY

The primary Objective of this research is to study the impact of arbitrage opportunities on currency futures in India. The present study employs Descriptive Research Design. The daily closing spot and future rupee exchange rate of Indian Rupee against USD, Pound, Euro and Yen is used for estimating the volatility. Time period of the study is 5 years starting from February, 2014 to March, 2019. Total number of observations were 1,247 in total. The exchange rate time series data has been collected from RBI database and currency future data was collected from National stock Exchange.

Statistical Tools

To study the impact of arbitrage opportunities the following tests were used:

- Descriptive Statistics
- Unit Root Analysis of data
- Johansen's Cointegration Test
- Vector Error correction Granger causality/Block Exogeneity Wald Test

5. DATA ANALYSIS & INTERPRETATION

Descriptive Statistics for Four Currency Pairs

To study the relationship between spot and futures currency prices, Time series data was used. **Exhibit 1** shows the descriptive analysis of the currency spot and futures prices for

the nearby contracts. The following table shows the descriptive statistics for all the currency pairs i.e. USD/INR, EURO/INR, GBP/INR and JPY/INR.

**Exhibit 1: Descriptive Statistics - Daily Spot Futures Price for USD/INR,
EURO/INR,GBP/INR and YEN/INR
(Period: February 2014 to March 2019)**

Statistics	USD/INR		EURO/INR		GBP/INR		YEN/INR	
	USP	UFP	ESP	EFP	PSP	PFP	YSP	YFP
Mean	66.61403	66.75314	75.64962	75.81295	83.04976	83.24848	62.98022	62.14244
Median	.24150	59.29750	76.47600	76.65750	83.65830	83.64500	62.62000	68.79250
Std. Dev.	6.730758	6.759263	8.385872	8.410885	11.66370	11.70402	5.868544	5.878765
Skewness	-0.001915	0.001230	0.352646	0.356829	0.125901	0.127919	0.373125	0.356307
Kurtosis	1.535066	1.541786	1.994303	2.002228	1.624515	1.629312	2.305535	2.281590
Jarque-Bera	111.5050	110.4839	78.39807	78.18978	101.5974	101.0194	53.99360	53.20181
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000

Note: USP stands for spot prices and UFP stands for future prices

ESP stands for spot prices and EFP stands for future prices

PSP stands for spot prices and UFP stands for future prices

YSP stands for spot prices and YFP stands for future prices

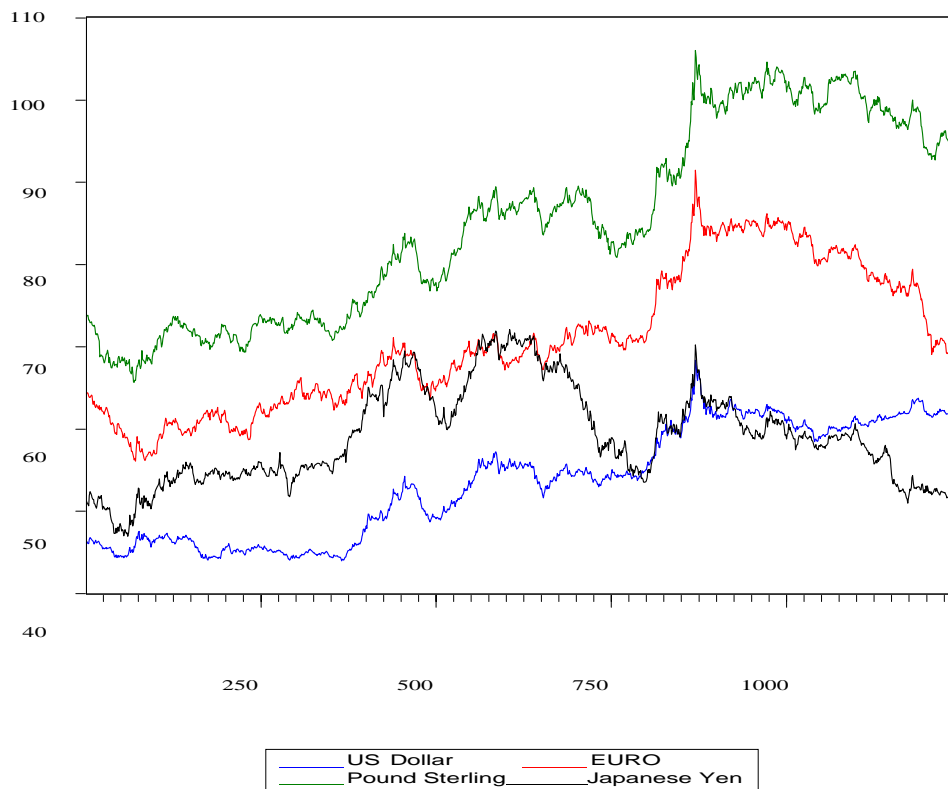
The mean return of all the currency pairs is high in the future market as compared to spot market. It implies that investors are getting higher returns in the future market as comparing to spot. The three important indicators of distribution of a data are Skewness, Kurtosis and Jarque- Bera statistic. Descriptive statistics indicate that except USD spot prices of all the pair reported a positive skewness. It shows that the distribution has a long right tail. A positive skewness shows that the tail on the right side is longer than the left and the bulk of the value lies to the left of the mean. Kurtosis for all the data set registered a value less than 3. This statistic indicated that distribution had short tails and was platykurtic. A high Jarque-Bera statistic and a significant probability value shows that the all the data series are not normally distributed. This kind of non-normal distribution indicate volatility.

Unit Root Test

Most of the time series data are non-stationary time series and contains unit root. Econometric modeling of time series data requires stationary data. A stationary time series data is one where the mean and variance are constant. So it is a prerequisite to check the series for unit root. Test of unit root in spot and future currency prices is prerequisite as the presence of unit root may give invalid inferences in analysis. Augmented Dickey-Fuller Test and Phillip Perron Test were used for unit root testing. The occurrence of a unit root indicate that the given data series has become unstable or non-stationary.

In the **Exhibits 2** the daily spot prices and future prices are plotted. Understanding of graphs indicate that each of the series is non stationary.

**Exhibit 2: Daily Spot Prices for USD/INR,EURO/INR,GBP/INR and YEN/INR
(Period: February 2014 to March 2019)**



Results of Augmented Dickey Fuller and Phillips Perron unit root test indicate that T statistics of all futures and spot foreign exchange rate series were found less then test critical value at 5% level of significance. So at this level null hypothesis couldn't be

rejected as probability value of all series were also found more than 0.05. This indicate that all the spot and future currency price series were non stationary at this level. Apart from that the stationarity was checked on first difference for all the data series. At first difference, the probability value for all the data series was found less than .05 and indicated the significant results. The null hypothesis was rejected for the all the data series.

Cointegration Test

One of the primary condition for any two series to be cointegrated is that they must be integrated in the same order. All the four currency pairs of spot and future prices for all the four currencies were integrated hence the long run relationship between spot and future currency prices can be tested using Johansen cointegration test. This test is useful in analyzing the presence of a stationary linear combination among the non-stationary data of the same order. If such combination is identified, an equilibrium relationship believe to exists between the variables.

**Exhibit 3: Johansen Cointegration Test of Spot and Future Price
(Period: February 2014 to March 2019)**

Co integration Between	Lag length selected	Co integration test using	Hypothesized No. of Co integrating Equations (CEs)	Eigen Value	Statistic	Critical value at 5%	Probability*
Daily Spot prices and Daily Future Closing of USD/INR	1 to 4 (in first difference of 2 series)	Trace test	None*	0.146432	197.0731	15.49471	0.0001
			At most 1	0.000344	0.427462	3.841466	0.5132
		Max-Eigen Value test	None*	0.146432	196.6456	14.26460	0.0001
			At most 1	0.000344	0.427462	3.841466	0.5132
Daily Spot prices and Daily Future Closing of EURO/INR	1 to 3 (in first difference of 2 series)	Trace test	None*	0.172546	236.6967	15.49471	0.0001
			At most 1	0.001021	1.270180	3.841466	0.2597
		Max-Eigen Value test	None*	0.172546	235.4265	14.26460	0.0001
			At most 1	0.001021	1.270180	3.841466	0.2597
Daily Spot		Trace test	None*	0.156888	213.0476	15.49471	0.0001

prices and Daily Future Closing of GBP/INR	1 to 4 (in first difference of 2 series)		At most 1	0.000880	1.093781	3.841466	0.2956
		Max-Eigen	None*	0.156888	211.9538	14.26460	0.0001
		Value test	At most 1	0.000880	1.093781	3.841466	0.2956
Daily Spot prices and Daily Future Closing of YEN/INR	1 to 4 (in first difference of 2 series)	Trace test	None*	0.138689	187.9405	15.49471	0.0001
			At most 1	0.002020	2.510760	3.841466	0.1131
		Max-Eigen	None*	0.138689	185.4298	14.26460	0.0001
			Value test	At most 1	0.002020	2.510760	3.841466

Trace test and Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Exhibit 3 indicates the results of Johansen cointegration results for all the four pairs of currency. At 5% level of significance null hypothesis was rejected and confirmed that there was at least cointegration equation between spot and future currency prices. The second hypothesis is that there is more than one cointegration equation was rejected because the trace statistics and Max-Eigen statistics values were less than the critical values. The probability value also found more than 0.05. Results shows that the presence of long term relationship between the spot and future closing prices of all the currency pairs.

VEC Granger Causality/Block Exogeneity Wald Test

The short run causality between future and spot prices was tested with the help of VEC Granger Causality/Block Exogeneity Wald Test. The Exhibit 4 shows the results of short run causality for all the four currency pairs for the period of the study. This Test is based on the null hypothesis which talks about exclusion of independent variable in equation with dependent variable. The null hypothesis hence rejected with a probability value less than 0.05.

**Exhibit 4 : VEC Granger Causality/Block Exogeneity Wald Test
(Period: February 2014 to March 2019)**

Dependent Variable	Excluded/Independent variable	Chi Square Statistic	df	Probability Value	Null Hypothesis	Direction
USD/INR Spot prices	USD/INR Future Prices	99.60632	4	0.0000*	Rejected	Bidirectional
USD/INR Future Prices	USD/INR Spot prices	27.44871	4	0.0000*	Rejected	
EURO/INR Spot prices	EURO/INR Future Prices	109.0120	3	0.0000*	Rejected	Bidirectional
EURO/INR Future Prices	EURO/INR Spot prices	10.28473	3	0.0163*	Rejected	
GBP/INR Spot prices	GBP/INR Future Prices	111.8931	4	0.0000*	Rejected	Bidirectional
GBP/INR Future Prices	GBP/INR Spot prices	11.13625	4	0.0251*	Rejected	
YEN/INR Spot prices	YEN/INR Future Prices	53.26062	4	0.0000*	Rejected	Unidirectional
YEN/INR Future Prices	YEN/INR Spot prices	6.237181	4	0.1821	Accepted	

* denotes significance level at the 0.05 level

Exhibit 5.4 shows that there was bidirectional causality in USD/INR, EURO/INR, GBP/INR spot and futures prices. The Probability value is less than 0.05 and is significant. So the null hypothesis of exclusion of futures prices as independent variable was rejected. Only future market of JPY/INR caused the spot market but not vice versa. Hence there was unidirectional causality in the JPY/INR market.

6. CONCLUSION

The study was taken up with an objective of estimating the impact of arbitrage opportunities on the currency futures market. In this direction, Johansen Cointegration test, Vector Error Correction Model and VEC Granger Causality /Block Exogeneity Wald Test were used. The results of all models indicate that

1. Currency spot and futures market are cointegrated and had a long term relationship in all the four currencies.
2. The results of Vector Error Correction Mechanism shows that there is an error correction mechanism in the both spot and futures markets (arbitrage process). In the present research it was found that all the four currencies had the arbitrage opportunities in the short run and this opportunity help the market in long run equilibrium.
3. Research could establish that future market lead the spot market in the short run and spot market lead the future market in the long run.

Currency spot and futures market both are efficient as there is long run relationship in market. The above study confirms that Currency futures and spot market are cointegrated and had a long term relationship between them. The results of Vector Error Correction Mechanism show that there is an arbitrage process in the both markets. It implied that whenever the disequilibrium occurs between the currency spot and futures market in the short run, arbitrage opportunities help to bring the equilibrium in the long run. Arbitrageurs try to gain out of price differentials of these two markets until the difference becomes insignificant. This process will help in maintaining the long run equilibrium. In the present study it was found that markets for all the four currencies had the arbitrage opportunities in the short run and this help the currency futures and spot market to be in long run equilibrium. Overall it can be concluded that in the short run arbitrage possibility in the future market impact the currency spot market and leads the spot market to the long run equilibrium.

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