

# An Empirical Study of Long Run Relationship between Spot and Futures Prices in Indian Financial Market

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## ABSTRACT

*This paper aims to analyse the long run relationship between the futures and spot exchange rates of four currencies ("USD/INR, EURO/INR, GBP/INR and JPY/INR"). The data was tested for stationarity, cointegration and causality, and the results affirm that a long run relationship exists among the futures and spot exchange rates. The findings are very significant for policy makers, investors, and marketers since it provides a reliable forecast of exchange rates in the futures market which measures to effectively manage the risks.*

**Keywords:** Futures, Vector Auto regression, Granger Causality, Engle-Granger and Johnson's Cointegration.

## I INTRODUCTION

The price discovery function is dynamic in the markets, and the information dissemination, gathering and interpretation of news, among the investors affects the prices of the markets. The effective measurement of any price discovery process by the swift adjustments of the prices from an old equilibrium to the new equilibrium due to the arrival of new information in the market. Three main components of empirical research in international finance are the determination of floating exchange rates, the foreign exchange market efficiency and interest parity.

The importance of this topic to government policymakers, firms, investors, and economists and the ready availability of data have resulted in a large volume of research in this area. The importance of this topic for policymakers is significant for assessing the performance of alternative international financial systems. The current system of controlled floating differs significantly from the exchange rate system which existed before 1971 and from textbook descriptions of freely flexible rates. Governments no longer seek to maintain fixed parities; neither do they forego direct intervention in the foreign exchange markets. The majority of the extraordinary created economies glided their swapping scale in mid-1973, after the end of the post-war Bretton Woods arrangement of fixed trade rates. While there had been a broad scholastic question on the overall benefits of fixed and drifting trade rates, this exchange had been carried on at a generally speculative dimension. The summed-up skimming routine gave analysts the observational informational collection required to determine such scholastic question, just as raising increasingly quick approach issues. Much of the international finance literature produced in the decade after the move to generalized floating focused on the development and estimation of empirical models of floating exchange rates. Therefore, for evaluating the futures and spot market linkages, currency distortions and, efficient currency market diagnosis, the current study examines the four currencies long term relationship among their spot and futures market.

## II REVIEW OF LITERATURE

Judge and Reancharoen (2014) analysed the lead-lag relationship in the Stock Exchange of Thailand (SET) and Thailand's derivatives market between the futures and spot market. The Granger causality test indicated that the SET50 index leads SET50 index futures. The results suggest that assimilation of new market-wide information in the Thai spot stock market was faster than the futures market. Kalantzis and Milonas (2013) examined the price correlation and impact of the introduction of electricity futures on the spot-price volatility of the French (Powernext) and German (EEX) electricity markets. Bivariate VECM-GARCH model results indicated that they had decreased spot price volatility. The study suggested that all stakeholders (i.e., producers, consumers, traders, investors) benefited from the volatility reduction. Kang, Cheong and Yoon (2013) analysed the volatility spillover in Korean spot and futures markets of KOSPI 200 spot and futures contracts by using three high-frequency intraday data. Bivariate GARCH models results indicated a strong bi-directional causal relationship between futures and spot markets, strongly suggesting that bi-directional volatility.

Kenneth and Sultan (1993) analysed the long-run cointegrating relationship between financial assets and the dynamic nature of the distributions of the assets on hedging for the British pound, the Canadian dollar, the German mark, the Japanese yen, and the Swiss franc. The risk-minimizing futures hedge ratios were estimated by using the bivariate error correction model with a GARCH error structure. The result suggests the dynamic hedging strategy proposed has the potential risk reduction to offset the transactions costs for most investors. Lien (1996) stressed on the importance of incorporating the cointegration relationship into statistical modelling of spot and futures prices. He found that Hedge ratios and hedging performance may change sharply when the cointegrating variable is mistakenly omitted from the statistical model. "The study concluded that a hedger who omits the cointegration relationship will adopt a smaller than optimal futures position, which results in a relatively poor hedge performance and derived that the hedger mis

specifies spot and futures price behaviour by modeling a partial cointegration system, instead of the complete cointegration system”.

Rosenberg and Traub (2006) compared price discovery of foreign exchange spot and futures market at Chicago Mercantile Exchange. The study was conducted on data of “International Monetary Market division of CME and concluded that both foreign currency futures and spot respond to unique information relevant for exchange rate determination”. Schgal, Ahmad and Deisting (2014) examined the spot and futures prices price discovery and volatility spillovers of four currencies USD, EURO, GBP and JPY with Indian rupee at Multi-Commodity Stock Exchange (MCX-SX) and National Stock Exchange (NSE) in India. The results concluded that long-term equilibrium relationship between spot and futures and between futures markets, and in short run futures price leads spot price and the opposite is true in the long run. Tse, Xiang and Fung (2006) examined the price discovery of the floor and electronically traded euro FX, and Japanese yen futures markets and their corresponding foreign exchange spot markets. The Hasbrouck information share model (1995), and the Gonzalo and Granger permanent-transitory model

(1995) were used and results show that electronic trading facilitates price discovery more efficiently than floor trading.

Theissen (2012) used threshold error correction model (TECM) to analyse price discovery by using arbitrage opportunities to affect return dynamics. His Model estimated through quote midpoints, and time-varying transaction costs. He concluded that the futures market leads in the process of price discovery and the presence of arbitrage opportunities effect the subtleties of the price discovery. Gupta and Bhatia (2019) analysed the relationship between the spot and futures values of the indices of the national stock exchange. The result was in case of cnx nifty 50 there was a long-term unidirectional causality from spot to futures, for the other two indices there was bidirectional causality. Yang, Yang and Zhou (2012), Bohl, Salm and Wilfling (2009), Cabrera, Wang and Yang (2009), and Chen and Gau (2009) have established unidirectional causality from spot market to the futures market whereas Bohl et al. (2011), So and Tse (2004), and Kang et al. (2006) have concluded their study with unidirectional causality from futures to spot market.

### III METHODOLOGY

It is a descriptive study to examine the long-term relationship between spot and futures prices of the four currencies by employing standard econometrics tools. The sample consists of the “USD/INR, EURO/INR, GBP/INR and JYN/INR”. Sample period for the study is from the commencement of futures trading of the respective currency futures to 31 March 2016 in case of the futures and spot prices of currencies. Data Collection of Foreign exchange rates was collected from the database of NSE, RBI, Federal Reserve, United States, Bank of England, Bank of Japan, European central bank. Variables for the study are:

- (a) Daily closing price of the spot exchange market for “USD/INR, EURO/INR, GBP/INR and JYN/INR” during the sample period.
- (b) Daily closing price of the futures exchange market for “USD/INR, EURO/INR, GBP/INR and JYN/INR” during the sample period.

For evaluating the long run relationship between the spot and future markets exchange rates, standard econometric tools are applied. The time series data of the four currencies of spot and futures were tested for stationarity by ADF and PP tests. The various analytical procedures include descriptive statistics, Engle-Granger, Johansen’s co-integration test, VAR and causality test based on VECM.

### IV RESULTS

**Table 4.1**  
**Descriptive Statistics**

Variables	USD/INR		EURO/INR		GBP/INR		JYN/INR	
	Futures	Spot	Futures	Spot	Futures	Spot	Futures	Spot
Mean	54.295	54.160	71.088	70.914	87.472	87.259	58.412	58.255
Median	53.695	53.579	70.538	70.354	87.655	87.524	57.310	57.140
Maximum	69.063	68.778	91.375	91.468	106.765	106.028	71.920	72.120
Minimum	43.915	43.790	56.235	56.070	65.835	65.647	47.135	46.930
Std. Dev.	7.493	7.459	7.778	7.754	11.882	11.845	5.729	5.726
Skewness	0.246	0.246	0.284	0.283	-0.194	-0.193	0.555	0.570
Kurtosis	1.612	1.615	2.255	2.248	1.557	1.553	2.473	2.497
Jarque-Bera	164.421	163.903	54.298	54.882	138.254	138.850	93.605	96.272
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

The descriptive statistics of the four foreign exchange currency prices are shown in table 4.1. The mean value of USD/INR futures is 54.295 and spot is 54.160. The skewness and kurtosis of USD/INR futures is 0.246 and 1.612 respectively, and skewness and kurtosis of the USD/INR spot market is 0.246 and 1.615 respectively, both the skewness and kurtosis of USD/INR futures and spot falls within the normal limits. The Jarque-Bera p-value suggests that the series do not follow normal distribution. The mean value of EURO/INR futures is 71.088 and spot is 70.914. The skewness and kurtosis of EURO/INR futures is 0.284 and 2.255 respectively, and skewness and kurtosis of the spot market is 0.283 and 2.248 respectively. Both the skewness and Kurtosis EURO/INR futures and spot fall in the normal limits. The Jarque-Bera p-value suggests that the series do not

follow normal distribution. The mean value of GBP/INR futures is 87.472 and spot is 87.259. The skewness and kurtosis of GBP/INR futures is -0.194 and 1.557 respectively, and skewness and kurtosis of the spot market is -0.193 and 1.553 respectively. Both the skewness and Kurtosis of GBP/INR futures fall in the normal limits. The Jarque-Bera p-value suggests that the series do not follow normal distribution. The mean value of JYN/INR futures is 58.412 and spot is 58.255. The skewness and kurtosis of GBP/INR futures is 0.555 and 2.473 respectively, and skewness and kurtosis of the spot market is 0.570 and 2.497 respectively. Both the skewness and Kurtosis of GBP/INR futures fall in the normal limits. The Jarque-Bera p-value suggests that the series do not follow normal distribution.

**Table 4.2**  
**Results of Unit Root Test**

Variables	ADF Test			Phillips-Perron Test		
	Int.	Tre. & Int.	NI & NT	Int.	Tre. & Int.	NI & NT
<b>At Level</b>						
USD/INR LFUT	-0.773	-1.947	1.733	-0.865	-2.169	1.576
USD/INR LSPOT	-0.841	-2.041	1.657	-0.881	-2.155	1.593
EURO/INR LFUT	-1.319	-1.759	0.550	-1.300	-1.737	0.560
EURO/INR LSPOT	-1.371	-1.790	0.516	-1.337	-1.779	0.508
GBP/INR LFUT	-1.116	-1.836	1.033	-1.133	-1.930	1.010
GBP/INR LSPOT	-1.030	-1.766	0.985	-1.096	-2.045	0.896
JPY/INR LFUT	-1.866	-1.873	0.405	-1.880	-1.887	0.405
JPY/INR LSPOT	-1.874	-1.881	0.379	-1.870	-1.876	0.384
<b>At 1st Difference</b>						
USD/INR LFUT	-31.310	-31.302	-31.245	-40.599	-40.588	-40.589
USD/INR LSPOT	-42.788	-42.777	-42.736	-42.814	-42.803	-42.773
EURO/INR LFUT	-35.024	-35.012	-35.027	-34.999	-34.987	-35.004
EURO/INR LSPOT	-35.589	-35.578	-35.593	-35.568	-35.556	-35.573
GBP/INR LFUT	-35.419	-35.412	-35.401	-35.508	-35.498	-35.505
GBP/INR LSPOT	-37.327	-37.320	-37.312	-37.436	-37.426	-37.433
JPY/INR LFUT	-37.508	-37.505	-37.515	-37.495	-37.492	-37.503
JPY/INR LSPOT	-38.271	-38.266	-38.279	-38.273	-38.268	-38.281

Int. = Intercept; Tre. & Int. = Trend & Intercept; NI & NT = No intercept & No Trend

The spot and futures prices of the four currencies were tested for stationarity by applying augmented Dickey-Fuller test (ADF) and Phillips-Perron (PP) test. The results of both the unit root tests are shown in table 4.2 both these tests were applied with intercept, trend and intercept, and no intercept and no trend at level as well as at first difference. It was analysed that at level for all the four foreign exchange currency prices in both spot

and futures series, the unit root is present. So, both the tests were applied after first differencing of the series with intercept, trend and intercept, and no intercept and no trend. The results show that all the four-forex spot and futures prices become stationary at the first difference as no unit root is present in the spot and futures of the four currencies.

**Table 4.3**  
**Results of VAR Lag Order Selection Criteria**

Lag	LR	FPE	AIC	SC	HQ
<b>USD/INR</b>					
0	12307.220	0.000	-16.321	-16.303	-16.315
1	136.697	0.000	-16.392	-16.362*	-16.381
2	21.688	0.000	-16.400	-16.358	-16.384
3	19.288*	0.000	-16.406	-16.352	-16.386*
4	9.251	0.000*	-16.406*	-16.340	-16.382
5	5.323	0.000	-16.405	-16.327	-16.376
6	8.691	0.000	-16.406	-16.315	-16.372
7	5.152	0.000	-16.404	-16.301	-16.366
8	12307.220	0.000	-16.321	-16.303	-16.315
<b>EURO/INR</b>					
0	NA	0.000	-9.902	-9.895	-9.900
1	8794.981	0.000	-15.839	-15.818	-15.831
2	107.250	0.000	-15.907	-15.87086*	-15.893
3	18.457*	0.000*	-15.913*	-15.864	-15.895*
4	1.237	0.000	-15.909	-15.845	-15.885
5	9.325	0.000	-15.910	-15.831	-15.881
6	5.049	0.000	-15.908	-15.815	-15.874
7	7.443	0.000	-15.908	-15.801	-15.868
<b>GBP/INR</b>					
0	NA	0.000	-9.366	-9.359	-9.364
1	9946.575	0.000	-16.073	-16.051	-16.065
2	113.113	0.000	-16.144	-16.107*	-16.130
3	22.778	0.000	-16.154	-16.104	-16.135*
4	2.123	0.000	-16.150	-16.085	-16.126
5	16.496	0.000	-16.155	-16.077	-16.126
6	8.950	0.000	-16.156	-16.063	-16.122
7	10.959*	0.000*	-16.158*	-16.051	-16.118
8	4.237	0.000	-16.156	-16.034	-16.111
<b>JPY/INR</b>					
0	NA	0.000	-9.826	-9.819	-9.823
1	7685.411	0.000	-15.031	-15.009	-15.023
2	78.553	0.000	-15.079	-15.042*	-15.065*
3	9.494	0.000	-15.080	-15.029	-15.061
4	9.083	0.000*	-15.080*	-15.016	-15.056
5	5.376	0.000	-15.079	-15.000	-15.049
6	10.094*	0.000	-15.080	-14.987	-15.045
7	5.492	0.000	-15.079	-14.971	-15.038
8	2.484	0.000	-15.075	-14.953	-15.029

\* indicates lag order selected by the criterion

Table 4.3 shows the results of Vector Auto Regressive Lag Order Selection Criteria selected by the various criteria's. The optimum lag length of 2 was selected by SC with values -16.362\* for USD/INR, -15.87086\* for

EURO/INR, -16.107\* for GBP/INR and -15.042\* for JPY/INR. Therefore for further analysis, the optimum Lag length 2 is considered for calculating co-integration as well as causality among the spot and futures.

**Table 4.4**  
**Results of Engle-Granger Cointegration Test**

Dependent	tau-statistic	Probability	z-statistic	Probability
<b>USD/INR</b>				
LFUT	-38.555	0.000	-1639.686	0.000
LSPOT	-38.559	0.000	-1639.883	0.000
<b>EURO/INR</b>				
LFUT	-32.223	0.000	-1225.452	0.000
LSPOT	-32.229	0.000	-1225.682	0.000
<b>GBP/INR</b>				
LFUT	-34.069	0.000	-1306.418	0.000
LSPOT	-34.070	0.000	-1306.482	0.000
<b>JYN/INR</b>				
LFUT	-36.759	0.000	-1415.435	0.000
LSPOT	-36.764	0.000	-1415.643	0.000

The Engle-Granger Cointegration Test results are shown in table Table 4.4 which reflects the long term cointegration of the spot and futures of the spot and futures prices of the four currencies. The test was applied considering futures as the dependent variable

and also spot as the dependent variable. The tau statistics and z statistics values along with their p-values strongly suggest that the futures and spot values of the USD/INR, EURO/INR, GBP/INR and JPY/INR series are cointegrated in the long run.

**Table 4.5**  
**Results of Johansen's Cointegration Test**

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	Critical Value (0.05)	Probability
Unrestricted Cointegration Rank Test (Trace)				
USD/INR None *	0.188	380.597	15.495	0.000
USD/INR At most 1	0.000	0.479	3.841	0.489
EURO/INR None *	0.201	336.143	15.495	0.000
EURO/INR At most 1	0.001	1.641	3.841	0.200
GBP/INR None *	0.187	308.817	15.495	0.000
GBP/INR At most 1	0.001	1.157	3.841	0.282
JYN/INR None *	0.211	355.881	15.495	0.000
JYN/INR At most 1	0.002	3.578	3.841	0.059
Unrestricted Cointegration Rank Test (Maximum Eigen value)				
USD/INR None *	0.188	380.117	14.265	0.000
USD/INR At most 1	0.000	0.479	3.841	0.489
EURO/INR None *	0.201	334.502	14.265	0.000
EURO/INR At most 1	0.001	1.641	3.841	0.200
GBP/INR None *	0.187	307.660	14.265	0.000
GBP/INR At most 1	0.001	1.157	3.841	0.282
JYN/INR None *	0.211	352.304	14.265	0.000
JYN/INR At most 1	0.002	3.578	3.841	0.059

\* denotes rejection of the hypothesis at the 0.05 level

The results of Johansen's cointegration test are shown in table 4.5 of the spot and futures prices of the four currencies. The trace statistics and eigen values along with their p-values reject the hypothesis that no cointegrating equation which can be hypothesized in

spot and futures of USD/INR, EURO/INR, GBP/INR and JPY/INR. And the result also suggests that there exist one cointegrating relationship between the spot and the futures values of USD/INR, EURO/INR, GBP/INR and JPY/INR.



**Table 4.6**  
**Results of Pairwise Granger Causality Test**

Null Hypothesis:	F-Statistic	Probability
<b>USD/INR</b> spot does not Granger Cause <b>USD/INR</b> futures	8.140	0.000
<b>USD/INR</b> does not Granger Cause <b>USD/INR</b> spot	525.925	0.000
<b>EURO/INR</b> spot does not Granger Cause <b>EURO/INR</b> futures	4.973	0.007
<b>EURO/INR</b> futures does not Granger Cause <b>EURO/INR</b> spot	342.220	0.000
<b>GBP/INR</b> spot does not Granger Cause <b>GBP/INR</b> futures	4.454	0.012
<b>GBP/INR</b> futures does not Granger Cause <b>GBP/INR</b> spot	469.413	0.000
<b>JPY/INR</b> spot does not Granger Cause <b>JPY/INR</b> futures	9.289	0.000
<b>JPY/INR</b> futures does not Granger Cause <b>JPY/INR</b> spot	288.471	0.000

The results of pairwise granger causality test are shown in table 4.6. The analysis rejects the null hypothesis as the p-value is less than 0.05 in both the cases. Therefore, it is accepted that USD/INR spot causes USD/INR futures, and also USD/INR futures causes USD/INR spot whereby confirming the bidirectional

relationship between the two variables. Similarly, the other three series show that there is bidirectional causality between the spot and the futures prices in the spot as well as futures market.

## V CONCLUSION

In impeccable operational financial markets, ideally the arrival of new information should be reflected simultaneously in the underlying spot market and the corresponding derivative market. However, in reality, information may be spread in one market first and then transmitted to another market due to the limitation in the market. The study confirms the existence of long-run cointegration between futures and spot prices of the four currencies examined, and the study also concludes that in Indian currency market, futures and the spot prices of the investigated currencies have bi-directional causality which may provide important guidance on the understanding of information transmission among the market participants. Our results are in line with Jackline and Deo (2011), Pizzi et al (1998), Roope and

Zurbruegg (2002) which also concluded that there is a bi-directional causality among futures and spot market. Hence the results indicate that in case of futures and spot market linkages, both trading platforms appear to be informationally efficient markets. However, it is evident that the currency distortions have continued for a long time, this may require a more fundamental and constructive correction, the regulators and the government need to re-address the inflation control policy by looking the problem more from supply side rather than from the demand side perspective. The focus can be on removing bottlenecks in production, controlling hoardings and matching the domestic demand in the line with exports. The future scope of the study can be combined with short-run dynamics and volatility analysis of these examined currencies.

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