International Journal of Research in IT and Management (IJRIM)
Available online at: http://euroasiapub.org
Vol. 7, Issue 10, September- 2017, pp. 1~13
ISSN(o): 2231-4334 | ISSN(p): 2349-6517 | Impact Factor: 6.505

Causal Relationship between Currency Derivatives and the Spot Market: A Study on Currency Futures in India

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Abstract

Of the many functions, price discoveries and hedging are among the most important functions of the futures contracts. Price discovery could be referred to as the use of the futures price to discover the prices existing in the spot market, which further depends upon the strength of the relationship between the prices of the futures contracts and their underlying. The following study is aimed at investigating the relationship between the spot rates of INR-USD, INR-GBP, INR-Euro and INR-Yen exchange rates and the futures contracts for the same pairs traded in Indian financial markets. The study uses the daily closing prices of spot exchange rates and near month futures contracts to examine this relationship. The authors have adopted the methodology given by Engle and Granger (1987) and have used Unit Root Tests, Co-integration Test and the Granger Causality test in order to establish the nature of the lead-lag relationship between spot and futures market for foreign currencies in India. The study has practical implications for market players who can take cues from futures market for their position on Indian Rupee vis a vis USD, GBP, Euro and Yen.

Keywords: Causality, Currency futures, price discovery

JEL Classification: G12, G14, G15

Introduction

In the year 1992 and 1993, India moved away from pegged exchange rate to the Liberalized Exchange Rate Management System (LERMS) and the market determined exchange rate regime. With increased volatility in exchange rate and to mitigate the risk arising out of excess volatility, currency futures trading were introduced in India (INR-US$) started on August 29, 2008 **(Sharma, 2011)**. This was considered as an important structural change in the exchange rate market of India. It is believed that the currency futures will help in hedging the exposures of exchange rate to unfavorable movements in exchange rate. The role of derivatives for risk taking and risk management cannot be understated by any means and it has increased significantly in recent times. Till January 2010, exchange rate futures was available only for US $ vis-à-vis Indian Rupee. Exchange-traded currency futures have now been expanded to the euro, pound and yen pairing **(Raghavendra & Velmurugan, 2013)**. 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.

Price discovery and hedging is considered to be one of the economic functions of future contracts. Here, price discovery means use of futures prices in order to price spot market transactions. But its significance depends upon the close relationship between the prices of futures contracts and the underlying assets. The essence of the price discovery function of futures markets hinges on whether new information is reflected first in changes of futures prices or in changes of spot prices **(Unlu & Eroy, 2012)**. In other words price discovery can be defined as; whether price changes in futures markets lead price changes in spot markets more often than the reverse. If that is the case, there exists a lead-lag relationship between the two markets. Therefore, the futures prices may serve as the market's expectation of a subsequent delivery period spot price. However there must be a significant long run and short-run relationship between spot and futures exchange rates, in order that futures contracts can be used for hedging **(Bhargava & Malhotra, 2007)**. The purpose of this study is to investigate relationship between spot Exchange rate and futures contract with respect to currency pairs of EURO-INR, GBP-INR, YEN-INR and USD-INR traded in Indian Derivatives Exchanges.

Review of literature

This section contains a brief review of the literature in the broad area of the present research:

Baillie & Bollerslev (1991) examined four foreign exchange spot rate series for a period of six-months in 1986, using hourly recorded price movements and found the hourly volatility patterns to be extremely similar across currencies. Also, they appeared to be correlated with the opening and closing of the major markets the world over but LM tests did not provide any evidence of the existence of volatility spillover effects, neither between the currencies nor across the markets. **Pan, Hocking, & Rim (1996)** examined the lead-lag relationship between currency option and currency spot markets for the Deutsche mark and the Japanese yen. Causality tests were performed to study the cause-effect relationship between the observed and the implied changes in exchange rate. The results revealed that the currency options market lagged the currency spot market by about ninety minutes. **Wei & Kim, (1997)** studied if there is existence of private information in the forex market, and whether speculation reduced or exacerbated volatility. They found that the absolute value of the options position as well as that of spot, forward and futures positions by large participants Granger-causes the exchange rate volatility, signifying large participants' currency speculation does not stabilize exchange rate volatility. Also, they failed to find any positive association between large participants' position in a foreign currency with its consequent appreciation. **Adrangi & Chatruth (1998)** examined the association between exchange rate variability and futures trading activity in the framework of disaggregated open interest and gave specific inferences vis-à-vis which group of traders contributed to exchange volatility. The results suggested that volatility in exchange rates was caused by the surges in the level of commitments of large speculators and small traders and rather than by the 'typical' levels of futures commitments were not destabilizing. Also, there was no impact of actual release of the commitment-of-traders data, on the movement of spot prices. **Jochum & Kodres (1998)** examined the effect of the Mexican Peso, the Brazilian real and the Hungarian forint futures contract on the respective spot markets and found a dependence relationship between them using the measures of linear dependence. Using a VAR approach and Granger-Causality test **Brown & Curci (2002)** found that there was an association between spot price volatility and futures trading activity in the Mexican peso exchange market which was found to be statistically significant. **Roope & Zurbruegg (2002)** studied the comparative information efficiency between the Singapore Exchange and the Taiwan Futures Exchange using the Taiwan Index Futures listed in both markets. They found that a stochastic trend existed between index futures and their underlying indices and that there were statistical evidences of price discovery originating from the Singapore futures market. **Sarwar (2003)** tested the association between future volatility of the U.S. dollar/British pound exchange rate and trading volume of currency options for the British pound. He found presence of sturdy simultaneous positive feedbacks between the two i. e. not only the option volume had a considerable predictive power for the exchange rates but the lagged volatilities were also predictive of options volume. **Rothig (2004)** used a VAR-GARCH approach to investigate the association between futures trading and spot market turbulence for the exchange rates of Australia, Canada, Japan, Korea and Switzerland in terms of the US dollar. They not only found an affirmative correlation between the variables but also found that in four out of the total of five currencies, futures trading activity added significantly to spot volatility. **Nikkinen, Sahlstrom, & Vahamaa (2006)** tested the linkage in expected future volatilities among major European currencies by analyzing the volatility expectations using currency options on the euro, British pound, and Swiss franc quoted against the U.S. dollar. They envisaged that there was a close association between the market expectations of future exchange rate volatilities of major European currencies. Their results also indicated a significant effect of the implied volatility of the euro on the volatility outlook of the British pound and the Swiss franc. **Frino, Jarnecic, Tan, & Stevenson (2006)** studied the Australian Dollar currency market and stated that in any trading period price discovery took place in the cash market in. **Bhargava & Malhotra (2007)** studied the relationship between the trading activities of speculators, day traders and hedgers and envisaged that while the speculators and day traders destabilized the futures market, effect of hedgers on the market was inconclusive. **Kim & Min (2008)** found positive contemporaneous relationships between the currency volatility and the futures volume for the Euros, British Pounds, Swiss Franc, Japanese Yen, and Canadian Dollars traded on the Chicago Mercantile Exchange (CME). They concluded a negative association between the volatility and open interest, a positive association between the hedging activities and currency markets and a bidirectional causal relation between the currency volatility and futures volume. **Akin & Fischmar (2008)** used VAR, ECM and Granger causality tests along with impulse response functions to explore the spillover effect between the spot and the futures price series as well as the time taken for shocks to dissipate with respect to the Australian dollar. They confirmed a long term relationship between the spot and futures exchange rates as well as the spillover effect of futures price on the short term adjustment in the spot exchange rate and vice versa and confirmed that the markets are weakly inefficient. **Guru (2009) used** Granger causality tests, cointegration tests and ARCH-GARCH methodology to explore empirically tested the causal linkage between spot, domestic forward and NDF markets for Indian Rupee. Their empirical results showed the influence of NDF markets over domestic currency markets and that they provided better information. **Chen & Gau (2010)** investigated the response of foreign exchange spot and futures markets with respect to the time of scheduled macroeconomic announcements using the currency pairs of EUR–USD and JPY–USD markets. Their results indicated that overall spot rates were more predictive of the prices as compared to CME futures rates but futures rates were more informative during the release of macroeconomic announcement. **Tornell & Yuan (2012)** studied the effect of futures trading activities of speculators and hedgers over the potential movements of major spot exchange rates. They found that though the tops and bottoms of net positions provided information about the spot exchange rates, but other positions were weakly correlated with movements in futures. They also found that position held by speculators were helpful in predicting price-continuations in spot rates while positions held by hedgers were indicative of reversals in price. **Boyrie, Pavlova, & Parhizgari (2012)** examined the role of the spot and the futures markets in price discovery for the Brazilian Real, South African Rand and Russian Ruble. The results indicated that while Brazilian Real futures market were more prominent in price discovery, the spot market lead the price discovery for the Russian Ruble whereas results for South African Rand were mixed. **Kitamura (2012)** used variance decomposition on the high-frequency data of Euro, Yen and Swiss franc and found that while news about Euro that was associated to trade had significant effect on the variance of the Swiss franc whereas for both the currencies, non-trade-correlated news of one currency had a reciprocal effect on the other. **D. & Jayapal (2012)** examined the stationarity and cointegration of foreign exchange market and found that neither the markets were stationary nor were they cointegrated. **Suhashini. J & Dr.K.Chandrasekar (2013)** ran tests for price, volume and open interest for futures currency pairs of USD-INR, EURO-INR, GBP-INR, JPY-INR in India. Using Granger Causality Test relation between change in future return on change in volume, change in volume on change in open interest, change in future price on change in spot price they showed that most of the variables had bidirectional causality at all lags and some had unidirectional causality. **Sriram & Senthil (2013)** analyzed the long term relationship between spot and future prices of currency (dollar). Findings indicated a long term relationship and unidirectional causal relation between spot and future prices wherein the change in spot prices caused the change in futures prices. They also found that the 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. **Chandra & Thenmozhi (2014)** examined the association between liquidity and price changes in the currency options market by investigating the interrelationship of currency options liquidity with spot exchange rate returns and volatility, and speculative tendency in the options market. They found that the changes in spot exchange rate had significant association with options market liquidity. Also, the results from

VECM revealed bidirectional causality between illiquidity and speculative activities, and that higher volatility was reinforced by illiquidity in currency options market. **Sehgal, Ahmad, & Deisting** investigated the price discovery and volatility spillovers between spot and futures prices of four major international currencies traded on two trading platforms in India. The findings confirmed the long-run equilibrium relationship between spot and future prices of sample currencies even after accounting for structural break in each currency series. The presence of short and long-run volatility spillovers between futures and spot markets was also found and the volatility spillovers were stronger from futures to spot in short-run while inverse was found in the long-run.

Research Gap

After having an extensive literature review it was observed that there were many studies relating to casual relationship between foreign currency futures and spot market. But none of the author has tried it with respect to Indian foreign exchange and that too with all the pairs of currency on which futures contracts are available. So accordingly this study tries to investigate relationship between spot Exchange rate and futures contract with respect to currency pairs of EURO-INR, GBP-INR, YEN-INR and USD-INR traded in Indian Derivatives Exchanges.

Data analysis and Methodology

This study examined relationship between spot Exchange rate and futures contract with respect to currency pairs of EURO-INR, GBP-INR, YEN-INR and USD-INR. The data covers the period from April 2014 to March 2016. Daily closing values of spot Exchange rate and futures contract are used. Futures contract data for the four currency pairs are taken from the official web site of multi commodity exchange whereas spot Exchange rate data are taken from the Reserve Bank of India website. For the futures prices series, the nearest futures contracts are used. The logarithms of the price series is used in the analysis.

For the purpose of our study we have adopted the methodology used by Unlu & Ersoy **(Unlu & Ersoy, 2012)**. They have used the Engle-Granger (1987) methodology. According to Engle-Granger (1987) two time series are nonstationary in levels but a linear combination of these series may be stationary. If a linear combination of these two series is stationary, these series are cointegrated, i.e. there is a long-run stable relationship between them. In the Engle-Granger methodology, if two series is nonstationary in the levels, but their first differences and the deviations from long-run equilibrium relationship between two series are stationary, two series are cointegrated of order CI (1,1). **(Eangle & Granger, 1987)**

In the Engle-Granger methodology, order of integration of the variables is determined in the first step. Augmented Dickey-Fuller (ADF) unit root test can be used to determine the order of integration of series. To test for the presence of unit root following ADF regression is used:

$$\boldsymbol{\Delta s_t = \mu + \delta s_{t-1} + \sum_{i=1}^{n} \delta_i \Delta s_{t-1} + e_t} \qquad \textbf{(1)}$$

The ADF test examine $H_0 : \delta = 0$, the null hypothesis of unit root process against $H1 : \delta < 0$. The rejection of null hypothesis states that the series S_t are stationary. If the results of first step indicate that variables are integrated of same order $I(1)$, long-run equilibrium relationship between variables is estimated by using OLS regression at the second step. Long-run equilibrium relationship can be shown as follows:

$$\boldsymbol{s_t = \beta_0 + \beta_1 f_t + e_t} \quad \textbf{(2)}$$

where s_t and f_t are contemporaneous spot and futures prices at time t, $\beta 0$ and $\beta 1$ are parameters, et is the deviations from long-run equilibrium relationship.

In order to determine if the s_t and f_t are actually cointegrated, denote the residuals sequence from long-run equilibrium regression by e_t. Thus, e_t is the series of the estimated residuals of the long-run equilibrium relationship. If these deviations from long-run equilibrium relationship are found to be stationary, s_t and f_t sequences are cointegrated of order (1,1), denoted $CI(1,1)$. Augmented Dickey-Fuller unit root test can be performed on the series of the estimated residuals to determine their order of integration. To test for the presence of unit root the following ADF regression is used:

$$\Delta\boldsymbol{\hat{e}_t = a_1\hat{e}_{t-1} + \textstyle\sum_{i=1}^{n} a_{i+1}}\Delta\boldsymbol{\hat{e}_{t-1}} + \in_t \quad \textbf{(3)}$$

If the rejection of the null hypothesis states that residual series contains a unit root, residual series are stationary; in other words deviations from long run equilibrium are stationary and s_t and f_t series are cointegrated of order (1, 1). Apart from this, we have also applied the Johansen Cointegration test to check if the variables are cointegrated.
Further, if the variables are cointegrated, an error-correction model that contains the last period equilibrium error terms and lagged value of first differences of each variable is estimated in the third step. The error correction model is expressed by the following equations:

$$\Delta\boldsymbol{s_t = \alpha_0 + \textstyle\sum_{i=1}^{n} \alpha_{1i}}\,\Delta\boldsymbol{s_{t-i} + \textstyle\sum_{i=1}^{n} \alpha_{2i}}\,\Delta\boldsymbol{f_{t-1} + \lambda\hat{e}_{1t-1} + u_{1t}} \quad \textbf{(4)}$$

$$\Delta\boldsymbol{f_t = \beta_0 + \textstyle\sum_{i=1}^{n} \beta_{1i}}\,\Delta\boldsymbol{f_{t-i} + \textstyle\sum_{i=1}^{n} \beta_{2i}}\,\Delta\boldsymbol{s_{t-1} + \theta\hat{e}_{1t-1} + u_{1t}} \quad \textbf{(5)}$$

Equations (4) and (5) describe the short-run as well as long-run dynamics of the equilibrium relationship between *st* and *ft* (Tse, 1995, p. 555). The value of the residual $\boldsymbol{\hat{e}_{1t-1}}$ estimates the deviation from longrun equilibrium in period t-1. The coefficients of equilibrium errors, λ and θ are speed of adjustment coefficient. If λ is zero, the change in s_t does not at all respond to the deviation from long-run equilibrium in t-1. If $\lambda$is zero and all α_{2i} is zero, then it can be said that (Δf_t) does not Granger cause Δs_t. It is known that one or both of these coefficients should be significantly different from zero if the variables are cointegrated. After all, if both λ and θ are zero, there is no error correction. **(Unlu & Ersoy, 2012)**

Empirical Results:

In the first step the spot and futures price series of EURO-INR, GBP-INR, YEN-INR and USD-INR are tested for stationarity using the ADF Test. Akaike information criterion is used to determine the optimal lag length. The results of ADF unit root test for the spot and futures price series of EURO-INR, GBP-INR, YEN-INR and USD-INR are given in Table 1 to table 4 respectively.

Table 1: The results of ADF Unit Root Test for EURO-INR

Series	Level		First Difference	
	Constant	Constant & Trend	Constant	Constant & Trend
Spot	-1.138109	-2.253921	-7.102145	-7.092978
Futures	-0.948067	-1.814340	-7.569680	-7.560547

Table 2: The results of ADF Unit Root Test for GBP-INR

Series	Level		First Difference	
	Constant	Constant & Trend	Constant	Constant & Trend
Spot	-1.256402	-1.980305	-7.248061	-7.240988
Futures	-1.074600	-1.656968	-10.25335	-10.24322

Table 3: The results of ADF Unit Root Test for USD-INR

Series	Level		First Difference	
	Constant	Constant & Trend	Constant	Constant & Trend
Spot	-1.702036	-2.020632	-7.751853	-7.775527
Futures	-1.584050	-1.898509	-10.36791	-10.37902

Table 4: The results of ADF Unit Root Test for YEN-INR

Series	Level		First Difference	
	Constant	Constant & Trend	Constant	Constant & Trend
Spot	-1.250126	-1.972461	-7.989278	-7.997554
Futures	-1.069084	-1.802718	-11.07260	-11.08005

For each pair of series we can see that at the variable's level value, the null hypothesis cannot be rejected because ADF test statistics value is greater than the critical values at the 1%, 5% and 10% levels. Therefore for the variable's first differenced value, the null hypothesis can be rejected, for the reason that ADF test statistics value is smaller than the critical values at the 1%, 5% and 10% levels1. Thus, both series are integrated of the first order, that is, I(1).

To determine whether there is a long-run stable relationship between foreign currency spot and futures markets, in other words, whether spot and futures markets move together in the long run, cointegration test is performed using Engle & Granger methodology. First, long-run equilibrium relationship between spot and futures market, for the four currency pairs of EURO-INR, GBP-INR, YEN-INR and USD-INR is estimated by using OLS regression. Later, the series of the estimated residuals of the long-run equilibrium relationship (the deviations from long run equilibrium relationship) is tested for stationarity by performing ADF unit root test. The results of the

[1] ADF critical values are -3.444039, -3.444039, & -2.569991 for the model with constant and -3.977703, -3.419412 & -3.132296 for the model with both constant and trend, at 1%, 5% and 10% levels of significance, respectively.

cointegration test for EURO-INR, GBP-INR, YEN-INR and USD-INR are shown in Table 5 to 8 respectively. Since the deviations from the long-run equilibrium relationship are found to be stationary, the null hypothesis of no cointegration is rejected for both systems. Therefore, for EURO-INR, GBP-INR, YEN-INR and USD-INR exchange rate, foreign currency spot and futures market are cointegrated, denoted *CI* (1,1).

Table 5: The results of Cointegration for EURO-INR

Dependent Variable	With Constant	With Constant & Trend
Spot	-7.57861	-7.57016
Futures	-16.7509	-16.735

Table 6: The results of Cointegration for GBP-INR

Dependent Variable	With Constant	With Constant & Trend
Spot	-9.30535	-9.29682
Futures	-16.7055	-16.6889

Table 7: The results of Cointegration for YEN-INR

Dependent Variable	With Constant	With Constant & Trend
Spot	-15.5328	-15.532
Futures	-19.233	-19.2226

Table 8: The results of Cointegration for USD-INR

Dependent Variable	With Constant	With Constant & Trend
Spot	-21.2755	-21.2841
Futures	-20.4614	-20.4593

In the next step, Johansen's Cointegration test is performed to check the cointegration between the variables. Both trace test and maximum eigen value test are performed and the results are reported in table 9 and 10 respectively.

Table 9: Unrestricted Cointegration Rank Test (Trace) for all the currency pairs

Currency Pair	Hypothesized No. of CE(s)	Eigenvalue	Trace Statistics	0.05 Critical value	Prob.
Euro-INR	**None ***	**0.148382**	**77.30287**	**15.49471**	**0.0000**
	At most 1	**0.002810**	**1.331193**	**3.841466**	**0.2486**
GBP-INR	**None ***	**0.095598**	**47.79483**	**15.49471**	**0.0000**
	At most 1	**0.002301**	**1.071186**	**3.841466**	**0.3007**
USD-INR	**None ***	**0.076362**	**39.34429**	**15.49471**	**0.0000**
	At most 1	**0.005344**	**2.486411**	**3.841466**	**0.1148**
Yen-INR	**None ***	**0.057599**	**29.22531**	**15.49471**	**0.0002**
	At most 1	**0.003926**	**1.817221**	**3.841466**	**0.1776**

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Table 10: Unrestricted Cointegration Rank Test (Maximum Eigenvalue) for all the currency pairs

Currency Pair	Hypothesized No. of CE(s)	Eigenvalue	Max. Eigen Statistics	0.05 Critical value	Prob.
Euro-INR	None *	0.148382	75.97168	14.26460	0.0000
	At most 1	0.002810	1.331193	3.841466	0.2486
GBP-INR	None *	0.095598	46.72364	14.26460	0.0000
	At most 1	0.002301	1.071186	3.841466	0.3007
USD-INR	None *	0.076362	36.85787	14.26460	0.0000
	At most 1	0.005344	2.486411	3.841466	0.1148
Yen-INR	None *	0.057599	27.40809	14.26460	0.0003
	At most 1	0.003926	1.817221	3.841466	0.1776

Max. Eigen Value test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

The results of Trace test and Max-Eigen value test for all the currency pairs indicate at least 1 cointegrating equation which means there exists a causal relationship in at least one direction for the currency pairs under consideration.

If two variables are cointegrated, there is causality among these variables at least in one direction **(Eangle & Granger, 1987)**. Since these variables are cointegrated, VECM and Granger Causality/Block exogeneity Wald test is used to determine the direction of causality. Results of Granger Causality test for the four currency pairs of EURO-INR, GBP-INR, YEN-INR and USD-INR are presented in table 11 to table 14 respectively.

Table 11: The results of Vector Error Correction Estimates for Euro-INR

Cointegrating Eq: 1	CointEq1
EURO_INR_FUTURES(-1)	1.000000
EURO_INR_SPOT(-1)	-1.005263 (0.00240)* [-418.195]**
C	0.222009
Long run equilibrium equation: EIF_{t-1}= -0.222009+1.005263 EIS_{t-1}	

Table 12: The results of Vector Error Correction Estimates for GBP-INR

Cointegrating Eq: 2	CointEq1
GBP_INR_FUTURES(-1)	1.000000
GBP_INR_SPOT(-1)	-1.007977 (0.00215)* [-467.743]**
C	0.522258
Long run equilibrium equation: GIF_{t-1}= -0.522258+1.007977 GIS_{t-1}	

Table 13: The results of Vector Error Correction Estimates for USD-INR

Cointegrating Eq: 3	CointEq1
USD_INR_FUTURES(-1)	1.000000

USD_INR_SPOT(-1)	-1.007838 (0.00290)* [-348.025]**
C	0.296342
Long run equilibrium equation: UIF_{t-1}= -0.296342+1.007838 UIS_{t-1}	

Table 14: The results of Vector Error Correction Estimates for Yen-INR

Cointegrating Eq: 4	**CointEq1**
YEN_INR_FUTURES(-1)	1.000000
YEN_INR_SPOT(-1)	-0.994633 (0.00296)* [-336.335]**
C	-0.488683
Long run equilibrium equation: YIF_{t-1}= -0.488683+0.994633 YIS_{t-1}	

*Standard errors in ( ) & **t-statistics in [ ]

In order to study the short run causality between the variables VEC Granger Causality/Block Exogeneity Wald Test is also applied, the results of which are presented in table 15 to table 18 respectively.

Table 15: VEC Granger Causality/Block Exogeneity Wald Test results for Euro-INR

Dependent variable: D(EURO_INR_FUTURES)			
Excluded	**Chi-sq**	**Df**	**Prob.**
D(EURO_INR_SPOT)	19.08711	6	0.0040
All	19.08711	6	0.0040
Dependent variable: D(EURO_INR_SPOT)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(EURO_INR_FUTURES)	37.29457	6	0.0000
All	37.29457	6	0.0000

Table 16: VEC Granger Causality/Block Exogeneity Wald Test results for GBP-INR

Dependent variable: D(GBP_INR_FUTURES)			
Excluded	**Chi-sq**	**Df**	**Prob.**
D(GBP_INR_SPOT)	32.51521	14	0.0034
All	32.51521	14	0.0034
Dependent variable: D(GBP_INR_SPOT)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(GBP_INR_FUTURES)	86.91108	14	0.0000
All	86.91108	14	0.0000

Table 17: VEC Granger Causality/Block Exogeneity Wald Test results for USD-INR

Dependent variable: D(USD_INR_FUTURES)			
Excluded	**Chi-sq**	**Df**	**Prob.**
D(USD_INR_SPOT)	43.38824	15	0.0001
All	43.38824	15	0.0001
Dependent variable: D(USD_INR_SPOT)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(USD_INR_FUTURES)	16.81148	15	0.3303*
All	16.81148	15	0.3303

Table 18: VEC Granger Causality/Block Exogeneity Wald Test results for Yen-INR

Dependent variable: D(Yen_INR_FUTURES)			
Excluded	**Chi-sq**	**Df**	**Prob.**
D(Yen_INR_SPOT)	26.09967	17	0.0727*
All	26.09967	17	0.0727
Dependent variable: D(Yen_INR_SPOT)			
Excluded	**Chi-sq**	**df**	**Prob.**
D(Yen_INR_FUTURES)	50.04037	17	0.0000
All	50.04037	17	0.0000

*Null hypothesis rejected at 0.05 level

It is evident from these results that there exists a bi-directional causality between the euro-INR and GBP-INR market whereas this causality is unidirectional in case of USD-INR and Yen-INR market. For USD-INR market the causality runs from spot market to futures market (futures market does not granger cause spot market) while for Yen-INR market it runs from futures market to spot markets (spot market does not granger cause futures market)

Table 19: Error Correction Terms

Error Correction:	D(EURO_INR_FUTURES)	D(EURO_INR_SPOT)
CointEq1	-0.050645 (0.15892) [-0.31869]	0.757358 (0.13353) [5.67187]
Error Correction:	**D(GBP_INR_FUTURES)**	**D(GBP_INR_SPOT)**
CointEq2	0.134237 (0.27052) [0.49622]	1.007553 (0.20303) [4.96256]
Error Correction:	**D(USD_INR_FUTURES)**	**D(USD_INR_SPOT)**
CointEq3	-0.974839 (0.18399) [-5.29825]	-0.419411 (0.29975) [-1.39919]
Error Correction:	**D(YEN_INR_FUTURES)**	**D(YEN_INR_SPOT)**
CointEq4	-0.541668 (0.37560) [-1.44214]	0.508176 (0.31940) [1.59104]

Standard errors in ( ) & t-statistics in [ ]

The error correction terms indicate the speed of adjustments. From the table it is clear that for Euro-INR market about 5 percent of disequilibrium is corrected each day by changes in futures prices whereas about 75 percent of disequilibrium is corrected each day by changes in spot prices. For GBP-INR market about 13 percent of disequilibrium is corrected each day by changes in futures prices whereas 100 percent of disequilibrium is corrected each day by changes in spot prices. For USD-INR market about 94 percent of disequilibrium is corrected each day by changes in futures prices whereas about 42 percent of disequilibrium is corrected each day by changes in spot prices. Similarly, for Yen-INR market about 54 percent of disequilibrium is corrected each day by changes in futures prices whereas about 51 percent of disequilibrium is corrected each day by changes in spot prices.

Conclusion

This paper investigates the causal relationship between foreign currency spot and futures exchange rate with respect to all the currency pairs traded on Indian Derivatives Exchange by employing Engle & Granger methodology. The results of the cointegration test provide significant evidence of bi-directional causality between the Euro-INR and GBP-INR market and unidirectional causality between USD-INR and Yen-INR market. Also, the results of error correction model indicate the speed of adjustments i.e. the pace at which disequilibrium is corrected in the market envisaging the existence of an informational linkage between spot and futures markets which shows that spot and futures markets can be used for arbitrage and hedging.

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