Price Discovery of Currency Futures at NSE

Jerlin Jose¹, Gangu Naidu Mandala¹, Kavitha Desai¹, Nilofer Hussaini¹, Shaik Shamshuddin²

¹Department of Professional Studies, Christ University, India

²Department of Management Studies, Gandhi Institute of Technology and Management, India

Received March 14, 2021; Revised June 7, 2021; Accepted June 20, 2021

Cite This Paper in the following Citation Styles

(a): [1] Jerlin Jose, Gangu Naidu Mandala, Kavitha Desai, Nilofer Hussaini, Shaik Shamshuddin , "Price Discovery of Currency Futures at NSE," *Universal Journal of Accounting and Finance*, Vol. 10, No. 1, pp. 276 - 285, 2022. DOI: 10.13189/ujaf.2022.100128.

(b): Jerlin Jose, Gangu Naidu Mandala, Kavitha Desai, Nilofer Hussaini, Shaik Shamshuddin (2022). *Price Discovery of Currency Futures at NSE. Universal Journal of Accounting and Finance*, 10(1), 276 - 285. DOI: 10.13189/ujaf.2022.100128.

Copyright©2022 by authors, all rights reserved. Authors agree that this article remains permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

Abstract The current study aimed to examine the causal relationship between the NSE currency future rates and currency spot rates in order to identify the price discovery mechanism at NSE market and its integration with foreign exchange market (spot market). To study the causal relationship between the said markets, we have considered daily closing rates for NSE currency futures and currency spot rates for selected pairs of currencies, i.e. USD/INR, GBP/INR, JPY/INR and EURO/INR. The data was obtained from www.nseindia.com and www.investing.com for the period from Jan-2010 to Sep-2017, which makes approximately 1750 observations for each currency pair in each market. It is found that the spot rate for JPY/INR leads the future rate. It is also identified that the spot rate for USD/INR does not cause the changes in futures. It indicates that the market integration between spot and futures at NSE for currency pair USD/INR is strong compared to other selected currency pairs. From the variance decomposition test we found that there is almost no impact of variance in USD/INR spot rate on future rate variance forecast errors. It implies that the causal relationship between for USD/INR spot and future rates is strong and mature compared to the measured causal relationships for the remaining currency pairs. This study concludes that the price discovery process for currency pair USD/INR is better at NSE currency futures among the selected currency pairs.

Keywords Currency Futures, Foreign Exchange Market, NSE, Spot Market

1. Introduction

Foreign exchange market is the world's largest market in terms of trade value is estimated at \$5.09 trillion (Bank for International Settlements) in the year 2016. The importance of foreign exchange management is gaining significance because the market is growing larger day by day. Foreign exchange trading in India introduced in the year when Reserve Bank of India allowed banks to undertake intraday trading in foreign exchange segment. A foreign exchange rate is highly volatile and responds to all global factors directly and indirectly. International trading community has greater interest in foreign exchange rates since their business significantly affected by the exchange rates. A currency derivative comes in handy for the traders and can be used as a tool for mitigating future exchange rate risk.

Currency derivatives in India launched at national stock exchange with the introduction of currency futures against USD in the year 2008 and subsequently allowed to trade against other strong currencies like EURO, POUND and YEN. Though the magnitude of exchange traded currency derivatives against over the counter trade is very small, the currency derivatives are exceptionally doing well at NSE F&O segment. Total traded turnover of Currency derivatives at NSE for the year 2016 stood at Rs 48, 57,075 Cr. with the average daily turnover of Rs 19,394.83 Cr.

World federation of exchanges reports that the currency derivative trade volume has increased significantly during the period of 2015-2016 in both futures and options. While the market has increased in the North American region by 14% during this period, the Asia-Pacific region has

witnessed tremendous growth rate of 23% which is driven by BSE and NSE with growth rate of 23% and 22% respectively.

Table 1. Changes in Currency Options and Futures 2015-2016

	2015	2016	% change	% of total (asset class)	% of total overall)
Currency Options		650	39.3%	18%	18%
Currency Futures	2 115	2 199	4.0%	82%	82%
Total Currency	2 581	2 850	10.4%		18%

Source: World Federation of Exchanges (WFE)

The report also validates that the currency derivatives on NSE, i.e. both futures and options available on USD/INR are most traded currency derivatives in the world for the year 2016-17 after USD/RUB futures that are traded on the Moscow Exchange.

With the constant changes of international businesses, traders are in need of efficient foreign exchange management. Currency derivatives are complex and yet powerful risk management tools and are applied heavily in foreign exchange management. It provides several benefits to the market participants such as hedging, arbitration opportunities, and investment leverage.

Source: www.nseindia.com

Figure 1. Growth of Currency Derivatives at NSE since Inception in Rs. Cr

Table 2. Top 10 currency contracts traded in 2016

	Contract Name	Exchange	Volume		Notional Value		Open Interest	
			2016	AGR	2016	AGR	2016	AGR
1	USD/RUB futures	Moscow Exchange	865 068 634	-4%	980 880	26%	2 626 442	-10%
2	USDINR Options	NSE India ltd	351 632 420	63%	351 609	66%	NA	NA
3	USDINR Futures	NSE India Ltd.	351 162 981	-2%	349 620	0%	NA	NA
4	USDINR Futures	BSE Ltd.	319 413 292	24%	NA	NA	NA	NA
5	USDINR Options	BSE Ltd.	207 386 529	22%	NA	NA	NA	NA
6	Mini U.S. Dollar Futures	BM& FBOVESPA	92 119 754	NA	981 794	NA	508 417	NA
7	U.S. Dollar Futures	BM& FBOVESPA	71 281 293	-8%	3 832 059	16%	13 388 898	1059%
8	EURO FX	CME Group	49 455 909	-24%	6 848 045	-32%	408 748	2%
9	USD Futures	Korea Exchange	56 869 526	8%	54 775 617	10692%	777 433	27%
10	JAPANESE YEN futures	CME Group	36 588 788	1%	4 201 948	12%	212 942	4%

Source: WORLD FEDERATION OF EXCHANGES (WFE)

2. Literature Review

Since the currency futures market facilitates an advantage for the investor through marginal investment, many researchers argue that the informational investors would opt for the futures market over spot market. Thus, currency futures market would attract all the informed traders and rates are adjusted accordingly. This would further lead the spot market exchange rates. Contrary to this argument, some researchers advise that the current currency needs to be settled in cash, hence the currency demand and supply would be absorbed into the spot rates. The study documents the finding of a survey of brokers' perception, introduced commodity derivatives market in India [1]. The survey results show the brokers' assessment about trading/marketing activities and their perception of the benefits and concerns about commodity derivatives. It also throws some light on the perception of brokers about the efficiency of Indian commodity derivatives in performing the functions of price discovery, hedging effectiveness and volatility dynamics.

In another article, it is outlined that the UK contribution to BIS and focus largely changes in FX markets. Many studies have examined the relationship between currency spot and futures markets [2]. Chan's study provides evidence that this price discovery process cannot be based on adverse selection between dealers and their customers, as postulated in standard models, because the spreads dealers quote to their customers are not positively related to a trade's likely information content.

Sehgal et al., [3] dynamic interdependence via growth spillovers between financial cycles represented by real bank credit growth and business cycle as real GDP growth and also examined the price discovery and volatility spillovers in spot and futures.

The current study aims to examine the causal relationship between the NSE currency future rates and currency spot rates in order to identify the price discovery mechanism at NSE market and its integration with foreign exchange market (spot market). To study the causal relationship between the said markets, we have considered daily closing rates for NSE currency futures and currency spot rates for selected pairs of currencies, i.e. USD/INR, GBP/INR, JPY/INR and EURO/INR. The data obtained from www.nseindia.com and www.investing.com for the period from Jan-2010 to Sep-2017, which makes approximately 1750 observations for each currency pair in each market [4].

The study of Sakthive et al. [5] observed that the spot market adjusts to new information faster than futures market suggesting that spot price leads the futures price and contributes largely to price discovery the results of the study show that there is unidirectional volatility transmission from currency spot to futures prices of JPY/INR, GBP/INR and EUR/INR and bidirectional spillover between currency spot and futures prices of USD/INR. Based on the findings, relevant policy recommendations are made.

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 of Gonzalo [6] consisted of the competitiveness and their connection with real exchange rate misalignments. It will then summarize a range of methodologies available for assessing real exchange misalignments, outlining potential obstacles and providing some suggestions for how these can be overcome. Study has not tested the convergence empirically, but seeing the pattern of trading and the study on market efficiency in India supports the dependency of two on each other i.e., there is a long-term stable relationship between foreign currency spot and futures market.

Many studies have examined the relationship between currency spot and futures markets. A majority of studies suggested that the futures lead the spot prices [7], [8] while some have advised otherwise. In the foreign exchange market, the currency futures market share is much smaller than the currency spot market, and it is argued that a significance of currency futures in determining spot rate is very less [9]. However, 2007 BIS Triennial survey, suggested that the currency futures market plays a significant role in price discovery process compared to the spot market. [10] examined the lead-lag relationship between NSE currency futures rates and spot currency rates using daily closing rates under a VECM model and concluded that the future rates lead the spot rates. It is also found that the futures lead spot in all pairs of currencies available at NSE i.e., USD/INR, GBP/INR, JPY/INR and EURO/INR.

The current study aimed to examine the causal relationship between the NSE currency future rates and currency spot rates in order to identify the price discovery mechanism at NSE market and its integration with foreign exchange market (spot market). To study the causal relationship between the said markets, we have considered daily closing rates for NSE currency futures and currency spot rates for selected pairs of currencies, i.e. USD/INR, GBP/INR, JPY/INR and EURO/INR. The data obtained from www.nseindia.com and www.investing.com for the period from Jan-2010 to Sep-2017, which makes it approximately 1750 observations for each currency pair in each market.

The Granger Causality Test is an appropriate method of identifying the lead-lag relationship between the time series data. It is necessary to have the variables stationarity in order to proceed further to test the Granger Causality. Hence, we applied the Augmented Dicky Fuller test in order to test the stationarity of the data. The table 3 summarizes the results from the ADF.

Table 3. ADF test of NONSTATIONARITY

Null Hypothesis: Unit root (individual unit root process)				
Series: DEURFUT, DEURSPOT, DGBPFUT, DGBPSOT, DJPYFUT, DJPYSPOT, DUSDFUT, DUSDSPOT, EURFUT, EUROSPOT, GBPFUT, GBPSOT, JPYFUT, JPYSOT, USDFUT, USDSPOT				
Sample: 1/01/2010 10/18/2017				
Exogenous variables: Individual effects				
Automatic selection of maximum lags				
Automatic lag length selection based on AIC: 1 to 9				
Total number of observations: 24170				
Cross-sections included: 16				
Method			Statistic	Prob.**
ADF - Fisher Chi-square			1219.32	0.0000
ADF - Choi Z-stat			-23.3688	0.0000
** Probabilities for Fisher tests are computed using an asymptotic Chi				
-square distribution. All other tests assume asymptotic normality.				
Intermediate ADF test results UNTITLED				
Series	Prob.	Lag	Max Lag	Obs
DEURFUT	0.0000	3	9	1046
DEURSPOT	0.0000	4	25	2015
DGBPFUT	0.0000	1	9	1302
DGBPSOT	0.0000	1	25	2031
DJPYFUT	0.0000	3	9	1046
DJPYSOT	0.0000	1	25	2018
DUSDFUT	0.0000	8	9	596
DUSDSPOT	0.0000	1	25	2031
EURFUT	0.4946	4	9	1046
EUROSPOT	0.5433	5	25	2015
GBPFUT	0.6011	2	9	1302
GBPSOT	0.5591	2	25	2031
JPYFUT	0.5470	4	9	1046
JPYSOT	0.1810	2	25	2018
USDFUT	0.8896	9	9	596
USDSPOT	0.5591	2	25	2031

The above test result exhibits that all the future rates and spot rates at level are non-stationary since the 'p' values is greater than .05 which fails to reject the null hypothesis of unit root (Non-stationary). The variables at first difference found to be stationary since the p value is less than .05 and rejecting the null hypothesis of non-stationary. Since, the variables at level i.e. without any order of difference found non stationary; it cannot be applied in Granger causality test. Therefore, the variables at first difference can be used in testing Granger Causality Test.

Granger Causality Test

The Granger Causality Test is applied for each pair of currency using first differenced data from both spot and futures markets. The following table 4 exhibits the result from granger causality test for EURO/INR spot and future rates and it implies that there is bi-directional causality

between EURO/INR spot and future markets since the p values for both hypothesis are less than .05 significance level and suggesting the rejection of null hypotheses.

Table 4. Granger causality test for EURO/INR spot and future rate

Pair wise Granger Causality Tests			
Sample: 1/01/2010 10/18/2017			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DEURSPOT does not Granger Cause DEURFUT	1293	197.312	0.00
DEURFUT does not Granger Cause DEURSPOT		10.8452	0.00

The following table 5 exhibits the result from Granger Causality Test for GBP/INR spot and future rates. The system automatically selected the lag length of 2 using

Akaike Information Criterion (AIC) for the model estimation. The result implies that there is bi-directional causality between GBP/INR spot and future markets since the p values for both hypotheses is less than 5% significance level and suggesting the rejection of null hypotheses.

Table 5. Granger causality test for GBP/INR spot and future rate

Pair wise Granger Causality Tests			
Sample: 1/01/2010 10/18/2017			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DGBPSPT does not Granger Cause DGBPFUT	1302	103.319	0.00
DGBPFUT does not Granger Cause DGBPSPT		21.8932	0.01

The following table 6. exhibits the result from Granger Causality Test for JPY/INR spot and future rates and it implies that there is uni-directional causality from JPY/INR spot rates to future market rates since the p values for null hypothesis “DJPYSPOT does not Granger Cause DJPYFUT” is less than .05 significance level and suggesting the rejection of the null hypotheses. It signifies that JPY/INR future rate does not cause JPY/INR spot rate.

Table 6. Granger causality test for JPY/INR spot and future rate

Pair wise Granger Causality Tests			
Sample: 1/01/2010 10/18/2017			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DJPYSPOT does not Granger Cause DJPYFUT	1293	147.461	0.0011
DJPYFUT does not Granger Cause DJPYSPOT		0.18529	0.8309

The following table 7 exhibits the result from granger causality test for USD/INR spot and future rates and it implies that there is uni-directional causality from USD/INR futures rate to spot market rates since the p values for null hypothesis “DUSDFUT does not Granger Cause DUSDSPOT” is less than .05 significance level and suggesting the rejection of the null hypotheses. It signifies

that USD/INR spot rate does not cause USD/INR future rate.

Table 7. Granger causality test for USD/INR spot and future rate

Pair wise Granger Causality Tests			
Sample: 1/01/2010 10/18/2017			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DUSDSPOT does not Granger Cause DUSDFUT	1319	0.43450	0.6477
DUSDFUT does not Granger Cause DUSDSPOT		3.58609	0.0280

Variance Decomposition: Although the causal relationship between spot and futures identified in the previous analysis, it does not disclose relative strength of the variables in the VAR system to the exogenous shocks. Variance decomposition is a method of identifying forecast error variance of each variable from a vector autoregressive (VAR) system. The results from this method are very sensitive to the ordering of variables which generally follows Cholesky's ordering. The Cholesky decomposition algorithm was first proposed by Andre-Louis Cholesky (October 15, 1875 - August 31, 1918) at the end of the First World War. He was a French military officer and mathematician. The idea of this algorithm was published in 1924 by his fellow officer and, later, was used by Banachiewicz in 1938. In the Russian mathematical literature, the Cholesky decomposition is also known as the square-root method. The variance decomposition technique applied for each VAR model estimated separately for each currency pair data sampled from spot and future market. The result would be used to identify the response in endogenous variable caused by shock in each exogenous variable in the estimated VAR. Table 8 represents the output from variance decomposition analysis from estimated VAR of USD/INR spot rate and future rates. The result depicts that only 0.06% variance in USD/INR futures rate caused by shock in USD/INR spot rate which is insignificant. It also indicates that the 27% of variation in USD/INR spot rate caused by shock in USD/INR future rate signifying the impact of future rate on spot rate.

Table 8. Variance Decomposition of USD/INR spot rate and future rates

Variance Decomposition of DUSDFUT:			
Period	S.E.	DUSDFUT	DUSDSPOT
1	0.280320	100.0000	0.000000
2	0.280423	99.94293	0.057066
3	0.281327	99.93462	0.065380
4	0.281327	99.93409	0.065914
5	0.281334	99.93401	0.065985
6	0.281334	99.93401	0.065989
7	0.281334	99.93401	0.065990
8	0.281334	99.93401	0.065990
9	0.281334	99.93401	0.065990
10	0.281334	99.93401	0.065990
Variance Decomposition of DUSDSPOT:			
Period	S.E.	DUSDFUT	DUSDSPOT
1	0.619856	26.69215	73.30785
2	0.620370	26.70954	73.29046
3	0.622602	27.20804	72.79196
4	0.622605	27.20809	72.79191
5	0.622623	27.21208	72.78792
6	0.622623	27.21208	72.78792
7	0.622623	27.21211	72.78789
8	0.622623	27.21211	72.78789
9	0.622623	27.21211	72.78789
10	0.622623	27.21211	72.78789
Cholesky Ordering: DUSDFUT DUSDSPOT

Graph 1.

Table 9 represents the output from variance decomposition analysis from estimated VAR of JPY/INR spot rate and future rates. The result depicts that only 18% variance forecast error in JPY/INR futures rate caused by shock in JPY/INR spot rate over the period of 10 days

which is relatively insignificant. It also indicates that the 55.8% of variation in JPY/INR spot rate caused by shock in JPY/INR future rate indicating significant impact of future rate on spot rate.

Table 9. Variance Decomposition of JPY/INR spot rate and future rates

Variance Decomposition of DJPYFUT:			
Period	S.E.	DJPYFUT	DJPYSPOT
1	0.429883	100.0000	0.000000
2	0.473246	82.51928	17.48072
3	0.474305	82.17570	17.82430
4	0.475882	81.82200	18.17800
5	0.476191	81.71857	18.28143
6	0.476210	81.71740	18.28260
7	0.476214	81.71709	18.28291
8	0.476216	81.71668	18.28332
9	0.476216	81.71662	18.28338
10	0.476216	81.71662	18.28338
Variance Decomposition of DJPYSPOT:			
Period	S.E.	DJPYFUT	DJPYSPOT
1	0.014080	55.82651	44.17349
2	0.014083	55.83978	44.16022
3	0.014123	55.89901	44.10099
4	0.014123	55.89890	44.10110
5	0.014123	55.89936	44.10064
6	0.014123	55.89930	44.10070
7	0.014123	55.89929	44.10071
8	0.014123	55.89929	44.10071
9	0.014123	55.89929	44.10071
10	0.014123	55.89929	44.10071
Cholesky Ordering: DJPYFUT DJPYSPOT

Graph 2

Table 10 represents the output from variance decomposition analysis from estimated VAR of GBP/INR spot rate and future rates. The result depicts that only 12% variance forecast error in GBP/INR futures rate caused by shock in GBP/INR spot rate which is found to be

insignificant. It also indicates that the 61% of variation in GBP/INR spot rate caused by shock in GBP/INR future rate in a period of 10 days indicating significant impact of future rate on spot rate.

Table 10. Variance Decomposition of GBP/INR spot rate and future rates

Variance Decomposition of DGBPFUT:			
Period	S.E.	DGBPFUT	DGBPSPOT
1	0.529465	100.0000	0.000000
2	0.567846	88.37070	11.62930
3	0.569556	87.90296	12.09704
4	0.571089	87.69876	12.30124
5	0.571450	87.58956	12.41044
6	0.571515	87.57805	12.42195
7	0.571519	87.57813	12.42187
8	0.571522	87.57737	12.42263
9	0.571523	87.57686	12.42314
10	0.571524	87.57681	12.42319
Variance Decomposition of DGBPSPOT:			
Period	S.E.	DGBPFUT	DGBPSPOT
1	0.613384	60.99715	39.00285
2	0.621477	60.38337	39.61663
3	0.624650	60.74757	39.25243
4	0.624651	60.74737	39.25263
5	0.624765	60.72553	39.27447
6	0.624814	60.71591	39.28409
7	0.624817	60.71582	39.28418
8	0.624819	60.71574	39.28426
9	0.624819	60.71560	39.28440
10	0.624819	60.71558	39.28442
Cholesky Ordering: DGBPFUT DGBPSPOT

Graph 3.

Table 11. Variance Decomposition of EUR/INR spot rate and future rates

Variance Decomposition of DEURFUT:			
Period	S.E.	DEURFUT	DEURSPOT
1	0.399747	100.0000	0.000000
2	0.450256	79.58620	20.41380
3	0.453078	78.63781	21.36219
4	0.454767	78.58596	21.41404
5	0.455053	78.50858	21.49142
6	0.455094	78.49857	21.50143
7	0.455101	78.49811	21.50189
8	0.455102	78.49817	21.50183
9	0.455102	78.49806	21.50194
10	0.455102	78.49803	21.50197
Variance Decomposition of DEURSPOT:			
Period	S.E.	DEURFUT	DEURSPOT
1	0.506717	50.37623	49.62377
2	0.510506	49.85129	50.14871
3	0.512942	50.32118	49.67882
4	0.512980	50.32859	49.67141
5	0.512994	50.32591	49.67409
6	0.513007	50.32344	49.67656
7	0.513008	50.32328	49.67672
8	0.513009	50.32334	49.67666
9	0.513009	50.32333	49.67667
10	0.513009	50.32333	49.67667
Cholesky Ordering: DEURFUT DEURSPOT

Graph 4.

Table 11 represents the output from variance decomposition analysis from estimated VAR of EUR/INR spot rate and future rates. The result depicts that only 21 per cent variance forecast error in EUR/INR futures rate caused by shock in EUR/INR spot rate over a period of 10 trading days which is insignificant. It also indicates that the 50 per cent of variance forecast error in EUR/INR spot rate caused by shock in EUR/INR future rate in a period of 10 days indicating significant impact of future rate on spot rate.

3. Conclusions

The current study aimed at examining the causal relationship between the NSE currency future rates and currency spot rates in order to identify the price discovery mechanism at NSE market. To study the causal relationship between the said markets, we have considered daily closing rates for NSE currency futures and currency spot rates for selected pairs of currencies i.e. USD/INR, GBP/INR, JPY/INR and EURO/INR. Granger Causality

Test is used for identifying the lead lag relationship between the currency spot and future markets. From this study, we identified that the currency future rates lead spot rates for USD/INR, GBR/INR and EURO/INR currency pairs. It is found that the spot rate for JPY/INR leads the future rate. It is also identified that the spot rate for USD/INR does not cause the changes in futures. It indicates that the market integration between spot and futures at NSE for currency pair USD/INR is strong comparing to other selected currency pairs. From the variance decomposition test, we found that there is almost no impact of variance in USD/INR spot rate on future rate variance forecast errors. It implies that the causal relationship between for USD/INR spot and future rates is strong and mature compared to the measured causal relationships for the remaining currency pairs. This study concludes that the price discovery process for currency pair USD/INR is better at NSE currency futures among the selected currency pairs.

REFERENCES

- [1] Osler, C. L., Mende, A., & Menkhoff, L. (2011). Price discovery in currency markets. *Journal of International Money and Finance*, 30(8), 1696-1718.
- [2] Hasbrouck, J. (1995), "One security, many markets: determining the contributions to price discovery", *Journal of Finance*, 50(4), 1175-1199.
- [3] Sehgal, S., Ahmad, W., & Deisting, F. (2018), Business Cycle and Financial cycle Interdependence, *Journal of Quantitative economics*, 16(2), 337-362
- [4] Srivastava, A. and Singh, M. (2015), "A study on pricing of currency futures in Indian currency market", *International Journal of Research in Finance and Marketing*, 5(6), 1-11.
- [5] Sehgal, S., Ahmad, W., & Deisting, F. (2018), Business Cycle and Financial cycle Interdependence, *Journal of Quantitative economics*, 16(2), 337-362
- [6] Gonzalo, J. and Granger, C. (1995), "Estimation of common long-memory components in co integrated systems", *Journal of Business and Economic Statistics*, 13(1), 27-35.
- [7] Hans R. Stoll and Robert E. Whaley (1990). The Dynamics of Stock Index and Stock Index Futures Returns. *The Journal of Financial and Quantitative Analysis*, 25(4), 441-468.
- [8] Ira G. Kawaller, Paul D. Koch and Timothy W. Koch(1987).The Temporal Price Relationship Between S&P 500 Futures and the S&P 500 Index. *The Journal of Finance*, 42(5), 1309-1329.
- [9] Lyons, Richard K. (2001). The Microstructure Approach to Exchange Rates. *MIT Press*, Cambridge, MA.
- [10] Varuna Kharbanda and Archana Singh, (2017). Lead-lag relationship between futures and spot FX market in India. *International Journal of Managerial Finance*, 13(5), 560-577