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Price Discovery and Spillover Effect USDINR Spot Exchange Rate and USDINR Futures MCX

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Abstract
The research work presented is an endeavor establish relationship between spot rate data of USDINR & Currency Future rate USDINR data of MCX. The daily closing data has been collected from RBI website and MCX website to conduct the research work presented. The data has been checked for Descriptive Statistics, ADF stationarity test, VAR/VECM for long and short term relationship check, GARCH 1,1,, ARIMA 1,1, and T-GARCH and E-GARCH to check the effect of good news and bad news flowing in the market. . The data sample collected from 29th October 2010 to 31st Aug, 2021.
Findings shows long-term relationship in two time-series data, no short-term relationship between the both time series data sets, series were found volatile and not stationarity have been seen at level but at 1st difference series were found stationary. Both time series data sets are asymmetric to good news and bad news flowing in the market. Also, both the time series sets of data are significantly positive towards positive news flowing in the market.

Keywords Spot-Rate, Currency-Futures, ADF, ARIMA, ARCH, VAR/VECM GARCH1,1, WALD Test, T-GARCH, E-GARCH.

Introduction

The research work presented is an endeavor establish relationship in spot rate data of USDINR&currency futures data MCX USDINR. Era of reforms during 1991 has given importance to derivative instrument in Indian Financial system. As derivative instrument has been added in equity market during 2000. Furthermore, development in Indian financial system continued and by the year of 2008 currency futures has been introduced in USDINR and followed by introduction of currency futures in Euro, Yen and Pond Sterling by the end of year 2010. Initially, currency derivative was a risk management instrument for the stakeholders of international business, specifically for importers and exporters to hedge their exposure of transaction and exchange risk. But later it has become a sound investment option for the people investing in FOREX. Because of these factors and others currency futures has put impact on its underlying market and made it more volatile and vice-versa. Altogether, it has increased the necessity to study volatility in currency futures and spot markets, their movement patters, their impact on each other's and their relationship between both.

Literature Review

Clarida, R. & Gali, J. (1994) stipulated an ascertainment the root cause of real exchange-rate volatility right after downfall of Bretton Woods 1971, through surveys. Study investigates money can impact the real exchange rates during short run only. Also VAR applied for forecasting the real-exchange rates with inflation lags differential and changes in lags in case of U.S. output comparted to the world output. The study is a contrast of Yen, DM in comparison of U.S. Dollar. Study source reported a relativeness of Dollar-DM and Dollar-Yen using VAR after collapse of Bretton Wood 1971 and found unconditional variance in comparison.
Hossain, A., (1997) demonstrates developed a model of macroeconomic in tradable and non-tradable commodities during the time period of 1973-1996 in Bangladesh with 4.5 GDP as per historical data. 4.5% GDP resulted because of foreign aid and increase in demand of nontradable goods too. Appreciation in demand of nontradable goods results in increase in output and employment of nontradable goods. Study indicates real exchange rate doesn't influence the demand of nontradable goods and sector, these goods appears price inelastic. Demand for tradable goods declined from 59% during 1973-1975 to 44% during 1995-1996. Share of employment respectively declined from 68% to 58%. But this declined was associated with per-capita income increase from 65% to 68%. Adverse effects on tradable goods demand resulted positive effects on per-capita income, real exchange rate and trade balance. This appreciation in entire economic boom in Bangladesh economy was a result in structural adjustment programs IMF-World Bank. It might encouraged investors to invest directly some key areas or export oriented manufacturing like gas and oil because of this Bangladesh

Economy experienced foreign capita-induced and boom in economy. Study reports cause and effect relationship between tradable-nontradable goods and exchange rates.

Hossain, A., (1997) demonstrated responses of exchange-rate to the inflation in Bangladesh starting since 1972-1999 annually and monthly both date investigated. Study reported consumer price inflation led to devaluation. Inflation impact on depreciation in currency has become sluggish after reforms undertaken. General perception is devaluation in currency value lead to increase in inflation in developing countries. Study stipulated possibility of causal linkage between devaluation and inflation. Study reported effects of nontradable goods, inflation influences the exchange rate and contrast of inflation and Exchange rate. Study is an extended version of the previous study conducted and lead to same results, still there can be a lot more macroeconomic variable can put in consideration. Study focuses on only structural adjustment made by IMF-World Bank and ripple effect of those structural adjustments.

Mussa, M., (1977) demonstrated extension of fundamental principles in monetary approach to BOP in floating exchange rate regime with intervention of authorities and controlled rate movements. Study indicates four points first relativeness of exchange rate with price of each national currency, not country's outputs and can be find by supply of monies & demand.

Frankel, J. A., (1999) always demonstrated an essay form on Not a one Currency Regime found fit for all nations, Currencies/time. This study stipulated that it's a choice of an individual country to imply the exchange rate regime from country's own choice depending and evaluating the current economic and global scenario. This study supports no single exchange rate regime for all times. Referred to East Asian Crises author indicates that the during East Asian Crises the major problem was nations did not have pegged to the dollar rather countries those pegged to the dollar like Maxico, Thailand, Russia, Brazil they sailed well during the time of crises or in general also. Further study indicates points for complete floating exchange rate suggestion and a complete flexible rate regime suggestion, Blancing Fixed vs. Flexible Exchange Rates, The Optimum Currency Area, Cornet Solution are right for some Countries and dollarization proposal. A rigid peg or free float has yet to be rationalized theoretically. This study reported a complicated intermediate regimes which are 22 insufficient to verify, transparent operations are also not possible to satisfy the trade partners and global investors.

Basurto, G., & Ghosh, A., (2000) demonstrated stabilization programs i.e. strict monetary policy in Asian Crisis Countries (Indonesia, Korea and Thailand) was designed to defend the crisis of Exchange rate but results confirms that with the huge depreciation in exchange rate and tightening of monetary policy has raised fear of raise interest rate that resulted in widespread bankruptcies and a large risk. To establish the relationship with tighter monetary policy, increase in nominal interest rates and Exchange rate volatility VAR is being used to get correlation values. Basurto, G., & Ghosh, A., stipulated biggerrates of interest are not correlated to exchangerate increased during the Est Asian Crisis. The study contributes towards examining if high rates of interest results in exchange-rate despeciation being other thing remain the same and found the higher real rate of interest are correlated to exchange rate but no impact of money supply in economy on rate of interest & exchange rate depreciation. Also the study contributes that the efficacy of News and adverse political conditions could create interest and exchange rate risk. The study reported examination of a East Asian Countries Cries situation and the remedial action taken or suggests an alternative approach to deal with crises but the research could lead to more clear view point if the variables study conducted pre and post crises conditions and compared.

Hua, H., (2002) demonstrated relativeness of tradeweighted real exchange rate of USD/DM reference to degree of the openness in economy to the trade with support of the theory intertemporal monetary model of a small open 23 economy with nominal rigidities. Economies produces shocks with when they are more open to foreign trade. Sources reported forty eight countries confirms relationship.

Karfakis, C., (2003) stipulatedexchange determination monetarist model of the time of hyperinflation in Romania to test the data of Lei/dollar exchange rate. Study indicates a swift enhance of money supply and inflation led to depreciation of Lei on the other hand enhance the Romanian real income became theroot of appreciation of Lei. Study reported policy implication expansion with an aim to manage inflation can produce economic growth and can boost the value of Lei.

Macdonald, R., & Ricci, A. L., (2004) recorded as sharp depreciation in South African Rand of 25 percent in year 2002 than value of Rand in YoY period and 45% average depreciation than the average of year 1995. Research question is to find the equilibrium level of currency depreciation and macroeconomic variables because macroeconomic variables continuously effects the exchange rate.

Egert, B., (2009) A high frequency study of South African Rand and U.S. Dollar in time period of Jan. 2001 to July 2007. The study examines importance of fundamentals of economic in describing the increase and decrease of exchange price in time duration of the study, ponder on whether monetary fundaments has role in nominal exchange rate determination in S.A. or the political risk have an impact of rand exchange rate, whether the export of goods changes the view point of the investors FDI/FIIs towards south African economy, whether the emerging economies have an impact of rand exchange rate and whether the interest policy of central bank influences the exchange rates.

Hsieh, W., (2009) demonstrated four major models of IND/USD exchange rates and PPP Model, presented the interest Parity Model, Monetary Model. Study Indicates PPP model an indicator of the coefficient has expected positive sign and significant at the 1% level

Liew, K. V., Baharumshah, Z. A., & Puah, H. C., (2009) demonstrated longrun relationship among exchange rate and determinants. Approach of multivariate cointegration is used. Study indicates small openness is good for emerging economies like Thailand..

Mirchandani, A., (2013) demonstrated FX of India experienced a substantial changes in 1991 to 2010. Study has developed relationship between inflation data, Exchange rate data, Interest Rate data and Foreign Exchange market, Current Account & International Trade. Research tool used is correlation.

Venkatesan, T., & Ponnamma, S. M., (2017) demonstrated rupee is setting its mark in international markets, its seen through Nepal and Bhutan started pegging of Indian rupee, high GDP of India enable India to stand out of the league of emerging economies. Study indicates increase in GDP enable to become strong exchange rate along with factors gross domestic savings, forex reserve and inflation. Study reported relativeness of Exchange rate INR/USD and Macroeconomic variables using research tools of econometric modelling, ADF test, Vector Auto Regressive Model and ARDL and found FDI has long-term relationship in efficacy of Ex and significance of macroeconomic variables in exchange rate.

Mishra, S., & Debasish, S.S.,(2019) demonstrated an analysis of volatility spillover amount exchange rate and crude oil price in India from June-2003 to March-2016. Study analyse efficacy of crude oil price on exchange-rate of INR/USD with research tool (GARCH) and (EGARCH). This work contributes up in prices of crude oil redirect to decrease in INR/USD exchange rate

Sharma, C., (2019) demonstrated relationship among export at commodity level in context of India and exchange rate risk. Panel data on monthly basis used to analyse covering hundred products during the time 2012-2017. To quantify volatility of exchange rate both real and nominal are considered and prediction has been done using autoregressive conditional heteroscedastic method (ARCH).

Vinish, K., & Sabat, J., (2020) demonstrated relationship amoung oil prices and Ex in India. GARCH & EGARCH models employed in this work to check efficacy of oil stock prices on nominal exchange rate in last decade. Study reported, All period have varying volatility.

Data

The data of underlying market and currency futures USDINR has taken from RBI website and MCX website data from 29th October, 2010 to 31st August, 2020.The study work has been divided into two parts. Part one to observe the Long-run and short-run relationship between variables spot exchange rate of USDINR and Currency futures USDINR MCX. Second, to observe the spillover effect in both the time series data.

Research Methodology

Non-stationary time series has unit-root and depict not even patterns. Findings entail that applying advanced statistical test on time series can't be considered,that's why stationarity of times series on first level is needed.

$$\Delta Y_t = a_1 Y_{t-1} + \sum_{j=1}^{p} \beta_j \Delta Y_{t-j} + \varepsilon_t \quad \ldots\ldots(1)$$

$$\Delta Y_t = \alpha_0 + a_1 Y_{t=1} + \sum_{j=1}^{p} \beta_j \Delta_{t-j}\, \varepsilon_t \quad \ldots\ldots(2)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + a_2 t + \sum_{j=1}^{p} \beta_j \Delta Y_{t-j} + \varepsilon_t \quad \ldots\ldots(3)$$

Vector Error Correction Model (VECM) detected long run relationship in series. Therefore,applied VECM to get the short run relationship between variables. As regression equation is below:

$$\Delta Y_t = \alpha_1 + p_1 e_i + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-1} + \sum_{i-0}^{n} \gamma_i Z_{t-i} \quad \ldots\ldots(4)$$

$$\Delta Y_t = \alpha_2 + p_2 e_i + \sum_{i=0}^{n} \beta_i \Delta Y_{t-i} + \sum_{i=0}^{n} \delta_i \Delta X_{t-1} + \sum_{i-0}^{n} \gamma_i Z_{t-i} \quad \ldots\ldots(5)$$

T-GARCH has been applied to know the symmetry against good news and bad news coming to the market equation is as follows:-

$$R_t = \alpha + bR_{t-1} + \varepsilon_t$$

$$\varepsilon_t / I_{t-1} N(0, h_t),$$

$$h_{it} = \alpha_0 + \sum_{i=0}^{p} \beta_i h_{t-1} + \sum_{j=1}^{q} \lambda_j \mu_{t-j}^2 + \delta_1 \mu_{t-1}^2 d_{t-1} \quad \ldots\ldots(6)$$

E-GARCH has been applied to check the responsiveness of the both variables towards good or bad news, equation is as follows:

$$R_t = \alpha + bR_{t-1} + \varepsilon_t$$

$$\mathrm{Log}(h_t) = \alpha_0 + \sum_{j=1}^{q} \beta_j \left| \frac{\mu_{t-j}}{\sqrt{h_{t-j}}} \right| + \sum_{j=1}^{q} \lambda_j \frac{\mu_{t-j}}{\sqrt{h_{t-j}}} + \delta_1 h_{t-1} .$$

$\varepsilon_t / I_{t-1} N(0, h_t)$,

Empirical Results

Results of Descriptive statistics shows currency futures has higher Mean, median, Standard Dev. it means currency futures MCX data itself is more volatile in nature rather than the data of underlying marker.

Table:1 Descriptive Statistics

	US_DOLLAR	**USDINR_FT_MCX**
Mean	62.23559	64.11798
Median	64.06795	66.00125
Maximum	76.80840	81.71250
Minimum	43.94850	43.94850
Std. Dev.	8.256109	8.525526
Skewness	-0.646460	-0.682778
Kurtosis	2.613924	2.615276
Jarque-Bera	180.0970	2403.062
Probability	0.000000	0.000000
Sum	147747.3	1837237.
Sum Sq. Dev.	161751.6	2082632.
Observations	2374	28654

ADF Test and Results

ADF test has been applied to know the stationarity in both time series data and found that at level both time series has unit rood therefore null hypothesis of ADF test is accepted i.e. series has a unit root. It means series are not stationary at level but are fount stationary at 1st difference.

Table-2 Unit Root Test at level

	Intercept		With Intercept& Trend		Without Intercept and Trend	
US_DOLLAR	-0.009546	0.9566	-2.075980	0.5584	-2.110903	0.0335
USDINR_FT_MCX	0.260203	0.9762	-1.778549	0.7154	-2.249304	0.0236

VECM Model:

In order to apply the VECM model. Following steps will be followed. 1. Lag selection 2. Johansen Test of Cointegration and 3. VECM in our data of USDINR_SP and USDINR_FT_MCX.

Lag Selection: From lag selection criteria it is given LR, FPE, AIC, SC and HQ Sequential Modified LR test statistics. To select lag * indicated lags has been selected because it's a selection criterion. As all four * are in lag one. Otherwise, criteria is lower the value better the model as optimum lag is 1 and 1lag have used in Johansen's test and in Vector Error Selection model.

Table-3 VAR Lag Order Selection Criteria

VAR Lag Order Selection Criteria						
Endogenous variables: US_DOLLAR USDINR_FT_MCX						
Exogenous variables: C						
Date; 01/15/22 Time; 16:25						
Sample: 1 28654						
(Included observations); 2370						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-12612.23	NA	143.9065	10.64492	10.64979	10.64669
1	-2920.454	19359.01*	0.040511*	2.469581*	2.484190*	2.474900*
2	-2916.581	7.728604	0.040516	2.469689	2.494038	2.478553
3	-2913.349	6.446473	0.040542	2.470336	2.504425	2.482746
4	-2912.511	1.668128	0.040650	2.473005	2.516833	2.488960

Johansen Test of Cointegration

Prerequisite of this cointegration is variable should be non-stationary at level but as convert it to first difference, it should be stationary. Variable should be integrated of same order.

Correlogram at level of USDINR spot exchange rate show null hypothesis stationary in variables& alternative hypothesis is variable is not stationary as probability value is less than 5% at level therefore null hypothesis is rejected & at alternative is accepted. When Correlogram checked at first difference of USDINR Spot exchange rates and selected first difference and found prob. More than 5% then null hypothesis is accepted as variable is non-stationary.

Same method has been applied on second variable i.e. USDINR futures rate of MCX and found the same results. All variables are integrated of same order.

After this applied Johansen Test and selected variable 1 as referred to variable selection criterion table.

Table-4(Johansen Test of Cointegration)

Date; 01/15/22 Time; 17:07				
(Sample adjusted): 3 2374				
Included observations: 2372 after adjustments				
Trend assumption: Linear deterministic trend)				
Series : US_DOLLAR USDINR_FT_MCX				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
# of CE(s)	Eigenvalue	Stats	Critical-Value	(Prob.**)
None *	0.062966	154.2671	15.49471	0.0001
At most (1)	7.00E-07	0.001661	3.841466	0.9651
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Trace	0.05	
# of CE(s)	Eigenvalue	Stats	Critical Value	(Prob.**)
None *	0.062966	154.2654	14.26460	0.0001
At most 1	7.00E-07	0.001661	3.841466	0.9651
Max eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon Haug Michelis (1999) p-values				
Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I);				
US_DOLLAR	USDINR_FT_MCX			
-0.070016	0.709289			
0.120374	0.009848			
Unrestricted Adjustment Coefficients (alpha):				
D(US_DOLLAR)	0.007573	0.000233		
D(USDINR_FT_MCX)	-0.184216	8.20E-05		
1 Cointegrating Equation(s):		Log likelihood	-2923.818	
Normalized cointegrating coefficients (standard error in parentheses)				
US_DOLLAR	USDINR_FT_MCX			
1.000000	-10.13033			
	(0.69979)			
Adjustment coefficients (standard error in parentheses)				
D(US_DOLLAR)	-0.000530			
	(0.00040)			
D(USDINR_FT_MCX)	0.012898			
	(0.00103)			

As the trace statistic No. of Cointegration model first model is none shows there is no cointegration among the variables as per null hypothesis. As critical value is 15.49471 higher than the 5% sorejected the null hypothesis. As probability is lesser than 5% meaning that null hypothesis is rejected & at most 1 shows p value more than 5% therefore it cannot reject the null hypothesis. As results shows

Trace test indicates 1 cointegrating eqn(Ss) at the 0.5 level. It means variables has long run relationship. Same results can be seen at maximum Eigenvalue test. If the variables are cointegrated or have long run relationship, then VAR i.e. VECM can be applied.

VECM Model

Table-5 Vector Error Correction Estimates

Date; 01/15/22 Time; 17:23		
Sample adjusted: 3 2374		
Included observations: 2372 after adjustments		
Standard errors in ( ) & t statistics in [ ]		
Cointegrating Eq:	CointEq1	
US_DOLLAR(-1)	1.000000	
USDINR_FT_MCX(-1)	-10.13033	
	(0.69979)	
	[-14.4762]	
C	706.6784	
Error Correction:	D(US_DOLLAR)	D(USDINR_FT_MCX)
CointEq1	-0.000530	0.012898
	(0.00040)	(0.00103)
	[-1.31562]	[12.4962]
D(US_DOLLAR(-1))	-0.005034	-0.142815
	(0.02055)	(0.05262)
	[-0.24500]	[-2.71397]
D(USDINR_FT_MCX(-1))	-0.004909	0.004775
	(0.00801)	(0.02051)
	[-0.61302]	[0.23284]
C	-0.012209	-0.001604
	(0.00576)	(0.01476)
	[-2.11884]	[-0.10870]
R-squared	0.000789	0.068475
Adj R-squared	-0.000477	0.067295
Sum sq. resids	186.1237	1220.660
S.E. equation	0.280356	0.717970
F statistic	0.623293	58.02280
Log likelihood	-347.2605	-2577.812
Akaike AIC	0.296172	2.176908
Schwarz SC	0.305905	2.186640
Mean dependent	-0.012147	0.000153
S.D. dependent	0.280289	0.743420
Determinant resid covariance (dof adj.)		0.040474
Determinant resid covariance		0.040337
Log likelihood		-2923.818
Akaike information criterion		2.473708
Schwarz criterion		2.498040
Number of coefficients		10

VECM model each variable have lag 1. And dependent variables are shown. Standard errors in () and t-statics in [].But there is no P value probability value to check the P value following test has been applied. To get the P value model 1 of dependent variable taken i.e. D(US_DOLLAR) = C(1)*(US_DOLLAR(-1) - 10.1303260216*USDINR_FT_MCX(-1) + 706.678390458) + C(2)*D(US_DOLLAR(-1)) + C(3)*D(USDINR_FT_MCX(-1)) + C(4)in system equation model 8 coefficient will be calculated. C1 is the coefficient of cointegration model. UD_dollar is our targetedvariable:

Dependent Variable:D(US_DOLLAR)				
Method: Least Squares (Gauss Newton / Marquardt steps)				
Date; 01/15/22 Time; 17:32				
Sample adjusted : 3 2374				
Included observations: 2372 after adjustments				
D(US_DOLLAR) = C(1)*(US_DOLLAR(-1) - 10.1303260216				
*USDINR_FT_MCX(-1) + 706.678390458) + C(2)*D(US_DOLLAR(				
-1)) + C(3)*D(USDINR_FT_MCX(-1)) + C(4)				
	Coefficient	Std Err	t-Stat	Prob
C(1)	-0.000530	0.000403	-1.315619	0.1884
C(2)	-0.005034	0.020548	-0.244997	0.8065
C(3)	-0.004909	0.008008	-0.613019	0.5399
C(4)	-0.012209	0.005762	-2.118842	0.0342
R squared	0.000789	Mean dependent var		-0.012147
Adjusted R-square)	-0.000477	S.D. dependent var		0.280289
S.E. of regression	0.280356	Akaike info criterion		0.296172
Sum squared resid	186.1237	Schwarz criterion		0.305905
Log likelihood	-347.2605	Hannan Quinn criter		0.299715
F statistic	0.623293	Durbin Watson stat		1.992304
Prob F-statistic	0.599921			

P value is visible above. Where C (1) is the coefficient of the cointegrating model. C (1)>> Error Correction term or Speed of adjustment towards equilibrium. Now long-run Causality and Short run causality can be ascertained. As C (1) is negative in sign and significant it means there is long rung causality in USDINR spot and USDINR_FT_MCX. Short run causality C(2)=C(3)=C(4)=0 meaning that no short run causality running from futures to spot checked by WALD test and found Chi-sq prob. More than 5% therefore no short run causality running from USDINR Futures MCX and USINR_spot.

Table:6 Wald Test

Equation Untitled			
Test Stat	Value	df.	Prob
F stat	1.631720	(3, 2368)	0.1799
Chi square	4.895159	3	0.1796
Null Hypothesis: C(2)=C(3)=C(4)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err
C(2)		-0.005034	0.020548
C(3)		-0.004909	0.008008
C(4)		-0.012209	0.005762
Restrictions are linear in coefficients.			

Found long run causality but no short run causality running from USDINR_futures to USDINR Spot.

Breusch Godfrey Serial Correlation LM Test:				
F statisti)	8.080162	Prob. F(2,2366)		0.0003
Obs*R-squared	16.09140	Prob Chi-Square(2)		0.0003
Test Equation:				
Dependent Variable: RESID				
Method: Least Squares				
Date; 01/15/22 Time; 17:57				
Sample: 3 2374				
Included observations; 2372				
Presample missing value lagged residuals set to zero.				
Variable	Coefficient	Std Err	t-Stat	Prob
C(1)	-0.001599	0.000634	-2.523868	0.0117
C(2)	-3.362553	1.020261	-3.295777	0.0010
C(3)	-0.017100	0.009389	-1.821230	0.0687
C(4)	-0.041170	0.013746	-2.994970	0.0028
RESID(-1)	3.365401	1.020960	3.296309	0.0010

RESID(-2)	-0.065538	0.021261	-3.082620	0.0021
R squared	0.006784	Mean dependent var		1.12E-18
Adjusted R-square)	0.004685	S.D. dependent var		0.280179
S.E. of regression	0.279522	Akaike info criterion		0.291052
Sum squared resid	184.8610	Schwarz criterion		0.305651
Log likelihood	-339.1874	Hannan Quinn criter		0.296366
F statistic	3.232065	Durbin Watson stat		2.000906
Prob F-statistic	0.006522			

Out to above table found that this model has serial co-relation.

Heteroskedasticity Test: Breusch Pagan Godfrey				
F statistic	3.378392	Prob F(4,2367)		0.0092
Obs*R squared	13.46524	Prob Chi Square(4)		0.0092
Scaled explained SS	63.12215	Prob Ch Square(4)		0.0000
Test Equation:				
Dependent Variable: -RESID^2)				
Method: Least Squares				
Date: 01/15/22 Time: 18:01				
Sample; 3 2374				
Included-observation; 2372				
Variable	Coefficient	Std. Err	t-Stat	Prob
C	-0.157930	0.247479	-0.638155	0.5234
US_DOLLAR(-1)	0.010562	0.017616	0.599576	0.5488
USDINR_FT_MCX(-1)	-0.021563	0.006869	-3.139221	0.0017
US_DOLLAR(-2)	-0.010511	0.017618	-0.596591	0.5508
USDINR_FT_MCX(-2)	0.024637	0.006862	3.590275	0.0003
R squared	0.005677	Mean dependent var		0.078467
Adjusted R-square)	0.003996	S.D. dependent var		0.240719
S.E. of regression	0.240238	Akaike info criterion		-0.012272
Sum squared resid	136.6092	Schwarz criterion		-0.000106
Log likelihood	19.55400	Hannan Quinn criter		-0.007843
F statistic	3.378392	Durbin Watson stat		1.549599
Prob F-statistic	0.009150			

Effect of Good News or Bad News on Both the series i.e. USDINR_Spot exchange and USDINR_Futures MCX using T-Garch and E-Garch

Prerequisite to get the ARCH/GARCH results is to check the volatility of the data. Then after, applied ARIMA 1,1 spot exchange rate and UDINR Futures MCX data:

Dependent Variable: D(US_DOLLAR)				
Method: ML ARCH Normal distribution (BFGS / Marquardt steps)				
Date: 01/15/22 Time: 18:56				
Sample adjusted: 3 2374				
Included observations: 2372 after adjustments				
Convergence achieved after 27 iterations				
Coefficient covariance computed using outer product of gradients				
MA Backcast: 2				
Presample variance: backcast (parameter = 0.7)				
GARCH = C(4) + C(5)*RESID(-1)^2				
Variable	Coefficient	Std. Error	z-Statistic	Prob
C	-0.008969	0.004387	-2.044467	0.0409
AR-(1)	-0.476528	0.232962	-2.045520	0.0408
MA(-1)	0.456799	0.236280	1.933290	0.0532
	Var Eq			
C	0.048918	0.001344	36.39879	0.0000

RESID(-1)^2	0.420920	0.025743	16.35057	0.0000
R squared	0.000989	Mean dependent var		-0.012147
Adjusted R squared	0.000146	S.D. dependent var		0.280289
S.E. of regression	0.280269	Akaike info criterion		0.168458
Sum squared resid	186.0864	Schwarz criterion		0.180624
Log likelihood	-194.7913	Hannan Quinn criter		0.172887
Durbin Watson stat	1.965734			
Inverted AR Roots	-.48			
Inverted MA Roots	-.46			

Dependent Variable: D(USDINR_FT_MCX)				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Date: 01/15/22 Time: 19:01				
Sample adjusted: 3 28654				
Included observations: 28652 after adjustments				
Convergence achieved after 115 iterations				
Coefficient covariance omputed using outer product of gradients				
MA Backcast: 2				
Presample variance: backcast (parameter = 0.7)				
GARCH = C(4) + C(5)*RESID(-1)^2				
Variable	Coefficient	Std. Error	z-Statistic	Prob
C	-0.002547	6.50E-05	-39.16390	0.0000
AR-(1)	0.651160	0.000503	1294.819	0.0000
MA(-1)	-0.962142	0.000186	-5165.159	0.0000
	Var Eq			
C	0.035859	0.000236	151.8419	0.0000
RESID(-1)^2	2.944766	0.018069	162.9778	0.0000
R squared	0.173334	Mean dependent var		-0.000931
Adjusted R squared	0.173276	S.D. dependent var		0.969401
S.E. of regression	0.881421	Akaike info criterion		1.906257
Sum squared resid	22257.52	Schwarz criterion		1.907699
Log likelihood	-27304.04	Hannan Quinn criter		1.906721
Durbin Watson stat	1.930956			
Inverted AR Roots	.65			
Inverted MA Roots	.96			

GARCH 1,1 on USDINR Spot exchange rate data and UDINR Futures MCX

Dependent Variable: D(US_DOLLAR)				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Date; 01/15/22 Time; 18:58				
Sample adjusted;: 3 2374				
Included observations: 2372 after adjustments				
Convergence achieved after 37 iterations				
Coefficient covariance computed using outer product of gradients				
MA Backcas;: 2				
Presample variance: backcast (parameter = 0.7)				
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)				
Variable	Coefficient	Std. Err	z-Stat	Prob
C	-0.003201	0.004392	-0.728840	0.4661
AR(1)	-0.538768	0.623730	-0.863785	0.3877
MA(1)	0.549065	0.618490	0.887751	0.3747
	Var Eq			
C	0.001937	0.000360	5.374351	0.0000
RESID(-1)^2	0.120080	0.012799	9.382007	0.0000
GARCH(-1)	0.855601	0.013094	65.34066	0.0000
R squared	0.001112	Mean dependent var		-0.012147

Adjusted R squared	0.000268	S.D. dependent var		0.280289
S.E. of regression	0.280252	Akaike info criterion		0.004941
Sum squared resid	186.0636	Schwarz criterion		0.019540
Log likelihood	0.139669	Hannan Quinn criter		0.010256
Durbin Watson stat	2.022246			
Inverted AR Roots	-.54			
Inverted MA Roots	-.55			

Dependent Variable: D(USDINR_FT_MCX)				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Date; 01/15/22 Time; 19:03				
Sample adjusted: 3 28654				
Included observations; 28652 after adjustments				
Failure to improve likelihood (non zero gradients) after 54 iterations				
Coefficient covariance computed using outer product of gradients				
MA Back cast; 2				
Pre-sample variance;back cast parameter = 0.7				
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)				
Variable	Coefficient	Std Err	z-Stat	Prob
C	-0.000574	0.017741	-0.032361	0.9742
AR(1)	-0.032856	0.087310	-0.376309	0.7067
MA(1)	-0.013611	0.094875	-0.143457	0.8859
	Variance Equation			
C	0.456873	0.122491	3.729848	0.0002
RESID(-1)^2	-0.017247	0.001349	-12.78707	0.0000
GARCH(-1)	0.570184	0.116590	4.890503	0.0000
R squared	0.006017	Mean dependent var		-0.000931
Adjusted R squared	0.005947	S.D. dependent var		0.969401
S.E. of regression	0.966514	Akaike info criterion		2.748439
Sum squared resid	26762.43	Schwarz criterion		2.750170
Log likelihood	-39368.14	Hannan Quinn criter		2.748996
Durbin Watson stat	2.089481			
Inverted AR Roots	-.03			
Inverted MA Roots	.01			

T-GARCHSpot Exchange data USDINR

T-GARCH impact of good news and bad news of USDINR Spot exchange rate data at one period lag value. As Residual ARCH term SID(-1)^2*(RESID(-1)<0) is significant it means there is significant difference of positive information and negative information is asymmetrical concept of effectiveness of positive information and negative information. To ascertain the effect of Good news over bad news or effect of bad news over good news E-GARCH has applied.

Dependent Variable: D(US_DOLLAR)				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Date: 01/15/22 Time; 19:11				
Sample adjusted; 3 2374				
Included observations: 2372 after adjustments				
Convergence achieved after 39 iterations				
Coefficient covariance computed using outer product of gradients				
MA Back cast; 2				
Pre-sample variance;back cast (parameter = 0.7)				
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0)				
+ C(7)*GARCH(-1)				
Variable	Coefficient	Std Err	z-Stat	Prob
C	-0.000567	0.004530	-0.125219	0.9004

AR(1)	-0.549670	0.620697	-0.885570	0.3758
MA(1)	0.562973	0.614026	0.916855	0.3592
	Variance Equation			
C	0.001032	0.000226	4.571831	0.0000
RESID(-1)^2	0.141144	0.015721	8.978175	0.0000
RESID(-1)^2*(RESID(-1)<0)	-0.105337	0.016065	-6.556787	0.0000
GARCH(-1)	0.902227	0.008624	104.6123	0.0000
R squared	0.000366	Mean dependent var		-0.012147
Adjusted R squared	-0.000478	S.D. dependent var		0.280289
S.E. of regression	0.280356	Akaike info criterion		-0.005047
Sum squared resid	186.2025	Schwarz criterion		0.011985
Log likelihood	12.98552	Hannan Quinn criter		0.001153
Durbin Watson stat	2.026940			
Inverted AR Roots	-.55			
Inverted MA Roots	-.56			

E-GARCH Spot Exchange data USDINR

As coefficient of Lembda i.e. C(6) is T-GARCH term is significant it means impact of good news and bad news is significantly different also, as C(6) coefficient is positive and since its positive then it shows that on USINR spot exchange rates good news influences the exchange rate prices.

Dependent Variable: D(US_DOLLAR)				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Date; 01/15/22 Time; 19:17				
Sample adjusted; 3 2374`				
Included observations: 2372 after adjustments				
(Convergence achieved after 46 iterations)				
Coefficient covariance computed using outer product of gradients				
MA Backcast: 2				
(Pre-sample variance: back cast)(parameter = 0.7)				
LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)*RESID(-1)/@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))				
Variable	Coefficient	Std Err	z-Stat	Prob
C	0.002213	0.004394	0.503722	0.6145
AR(1)	-0.534180	0.603000	-0.885871	0.3757
MA(1)	0.547443	0.597019	0.916960	0.3592
	Var Eq			
C(4)	-0.166293	0.015054	-11.04646	0.0000
C(5)	0.173332	0.014491	11.96100	0.0000
C(6)	0.073610	0.010471	7.029781	0.0000
C(7)	0.987737	0.003212	307.5260	0.0000
R squared	-0.000509	Mean dependent var		-0.012147
Adjusted R squared	-0.001353	S.D. dependent var		0.280289
S.E. of regression	0.280479	Akaike info criterion		-0.009760
Sum squared resid	186.3654	Schwarz criterion		0.007272
Log likelihood	18.57593	Hannan Quinn criter		-0.003560
Durbin Watson stat	2.024905			
Inverted AR Roots	-.53			
Inverted MA Roots	-.55			

T-GARCH on USDINR_FT MCX Data

T-GARCH impact of good news and bad news of USDINR futures MCX data at one period lag value. As Residual ARCH term SID(-1)^2*(RESID(-1)<0) is significant it means there is significant difference of positive information and negative information is asymmetrical concept of effectiveness of positive information and

negative information. To ascertain the effect of Good news over bad news or effect of bad news over good news E-GARCH has applied.

Dependent Variable: D(USDINR_FT_MCX)				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Date; 01/16/22 Time; 13:15				
Sample adjusted : 3 28654				
Included observations: 28652 after adjustments				
Failure to improve likelihood (singular hessian) after 126 iterations				
Coefficient covariance computed using outer product of gradients				
MA Back cast: 2				
Pre-sample variance: back cast (parameter = 0.7)				
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)				
Variable	Coefficient	Std Err	z-Stat	Prob
C	0.014976	0.000225	66.61552	0.0000
AR(1)	0.684157	0.001235	554.0723	0.0000
MA(1)	-0.946876	0.000401	-2358.934	0.0000
	Var Eq			
C	0.025603	0.000182	141.0248	0.0000
RESID(-1)^2	6.156543	0.086744	70.97356	0.0000
RESID(-1)^2*(RESID(-1)<0)	-6.154109	0.086734	-70.95418	0.0000
GARCH(-1)	0.149020	0.001114	133.7830	0.0000
R squared	0.147985	Mean dependent var		-0.000931
Adjusted R squared	0.147926	S.D. dependent var		0.969401
S.E. of regression	0.894833	Akaike info criterion		1.333018
Sum squared resid	22940.01	Schwarz criterion		1.335037
Log likelihood	-19089.82	Hannan Quinn criter		1.333667
Durbin Watson stat	1.963948			
Inverted AR Roots	.68			
Inverted MA Roots	.95			

E-GARCH Results on USDINR_FT MCX Data

As coefficient of Lemda i.e. C(6) is T-GARCH term is significant it means impact of good news and bad news is significantly different also, as C(6) coefficient is positive and since its positive then it shows that on USINR futures exchange rates good news influences the exchange rate prices.

Dependent Variable: D(USDINR_FT_MCX)				
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Date; 01/15/22 Time; 19:31				
Sample adjusted: 3 28654				
Included observations: 28652 after adjustments				
Convergence achieved after 51 iterations				
Coefficient covariance computed using outer product of gradients				
MA Back cast: 2				
Pre-sample variance: back cast (parameter = 0.7)				
LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)*RESID(-1)/@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))				
Variable	Coefficient	Std Err	z-Stat	Prob
C	0.009831	0.000239	41.09336	0.0000
AR(1)	0.629556	0.001543	408.0918	0.0000
MA(1)	-0.942597	0.000450	-2092.785	0.0000
	Var Eq			
C(4)	-1.164066	0.005135	-226.6987	0.0000
C(5)	1.160633	0.009669	120.0422	0.0000
C(6)	1.176720	0.009304	126.4738	0.0000

C(7)	0.718243	0.001455	493.5140	0.0000
R squared	0.161421	Mean dependent var		-0.000931
Adjusted R squared	0.161363	S.D. dependent var		0.969401
S.E. of regression	0.887749	Akaike info criterion		1.506840
Sum squared resid	22578.24	Schwarz criterion		1.508859
Log likelihood	-21580.00	Hannan Quinn criter		1.507490
Durbin Watson stat	1.901273			
Inverted AR Roots	.63			
Inverted MA Roots	.94			

Conclusion: As applied by econometrics tools and studying carefully the results of the eviews its has been notice that the raw data of time series has unit root and it means there is stationarity at level and 1st difference series were found stationary. Also results of VAR and VECM shows that there is long run relationship between USDINR Spot exchange rate and USINR futures exchange data of MCX. Further, results of ARCH shows that both the time series data are variable in nature. As T-GARCH applied to know the effect of good news and bad then both the series were found significant and asymmetric to good news and bad news. Later E-GARCH shows that both the time series data USDINR spot exchange data and USINR futures exchange data taken from MCX are gets influenced by only good news their reacts positively to positive news of the markets.

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