

**EMPIRICAL ANALYSIS OF CURRENCY FUTURES AND SPOT MARKET IN
INDIA**

Thesis Submitted For the Award of the Degree of

DOCTOR OF PHILOSOPHY

**in
(Finance)**

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**LOVELY PROFESSIONAL UNIVERSITY
PUNJAB
2022**

DECLARATION

I, hereby declared that the presented work in the thesis entitled “Empirical Analysis of Currency Futures and Spot Market in India” in fulfilment of degree of **Doctor of Philosophy (Ph. D.)** is outcome of research work carried out by me under the supervision Dr. Govind Patra, working as Professor-Finance, in the Mittal School of Business of Lovely Professional University, Punjab, India. In keeping with general practice of reporting scientific observations, due acknowledgements have been made whenever work described here has been based on findings of other investigator. This work has not been submitted in part or full to any other University or Institute for the award of any degree.

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CERTIFICATE

This is to certify that the work reported in the Ph. D. thesis entitled “ Empirical Analysis of Currency Futures and Spot Market In India” submitted in fulfillment of the requirement for the reward of degree of **Doctor of Philosophy (Ph.D.)** in the Mittal School of Business, is a research work carried out by Ashwani Singh, _____ 41800997, is bonafide record of his/her original work carried out under my supervision and that no part of thesis has been submitted for any other degree, diploma or equivalent course.

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Acknowledgement

I express the deepest regards and gratitude from the all of my heart to my guide and supervisor, Dr. Govind Patra, Professor-Finance, Mittal School of Business at Lovely Professional University, Phawada, who motivated me lot to complete this research work and also inspired me to be a better human being. He supervised and provided his unconditional support for the successful completion of this study. I hold high regards for my guide for his all the motivational efforts and altruistic assistance for completing this research work in the best way possible and for bringing me in the right track whenever I am straggled. I shall be indebted to my guide forever for his caring and concern during my highest educational learning from this university. I also extend my gratitude and regards from the core of my heart to my Research Degree Evaluation Cell Member, for their guidelines, strict monitoring, valuable suggestions and remarks for the betterment of this research work during my study period. I do express my thanks to honorable Chancellor, Ashok Mittla and Pro-Chancellor Rashmi Mittal Lovely Professional University for giving me the opportunity to take up this study. I do thank to my friends like Mr. Manav Nanda, Mr. Ravi Kumar, Mr. Carol Rogers, Dr. Pradeep Suri, Mr. Shiv Shankar Tiwari, Mr. Rohit Dilawar, Mr. Sandeep Paul from my close group who were always supportive to me. I also thank to all those friends whose names are not written here but they helped me whenever I approached them for their helps during academic and non-academic moment. I avail this opportunity to express my special thanks to my wife Mrs. Swati Singh who was always supportive to me and looked after me like no one. Last but not the least, Thanks to my parents & God, I see the real because God has chosen this path for me, I struggled for many things during my childhood and scarified all comforts and happiness just to achieve highest Degree. I bow down to my God, He who always given His ears to my prayers, guided me and filled me with new energy to achieve this level (Doctorate level I, once again thanks to my guide and supervisor Dr. Govind Patra who not only guided, supervised and supported me during my research period but also inspired me to be good human being and made me to believe in the policy of “Hard work can never be substituted with any other thing”.

ASHWANI SINGH

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CHAPTER-I

INTRODUCTION AND RESEARCH DESIGN

1.1 Introduction

Global Financial markets and financial market services has opened a new avenue for various opportunities those are associated with risk and result in large volume cross border investments, remittance of funds, international financial services, cross borders employment generation and FOREX management. On the other hand, globalization of has made easy imports and strengthen the service industry globally. Also, globalization of financial markets resulted in a connected global financial system or connected financial markets which has made developing countries and under developing countries connect to the world economy. Globalization has brought all the economies under one umbrella of global economy. Which later developed the system of Global GDP, Trade Unions and FOREX etc. Small Economies has maximised their economic growth with globalization and participated in world economy.

But, the system of world economy or integrated financial system has increased the quantum of cross border transactions, which has increased the risk¹ magnitude associated with high volume cross border transactions. To minimise the risk exposures in cross border transactions, hedging has emerged as a new tool. Hedging with derivative instrument has become more popular to manage the transactional risk in international business.

Since one entity deals with multi-national working with different currency of each different country then Foreign Exchange risk arises because of continuous cross border transition to run the operations. Appreciation or depreciation in home currency and foreign currency puts negative and positive impact vice-versa. The risk scenario of whole world economy got changed by integration of countries' economies into world economy. This phenomenon has been seen in recent recessions events in US.

FOREX exchange rates are a value relationship between currencies of two countries. When two organizations or businesses from two different countries with their home currency initiate business that involve cash flow denominating in their home currency, that exposes organizations or businesses to foreign exchange risk. On rates which currently

¹ RBI (2008), Report of internal working group on currency futures, Mumbai, India.

getting exchanged from one currency to another is called as spot exchange rate or the Cash, rates which are agreed on current date and transaction would take place in future for delivery is called as forwards exchange rate.

There are several risk exposures in currency markets. Basically risk exposures are categories as²:

- Transaction Exposure
- Translation Exposures
- Operating Exposure

Transaction risk takes place when liabilities get increased because of high level of cross border trades and small change in exchange rates may affect financial position of an organization negatively because loss multiplies in huge cross border transactions. To avoid adverse effect on financial position of an organization what businesses do, they hedge their risk with an optimum hedging technique or strategic planning. Usually organizations use currency futures as hedging tool to minimise their transaction risk. At some cases transaction exposure is also called accounting risk where the value of assets, liabilities and income changes with changes in exchange rates.

The operating risk is directly proportionate to currency volatility. It increases with more volatile currency prices and decreases with price drops. For large organizations trading in multiple countries with multiple currencies operating risk is big. Though small organizations working with-in the country with same home currency may also face economic risk exposure. Only strategic planning can eliminate the economic risk.

The volatility of currency price or exchange price can dominate the cash flow of an organization and can result in uncertainty in future. To hedge the risk associated with organizations dealing with cross-border transactions Derivative instrument play a major role. The most important tool is Derivate market when multinationals get their cash flow effected because of adverse effect on exchange rate prices. Derivate is the financial contracts which has value derived from the underlying markets viz, stock price, commodity price, interest rates, exchange rate or index level etc.

² Doharing Bjorn (2008), „Hedging and invoicing strategies to reduce exchange rate exposure‘, -Economic and Financial Affairs||. Economic Paper - 299.

Derivatives instruments valued instruments used to hedge the financial risk management. They may be used on several occasions, like to hedge an existing market, to secure the financial investment when there is a probability of future drop in prices or as an insurance on some occasions of big investment decision making process.

1.2 Need and Motivation of the study

Indian currency markets have been always volatile in nature and positively co-related to their respective currency futures exchange rates. It has become necessary to hedge or manage the volatility of spot exchange rates to drop the rate of risk exposure associated with spot exchange rates effectively. Volatility of exchange rates made difficult for businesses to furcate the future cost and returns. Instrument of Derivative currency has widely used in currency markets and commodity markets to hedge the risks. Currency derivative was first introduced in Indian currency market in year 2008 but rapidly it has gained the market share for currency risk exposure management. Though currency derivatives have gained the popularity in currency markets in India and in last two decades in whole world. But, still there are few studies are available to estimate or establish significant relationship and details of its characteristics. Researches are available in context to US, Europe, Japan and Britain. Those researches are available in Indian context has limited work with observation, relationship establishment in context of one currency exchange rate with very limited data.

1.3 Research Gap

As result of review of literature it is found that enough emphasis has been given on Exchange Rate Volatility of nominal and real exchange rate and macroeconomic performance of the countries, studies also conducted on currency futures and established relationship with spot market but in respect of other than Indian countries. Few studies have been conducted to explore the relationship and exchange rate volatility of currency futures with spot exchange market but those are done to the limited time span. But now when if we look at Indian currency derivative market then currency futures have been started from year 2010 in four currency namely USDINR, EUROINR, GBINR, JPYINR and it has already been almost one decade and we found no significant and constructive study in this regard. There are numerous studies found to study derivative markets and emphasised on spot exchange rate of developed markets like US, Europe and Japan. Since India being a developing derivative market therefore the area of currency markets left least explored in

India. Therefore the proposed research proposal is an endeavour to explore the efficacy over spot exchange market from introduction of currency future market in India and this is an endeavour to fill the research gap with the proposed research proposal. The proposed study is an empirical study of Indian Currency Futures Market and its integration with spot exchange market. After an extensive literature review it has found there are few studies available on this topic and area because Currency Futures Market is an emerging market started from year 2008. Proposed research work is an endeavour to conduct an empirical study of Indian Currency Futures Market and its Interaction with sport exchange market.

1.4 Significance of the Study

This research work can be certainly helpful to the investors to comprehend volatility in currency market. This work can be helpful to understand investors and stakeholders that concept speculation in currency markets and investing with understanding of volatility effect and enhance the understanding of currency transactions. This research is an endeavour to offer new evidences on Currency Futures in Indian context.

1.5 Research Questions

- Does introduction of currency futures have any effect of spot rate?
- Does Price Discovery mechanism is appropriate in Indian Futures Market?
- Is there presence of Dynamic Relationship between Trading Volume, Market Depot and Price Volatility in Indian Currency Future Market?
- What is the Volatility behaviour of Spot Rate?

1.6 Objectives of the study

Presented research work has been carried out to give valid answers to the formulated research questions with focus on specific objectives for analysis.

- To explore the movement-pattern of spot exchange rate after introduction of currency futures in foreign exchange market in India.
- To study the price discovery mechanism in Indian currency future markets.
- To examine the dynamic relationship between price volatility, trading magnitude and market deepness for currency futures contracts in India.
- To forecast the currency spot price in Indian foreign exchange market

1.7 Data and Methodology used for the Study

This study relies only on secondary sources for its findings. We get our numbers from the Reserve Bank of India (RBI) and the National Stock Exchange of India (NSE). The need of a sample for a certain goal determines how large that sample will be. Information on the spot exchange rate of the US dollar to the Indian rupee (USDINR), the Euro to the Indian rupee (EURINR), the British pound to the Indian rupee (GBPINR), and the Japanese yen (JPYINR) from 2004 to August 2020 was gathered from the Reserve Bank of India's website (RBI) in order to investigate the spot exchange rate's trend after the introduction of currency futures in India's (Reserve Bank of India). Objective Two i.e. To study the price discovery mechanism in Indian currency future markets data of underlying market and currency futures USDINR has taken from RBI website and NSE 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 NSE. Second, to observe the spillover effect in both the time series data. Objective Three i.e. In order to analyze the dynamic relationship between price volatility, trading magnitude, and market depth for currency futures contracts in India, we use data from the NSE (National Stock Exchange) of USDINR futures prices from 29th October, 2010 to 31st August, 2020. For Objective Four, we use data from the RBI (Reserve Bank of India) Spot Exchange rate price of USINR, EURINR, GBPINR, and JPYINR in order to predict the currency spot price in the Indian foreign

The four contract periods available in currency futures trading are: the near month, the middle month, the weekly, and the distant month. Each of these four factors is taken into account in this study. Microsoft Excel and the statistical analysis program E-Views were used to examine the collected sample data.

Graphs, descriptive statistics, the Unit Root Test (ADF), the Johansson Co-Integration test, the Granger causality test, the Vector Error Correction model (VECM), and the impulse-response function are all used in the research process. The volatility has been modeled using the ARCH and GARCH models, and the Walts Test has also been used. The following is a summary of the approaches taken:

1.7.1. Unit Root Test

Presented study is based on secondary data of times series data. Data of exchange rate and other variables like currency future prices, open interest and trading volume of currency derivative is taken from NSE and RBI. Stationary time series is a precondition in econometric analysis of time series. Therefore, primary task was to check for Stationary of time series sets. In order to make data suitable for further analysis part series were made stationary first. Unit root tests and Augmented Dickey Fuller were used to first ensure Stationary in time series data (ADF). When both the mean and the standard deviation of a time series remain stable across several observations, we say that the series is stationary. This equation is used to calculate the unit root of an ADF: -

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

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

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

1.7.2. Johansson Co-integration Test

Test of Co-integration is definitely an important invention in the field of econometric analysis, it has wide implications and application specifically in Finance research arena in recent past. Two time series moves together and movement of one series is dependent or controlled by the movement of another time series that is called co-integration amount two time series data sets. X_t and Y_t are the statistical properties of co-integration in two time series in normal situations. Integration-1 denotes that the initial difference between two time series is an integration of order 1, indicating that the series are not level-stationary. If two or more time series variables are integrated to the same order and the linear combination of those series is stationary, then the series are said to be co-integrated. It indicates the existence of a steady connection between the variables. There are a few different names for the Johansen test.

1.7.3. Vector error correction model (VECM)

To find and examine the long-term relationships between variables in time series data, researchers often use a test of co-integration. Whether series are co-integrated, only then may they be used in the Vector Error Correction Model (VECM) to determine if the variables have a short-run connection; otherwise, a Vector Autoregressive Model (VAR) may be used. Since the supplied data are time series and were determined to be co-integrated, the VECM model is used to decipher the short-run connection between the variables.

1.7.4. Granger Causality Test

Test of granger causality is an econometric or statistical notion of causal relationship based on the estimation. Variables named X_1 causes another variable X_2 then previous value of variable X_1 ought to have information that helps to forecast variable X_2 . Granger 1969³ framed this mathematical structure on the concept of linear regression modeling of stochastic process. The concept of Granger Causality was invented in the year 1960 and then-after it has been applied extensively to check causality in Finance and economic. The Granger causality model was used in the provided study to trace the direction and directionality of the relationships between variables. The third goal, which is to investigate the dynamic connection between price volatility, trading volume, and market depth for currency futures contracts in India, is analyzed using the Granger Causality Test.

1.7.5. ARCH and GARCH model

Then job of least squares is a job of handyman in financial econometrics, econometricians basically needed to find out the degree of change in one variables in comparison of changes in other variable. Also, econometricians work on to estimate and analyse the level of errors present in the model. Volatility is calculated as a result of this data behavior, and the Auto-Regressive Conditional Heteroscedasticity (ARCH) and Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH) methodologies are the standard tools for gauging volatility in time series. ARCH and GARCH has come up as imperative tools

³ Granger C. W. J., _Investigating Causal Relations by Econometric Models and Cross-spectral Methods', -Econometrica- The Econometric Society]], Vol. 37, pp. 424-438

to analyse data in forecasting, time series volatility in finance research work. In presented study the tools have been used for model volatility of the currency futures prices.

1.8 Limitations of Study

Limitation of secondary daily data is collected for NSE currency derivative and RBI. Closing prices of currency futures and spot rate have been collected to conduct the presented research work. Data collected and processed is a secondary data in nature, primary data have not been used to conduct this research i.e. currency derivative trading therefore the presented research work has limitation of not taking its influence in results. Further, presented research work has taken spot exchange prices of all four currencies. Presented research work has limitation that study has variation in time frame for all four currency as USDINR time period is longer than other currencies i.e. EURINR, GBPINR and JPYINR. Also the financial stock 2007 to 2009 has been considered in study of USINR only but for other currencies i.e. . EURINR, GBPINR and JPYINR futures has not been considered.

1.9 Organization of the study: The presented study is organized into seven chapters.

- **Chapter I:** - The introduction, justification, problem description, research goals, sample strategy, findings, and caveats are all laid out here, along with an overview of the overall thesis outline.
- **Chapter II:** - This chapter discusses review of literature on Currency futures Market, Exchange rate volatility, the review pertains to ‘Price discovery mechanism in future and spot market’, ‘dynamics of relationship among trading volumes, market depth and price volatility’, ‘volatility effect between the different futures market and cash market’.
- **Chapter III:** - This chapter provides theoretical literature on derivative market in India and discussion on Currency Derivative-Futures and Options at NSE, including trading mechanism.
- **Chapter IV:** -This chapter is devoted to the detail descriptions of data and methodologies used under this study.
- **Chapter V:** - The purpose of this study is to investigate the pattern of change in the spot exchange rate after currency futures were introduced to the Indian foreign exchange market and Examine how prices are set in the Indian currency futures market.
- **Chapter VI:** - The goal of this analysis is to better understand the complex interplay

between currency futures contract price volatility, trading volume, and market depth in India.

- **Chapter VII:** - To forecast the currency spot price in Indian foreign exchange market
- **Chapter VIII:** - This chapter presents the major findings, conclusion and suggestion of study.

CHAPTER-II

REVIEW OF LITERATURE

Any financial market transaction for a future return exposes players to a variety of market risks. The danger can sometimes be multiplied by the purposeful efforts of a few manipulative people. The various risks involved in financial market transactions, particularly those caused by deliberate efforts, have compelled regulators to implement several changes in the operation of the financial markets environment (stock market and forex market as well), such as automated on-line trading in exchanges, as well as making available and possible trading terminals of national level stock exchanges across the country. As a result, the geographical location of an exchange has been immaterial, the settlement duration has been reduced, and the forex markets have been opened to foreign exchange portfolio investors, among other things. With the growing presence of foreign exchange portfolio investors, risk management devices to control foreign exchange risk exposure became necessary, and derivative in foreign exchange was the predicted financial market growth. With the intention of providing investors with risk management tools, India was one of the first developing economies in the South Asian region to offer derivative products on two of its primary existing exchanges, the NSE and BSE, in 2000.

In terms of economic and social consequences, the introduction of derivative trading at various available stock exchanges is seen from many angles. The introduction of derivatives had one effect in terms of enhanced efficiency and smoothing price volatility in the cash market. Another way to look at derivatives trading was its impact on increasing speculation in the futures market, which had a destabilising effect on spot market pricing.

Since the liberalization policies and structural reforms implemented by the government of India in 1991, the establishment of the derivative market in India has been the single most significant event in the growth of the country's capital market. Derivatives are widely recognized as having substantial importance to the financial market and to an economy's capacity to handle risk. Scholars, researchers, and practitioners alike have been rekindling their interest in derivatives and derivatives markets ever since the introduction of this new financial instrument into the securities markets. As a result, there has been a surge in recent years of both domestic and international empirical investigation of the derivatives market. This chapter compiles studies on derivatives, focusing on currency futures and the behavior of the related spot market in general, as well as the effects of the

introduction of futures on the underlying foreign exchange market. To provide the framework for the present inquiry, this chapter will look at some of the most influential studies conducted on foreign currency derivatives and stock derivatives.

To contribute to the body of knowledge, this in-depth research measures the symmetric and awry behavior of the spot market from an Indian viewpoint and investigates the link between price volatility, trading volume, and market depth in monetary futures markets. It is helpful to have a fundamental understanding of the connection between return and volume, which is often discussed in the academic material before diving into the details (regardless of explicit reference to open revenue as intermediary factors for estimating market profundity). This study aimed to focus in on the connection and exhibiting of uncertainty by obliquely investigating market expertise, market structure, financial backer behavior anomalies, and the significance of fates showcasing. The reviewers did extensive research on the subject at hand in order to identify the gaps in the literature.

In addition, the cost disclosure system in the Indian money prospective market is analyzed, as is the evolution of this system from the introduction of cash subsidiaries in the fundamental spot market.

2.1 Review of Literature of To explore the movement-pattern of spot exchange rate after introduction of currency futures in foreign exchange market in India.

Jose Saul Lizondo (1982)⁴ used regression mode to investigate the behaviour of foreign exchange futures markets under stable exchange rates and the anticipation of devaluation. It was discovered that a rising trend in futures prices depicts behaviour compatible with market efficiency, and that even in the absence of a risk premium, market participants properly predict the potential of a devaluation.

Clifton (1985)⁵ examined the ties that bind US currency futures markets to interbank FX trading. Findings from the research indicated that the interbank exchange market and currency

⁴ Lizondo, J. S., (1982), 'Foreign Exchange Futures Prices under Fixed Exchange Rate', -Journal of International Economics||, Vol. 14, pp. 69-84.

⁵ Clifton, E.V., 'The Currency futures Market and Interbank Foreign Exchange Trading', —The Journal of Futures Markets|| Vol. 5, pp. 375–384.

futures trading markets were highly intertwined. It was shown that a number of comparable reasons impact and explain the interdependence of the spot and futures markets. However, the data show that price fluctuations in the interbank market were also impacted by futures trading over the time, resulting in an increase in price volatility.

Kenneth L. Cavanaugh (1987)⁶ investigated price movements in currency futures markets. Their research methodology and approaches included the Liung-Box test, the Wilcoxon signed-rank test, Q-statistics, and autocorrelation. After testing Samuelson's sub-martingale and martingale models of value behavior in a realistic futures market, the authors found evidence of a positive sequential relationship following large price swings in four out of ten cash prospects contracts and evidence of a negative sequential relationship in the other six. The analysis reflected bias caused by institutional constraints on normal cost fluctuations. Mimicked trading based on out-of-sample forecasts reveals scenarios that futures market dealers may exploit to make net acquisitions much more than buy and hold.

Ieuan G. Morgan and Thomas H. McCurdy (1987)⁷ Study tested the martingale theory for five different currencies, looking at their daily and weekly rates of change in futures prices (BP, CD, DM, JY, and SF). Many different diagnostic procedures were carried out. Model specification, residual, and omitted variable tests were all a part of this battery of analyses. The GARCH model's depiction of conditional heteroskedasticity met these requirements in almost all cases. Possibly owing to a convoluted pattern in futures prices related to the day of the week, the Martingale hypothesis was found to be rejected for daily data, but the same fundamental pattern was accepted for weekly data in four of the five currencies in the sample.

A.G.Malliaris and Jorge L. Urrutia (1990)⁸ explored the variables that affect futures trading in the agricultural, metals, and financial markets. Soybeans and maize were among the agricultural commodities traded on the Chicago Board of Trade, while silver and gold were among those traded on the New York Comex, and Treasury-Bill and Treasury-Bond futures were among those traded on the Chicago Mercantile Exchange and the Chicago Board of Trade. From 1980 through 1986, entire monthly trade volume and prices were analyzed.

⁶ Kenneth L. Cavanaugh, (1987), 'Price dynamics in foreign Currency Futures Markets', -Journal of International Money and Finance, Vol. 6, pp. 295-314

⁷ McCurdy, T.H. and Morgan I.G., (1987), 'Testing the martingale hypothesis in deutsche mark futures with models specifying the form of heteroscedasticity', -Journal of Applied Econometrics, Vol. 3, pp. 187-202

⁸ Malliaris A.G. and Urrutia J.L., (1990), 'Economic determinants of trading volume in futures markets', -Economic Letters, Vol. 35, pp. 301-305.

Dickey and Fuller studies showed that trade volume was distributed randomly. The model's ability to explain data was considerably improved by include a large number of important economic factors that are updated weekly in the regression equation.

Hiemstra and Jones (1994)⁹ Using direct and nonlinear Granger causality tests, the analysts looked at the one-of-a-kind connection between daily Dow Jones stock returns, % developments on the New York Stock Exchange (NYSE), and trading volume. We used the tests to analyse the pace of change in NYSE trading volume and daily earnings from the Dow Jones from 1915 through 1946 and 1947 through 1990. Both examples show strong bidirectional nonlinear causality between stock returns and exchange volume, which is not definitively shown by the revised Baek and Brock test. It also investigated if the nonlinear causation between volume and stock returns seen by the modified Baek and Brock test may be a reflection of volume's role as a proxy for daily data stream in the stochastic cycle that produces stock return variation. The updated Baek and Brock test still accurately represents key instability effects, but it now reveals a significant nonlinear Granger connection between trading volume and stock returns. However, it is possible that non-direct hypothetical cycles and precise normalities were considered when exhibiting the intertwined components of stock prices and exchanging volume.

Antonios and Phil Holmes (1995)¹⁰ analyze the impact of FTSE-100 Stock Index Futures trading on spot market volatility. This study made use of the daily closing price indexes for the months of November 1980 and October 1991. Methods from the GARCH family were used to investigate the relationship between information and price fluctuations. From what we can tell, daily spot price volatility increased (possibly due to increased market awareness rather than speculators), which has destabilizing effects. This heightened volatility seemed to be a direct result of the enhanced accessibility of market information made possible by futures trading.

Brailsford Timothy (1996)¹¹ performed a controlled experiment to determine whether or not there is a connection between trading volume and stock return volatility on the

⁹ Hiemstra C. and Jones J. D., 'Testing for Linear and Nonlinear Granger Causality in the Stock Price-Volume Relation', -Journal of Finance||, Vol. 49, pp. 1639-1664

¹⁰ Holmes P. and Antonios A., (1995), 'Futures trading, information and spot price volatility: evidence for the FTSE-100 Stock Index Futures contract using GARCH', -Journal of Banking and Finance|| Vol. 19, pp. 117-129.

¹¹ Timothy, B. J. (1996) 'The Empirical Relationship between Trading Volume, Returns and Volatility', -Accounting and Finance||, Vol. 36, pp- 89-111.

Australian stock market between April 24, 1989 and December 31, 1993. In addition, a GARCH paradigm was used to examine trading volume in the light of conditional volatility. In the context of the Australian market, he examined the asymmetry model and the mixture of distributions hypothesis. The findings provide substantial support to the asymmetry theory. This result is consistent with the findings of Lamoureux and Lastrapes (1990), who demonstrated that the ARCH effect and persistence in variance were dampened when trading volume was included as an explanatory variable in the general ARCH model. These findings have implications for future studies that aim to predict return behaviour by analysing trade volume data. This suggests that the ARCH effects and most of the persistence in variance may have a rationale, and that this rationale may be proxied by the amount of trades.

Andersen (1996)¹² Using the concept of market microstructure, which proposes that traders' actions are driven by a combination of asymmetric information and liquidity demands, we demonstrate that the volatility of returns is positively correlated with the amount of trading. A continuously compounded daily return series was constructed using the closing prices of IBM common stock from January 1, 1973, through December 31, 1991 (a total of 4693 data points). This new framework modified the hypothesis of mixed distributions. The information flow was the primary motivator for the dynamic features, which were modelled as a stochastic volatility process and generalized conventional ARCH prerequisites. The improved performance of the updated MDH representation was confirmed through specification testing. The results show that the model works well for investigating the underlying economic factors of the returns' volatility clustering.

Chatrath, Ramchander, and Song (1996)¹³ We looked into how the volatility of spot exchange rates correlates with the volume of cash rates trading. The focus of this investigation expands on the existing body of knowledge in two ways; both involve the correlation between cash outcomes and spot rates. The volatility and futures trading volume of the British pound, the Canadian dollar, the Japanese yen, the Swiss franc, and the German mark are first analyzed (DM). Additionally, the analysis employs a measure of

¹² Andersen T. G., (1996), 'Return Volatility and Trading Volume: An Information Flow Interpretation of Stochastic Volatility', *Journal of Finance*, Vol. 51, pp-169-204.

¹³ Chatrath A., Ramchander S. and Song F., (1996), 'The role of futures trading activity in exchange rate volatility', *Journal of Futures Markets*, Vol. 16, pp. 561-584.

volatility that is consistent with the return dispersion of the most foundational monetary types. Bollerslev's (1986) Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model was demonstrated to be an acceptable proxy for unpredictability in scaling series swaps, as evidenced by the evidence presented here. It is shown how this process may also pinpoint times of volatility. Using a vector autoregressive estimator, we discover that trading currency outcomes significantly increases the volatility of currency exchange rates, whereas trading scale changes back to trading prospects has a much smaller effect.

Ming-Shiun Pana, Kam C. Chan, and Robert C.W. Fok (1997)¹⁴ examined the 1977–1987 futures prices of four different currencies using a random walk model. Chicago Mercantile Exchange International Monetary Market (IMM) currency futures values were obtained for the time period January 2, 1977 to December 31, 1987. (CME). The study mainly focused on currency futures for the British pound (BP), the German mark (GM), the Japanese yen (JY), and the Swiss franc (CHF) (SF). The significance threshold for the random walk hypothesis was determined via the use of the variance ratio test, asymptotic standardized statistics, and the bootstrap method. The findings found no evidence of non-randomness in the returns of currency futures markets, with the exception of Japanese yen futures. The combined substantial levels of variance ratio further supported this result. Last but not least, the identification of a random walk in currency futures prices suggested that the futures price was not an unbiased estimator of the future spot rate, lending support to the concept of employing the log of first-difference to achieve Stationary in the testing of various hypotheses in currency futures research.

In the currency futures market of the Singapore International Monetary Exchange, John M. Sequeira (1997)¹⁵ attempt to look at the possibility of long-term connections between the settlement prices of the three most-traded currency futures (the German Mark, the Japanese Yen, and the British Pound). From July 1986 through December 1993, the Singapore International Monetary Exchange (SIMEX) published daily statistics for four months: March, June, September, and December contracts for British Pound (BP), German Mark

¹⁴ Pana M.S., Chan K. C. and Fok R. C.W., (1997), ‘Do currency futures prices follow randomwalks?’, -Journal of Empirical Finance|| Vol. 4, pp. 1-15.

¹⁵ John M. Sequeira, (1997), ‘Econometric modeling of long-run relationships in the Singapore currency futures market’, -Journal of Mathematics and Computer in Simulation||, Vol. 43, pp. 421- 427

(DM), and Japanese Yen (JY). Vector autoregressive (VAR) analysis and the co-integration test were carried out. Using the improved Dickey-Fuller test, we checked whether or not each series exhibited Stationary, and we discovered that they did not. Co-integration among settlement prices as a proxy for these underlying long-run economic linkages was also explored. The long-term relationships between the variables were not found by cointegration tests or vector autoregressive models of return rates. Thus, no data was found to support the hypothesis that there was a long-term relationship between the prices at which currency futures settled in Singapore.

Arjun Chatrath and Bahram Adrangi (1998)¹⁶ determined how the biggest group of future traders responded to fluctuations in the currency rate by looking at both contract holdings and use. The inability of prior research on futures trading and the relationship between exchange rate variability to provide a definitive answer as to whether or not a given group of traders stabilizes or destabilizes the spot market prompted this investigation. The research looked at the four main currencies from January 1, 1986, to November 11, 1996: the British pound (BP), the German mark (DM), the Canadian dollar (CD), and the Japanese yen (JY). Almost all futures trading in foreign exchange is done in these four currencies. An ARIMA model was employed to separate daily volume into normal, abnormal, and moving average fluctuations. Using regression analysis, the authors then demonstrated that the unpredictable element of futures activity was disruptive, while the predictable element was not. The conditional variance was calculated using the generalized autoregressive conditional heteroskedasticity (GARCH (1, 1)) model proposed by Bollerslev (1986). The findings showed that the currency market had not become more volatile despite the ongoing growth in futures contracts; rather, it had led to a greater involvement of both large speculators and small traders, further destabilizing the markets. It was also shown that releasing information about traders' commitments did not affect volatility, suggesting that the positive relationship between the short-term components of speculative and small traders' commitments and exchange rate volatility appeared to stem from trading mechanisms rather than traders' commitments (COT). This research used the same GARCH model as that of Chatrath, Ramchander, and Song (1996).

¹⁶ Adrangi B. and Chatrath A., (1998), 'Futures Commitments and Exchange Rate Volatility', -Journal of Business Finance & Accounting, Vol. 25, pp. 501-521

Christian Jochum and Laura Kodres (1998)¹⁷ looked at whether or not currency futures trading affected underlying currency values. The effects of introducing futures contracts for the Mexican peso, Brazilian real, and Hungarian forint on their respective cash markets were experimentally studied. For the purpose of studying the short- and long-term connections between the two markets, the Granger causality test, the Vector Error correction model with Impulse response function, and the variance decomposition function were used. Volatility in the spot market was modeled with the use of the Switching ARCH (SWARCH) Model. Currency crises and other large swings in the exchange rate were previously thought to be best captured by the SWARCH framework developed by Hamilton and Susmel (1994). The results disproved the hypothesis that the futures and spot markets develop independently. Spot market volatility was shown to be poorly explained by futures volatility, and it was found that volatility did not increase with the introduction of futures.

Vincent Bodart and Paul Reding (1999)¹⁸ sought to break down what impact the swapping scale system and the going with level of conversion standard modification may have on the unforeseen volatility and worldwide interconnections of security and financial transactions. It examined whether significant differences in volatility patterns and international correlations could be identified across alternative sub-periods of ERM (Exchange Rate Mechanism) exchange rate variability or between countries that were on a credible peg with the DEM (Dropout Exchange Rate Mechanism) for the majority of the period (those countries which dropped out of the ERM). Correlation analysis and volatility models such as GARCH (1,1) were utilised to analyse and explore the pattern of exchange rate mechanism. The study revealed that a rise in ERM exchange rate volatility produces a significant decline in the conditional correlation of daily bond market returns between Germany and the other European nations. This conclusion was found to be consistent with the hypothesis that fixed exchange rates optimise international bond market correlations by enforcing strong domestic monetary policy coordination. While the study suggested that stock correlations with Germany were influenced by the degree of exchange rate volatility,

¹⁷ Jochum C. & Kodres L. (1998), 'Does the Introduction of Futures on Emerging Market Currencies Destabilize the Underlying Currencies', IMF Working Paper, Vol. 98.

¹⁸ Bodart V. and Reding P., (1999), 'Exchange Rate Regime, Volatility and International Correlation on Bond and Stock Markets' — Journal of International Money and Finance, Vol. 18, pp. - 133-151.

the evidence was less compelling. This finding might be attributable to a greater impact of unusual shocks on the behaviour of domestic stock prices.

Hung-Gay Funga and Gary A. Patterson (1999)¹⁹ During trading hours and off-market periods, the patterns and features of data flow across currency futures markets were analyzed. The analysis used futures on the Canadian dollar (CD), German mark (DM), Japanese yen (JY), British pound (PS), and Swiss franc (CHF) from 1977 to 1994. (SF). Both during trading hours and off-market periods, the researchers identified substantial information transmission between currencies using Vector Autoregressive Analysis (VAR). During trading hours and off-market times, the pattern of information flow across markets was found to be quite consistent. According to the results of this study, the financial markets do not care about the timing or origin of news. When determining prices, the US currency futures market treats all available data equally. This study also discovered that currencies have several purposes in international trade. According to the statistics, the British pound was the quickest to react to data from other currency futures, followed by the German mark and the Swiss franc.

Ioannis Asimakopoulou, David Ayling, and Wan Mansor Mahmood (2000)²⁰ explored the two together by employing a non-linear causality test for currency futures. This research looked at the daily changes in the value of the British pound, the German mark, the Japanese yen, and the Swiss franc versus the US dollar from January 1986 to April 1997. This study used daily returns on four different currency futures to discover a significant unidirectional non-linear Granger causality relationship among the four different currencies, indicating market inefficiency due to the fact that changes in one currency's futures return can be predicted using lagging information from another currency's futures return. Taking into account the persistence of variation for each currency return, the researchers discovered far weaker associations, suggesting that omitting a common piece of information may produce erroneous results. The results demonstrated a non-linear, causal link in just one direction across all four currencies.

¹⁹ Funga H. G. and Patterson G.A.,(1999), 'Volatility linkage among currency futures markets during US trading and non-trading periods' -Journal of Multinational Financial Management||, Vol. 9, pp. 129-153.

²⁰ Asimakopoulou I. , Ayling D. and Mahmood W.M., (2000) 'Non-linear Granger causality in the currency futures returns' -Economic Letters||, Vol. 68, pp. 25-30

However, the authors found statistically negligible and weaker non-linear causal relationships after filtering the returns using a GARCH (1, 1) model.

Rohan C. David and Mukesh Chaudhary (2000)²¹ we looked at the movements in BP, CD, DM, JPY, and CHF futures contracts in response to domestic macroeconomic news releases (SF). Data shows a response from all five futures to macroeconomic news, particularly when it is provided first thing in the morning (about 7:30). (CST). Daily intraday futures data for the five instruments (BP, CD, DM, JY, and SF) were collected from January 3, 1994, to December 30, 1996, at 15 minute intervals. All five currency futures were purchased via the CME's IMM division. The experiments showed that information on the employment market, the trade deficit, industrial production, and capacity utilization influenced all five futures, but information about other announcements did not. Shortly, the announcement's effect on volatility will begin to fade. Five different devices provide varying amounts of these benefits.

Kit Pong Wong (2003)²² investigated the best hedging strategy for a competitive exporting business under hedgeable exchange rate risk and non-hedgeable pricing risk. The company has used a variety of risk-sharing products, including currency futures and options. It was discovered that the hedging component of currency options was caused by two independent sources of non-linearity: first, the multiplicative nature of price and exchange rate risk, and second, the firm's marginal utility function. The researcher demonstrated that a long put option position was part of the best hedging strategy for the company.

Minho Kim and Minchoul Kim (2003)²³ We analyzed the patterns and consequences of implied volatility in the spot markets for the German Mark (DM), Japanese Yen (JY), Swiss Franc (SF), British Pound (BP), and Canadian Dollar using a daily data set spanning the 12 years from 1987 to 1998. (CD). As a result, the study looked at how futures contracts for

²¹ David R. C. and Chaudhary M (2000) 'Currency futures, news releases, and uncertainty resolution',

-Global Finance Journal, Vol. 11, pp. 109-127.

²² Wong K. P., (2003), 'Currency hedging with options and futures', -European Economic Review, vol. 47, pp. 833-839.

²³ Kim M. , Kim Min., (2003), 'Implied volatility dynamics in the foreign exchange markets',

-Journal of International Money and Finance, Vol. 22, pp. 511-528.

currencies' implied volatility relates to the profits investors might expect from buying or selling such contracts. The authors also investigated whether or whether the scheduled macroeconomic announcements had an effect on implied volatility and intraweek movements on the announcement day. Regression and the Black-Scholes option pricing model were used to futures contracts and the spot currency market to determine the effect and linkage of currency options. Regardless of the direction in which a currency's value is moving, the estimation findings revealed that market players expect a higher level of volatility in the future. To put it another way, it is assumed that more implied volatility would result from additional dollar appreciation and depreciation in relation to other currencies. It was also shown that implied volatilities are low on Mondays and Tuesdays, but high on Wednesdays and Thursdays, remaining high over the weekend.

M. T. Raju and Kiran Karande (2003)²⁴ carried out studies on the Indian stock derivative market's price discovery function and volatility modeling. In the first part of the research, the authors looked into and attempted to quantify price discovery to determine whether it was happening in the futures market. Stock index futures and spot markets were the only topics of study. From June 2000 through October 2002, index futures and the BSE 100 Index were employed as independent variables in this analysis. The unit root test was performed to ensure that the data were stationary, and the Johansson Co-integration test was used to determine whether or not the two variables were indeed co-integrated. Volatility was characterized via the use of Auto-Regressive Conditional Heteroscedasticity (ARCH) and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) models in the second half of the study (GARCH). Data analysis revealed that when equilibrium is disrupted, it is the futures market that responds, not the spot market. In addition, the findings demonstrated that the futures market reflects news ahead of the spot market. Moreover, the findings demonstrated that volatility in the spot market has been mitigated since the introduction of stock index futures.

Niclas Hagelin (2003)²⁵ investigated the usage of currency derivatives by Swedish enterprises in order to give empirical information on the factors of firms' hedging actions.

²⁴ Raju M. T. , and Karande K., 'Price Discovery and Volatility on NSE Futures Market' -Securities and Exchange Board of India|| Working Paper Series No. 7.

²⁵ Hagelin, N., (2003), 'Why Firms Hedge with Currency Derivatives: An Examination of Transaction and Translation Exposure.' —Applied Financial Economics||, Vol. 13, pp. 59-69.

The study combined survey data with publicly accessible data. The use of survey data allowed us to distinguish between currency derivative usage targeted at hedging translation exposure and usage intended at hedging transaction exposure. It is of relevance because translation exposure and transaction exposure affect businesses differently. Wilcoxon rank sum tests, tobit regressions (Probit analysis (i.e. the choice to hedge), and a shortened regression were employed in the analysis (i.e. the regression equation for non-zero outcomes). The findings were consistent with the hypothesis that companies use currency derivatives to boost company value by lowering the indirect costs of financial crisis or relieving the underinvestment problem. There was no evidence to support the idea that translation exposure hedges are utilised to boost business value.

Marcia, Thomas V., and Andrew C. (2004)²⁶ investigated the inter-day and intraday return characteristics of International Monetary Market foreign exchange futures markets from 1977 to 1991. Foreign currencies such as the Swiss franc, Japanese yen, Canadian dollar, and German mark were examined (CD). Descriptive statistics and a chi-square test were used for analysis in this research. Findings showed that small daily returns were often the result of large overnight losses and large trading day gains. Intraday, foreign currencies strengthened most strongly during the first and end hours of the U.S. trading day. It was also shown that there is a large amount of variation in the patterns of currency returns across different asset classes.

Changyun Wang (2004)²⁷ The CAPM and the Simple Regression Model were applied to an analysis of trader position data for futures contracts on the British pound, Canadian dollar, German mark, Japanese yen, and Swiss franc traded on the Chicago Mercantile Exchange's International Monetary Market between January 1993 and March 2000. When trading volume was recast as a gauge of sentiment, a positive association between optimism and financial gains was discovered. Those who adopted a "hedge" mindset, on the other hand, reacted unfavorably to projections of future profits. Moreover, we found that strong sentiment by trader type was more indicative of future market moves than moderate emotion. Based on the findings, it seems that hedge funds and other institutional investors

²⁶ Cornett M.M., Schwarz T.V. and Szakmary A.C., (1995), 'Seasonalities and intraday return patterns in the foreign currency futures market', -Journal of Banking & Finance||, Vol. 19, pp. 843-869

²⁷ Wang C., (2004), 'Futures trading activity and predictable foreign exchange market movements',

-Journal of Banking & Finance||, Vol. 28, pp. 1023-1041.

often do worse than individual speculators in these futures markets. Futures risk premiums were determined using equilibrium pricing models that factored in both market risk and hedging demand. The belief was that speculators ought to be rewarded financially for taking the risk they did. The results showed that the benefits made by speculators may be largely attributed to the risk premiums applied to futures contracts. Therefore, the good results seen by speculators did not seem to disprove the EMH. Based on the results of conventional hypothesis testing (t-statistics), the DM futures market is inefficient since speculators have some prediction ability.

Michael Ehrmann and Marcel Fratzscher (2005)²⁸ We looked examined the role that real-time data had in the correlation between economic fundamentals and currency rates and found that economic news from the US, Germany, and the Eurozone significantly influenced daily changes in the USD/EUR/DEM exchange rate between 1993 and 2003. It was shown that the larger significance of US macroeconomic news may be at least partially attributed to the fact that it is released sooner than comparable German and Eurozone news. When market volatility is strong or when major negative shocks occur, the exchange rate also looks to be more reactive to the news. Overall, the model using real-time data was demonstrated to be able to describe around 75% of the monthly directional changes in the US dollar-euro exchange rate, however it could not adequately explain the size of the exchange rate changes.

Jussi, Petriand, and Sami (2006)²⁹ investigated the links between projected futures volatility and key European currencies. Volatility expectations suggested by currency options were examined for this purpose. The study used data from a sample period that began on January 2, 2001, and ended on September 29, 2003. In terms of daily trading volume and economic importance, the Euro, British pound, and Swiss franc were selected as the most significant European currencies to examine. Determining whether or not the inferred volatilities time series is stationary was done with the use of the improved Dickey-Fuller and Phillips-Perron unit root tests. Using vector autoregressive modeling, the dynamics of implied volatilities across currencies were analyzed. ConclusionsThe results

²⁸ Ehrmann M. and Fratzscher M. (2005), 'Exchange rates and fundamentals: new evidence from real-time data' -Journal of International Money and Finance||, Vol. 24, pp. 317–341

²⁹ Nikkinen J., Sahlstrom P. and Vahamaa S., (2006), 'Implied volatility linkages among major European currencies', -International Financial Markets, Institution and Money||, Vol. 16, pp. 87– 103.

indicated a strong correlation between market expectations of future exchange rate volatility for the main European currencies. It was also shown that forecasts of volatility for the British pound and the Swiss franc are significantly affected by the implied volatility of the euro. Furthermore, the results showed that Euro volatility expectations are independent of the movements of other currencies.

Toshiaki Watanabe (2010)³⁰ Futures contracts traded on the Osaka Securities Exchange (OSE) for the Nikkei 225 stock index were analyzed to identify the relationship between open interest, trading volume, and price volatility. In this analysis, we used the approach taken by Bessembinder and Seguin (1993) to examine volatility. In order to analyze the relationship between volatility, volume, and open interest across time, a vector error correction model (VAR) was used. Volatility was shown to have a substantial positive association with unanticipated volume and a considerable negative correlation with anticipated open interest. There was no link between price volatility, volume, or open interest during the period when regulation was rising quickly. This may be an indication that the rules have an effect on the relationship between price volatility, volume, and open interest.

Somnath Sharma (2011)³¹ checked for links between currency futures activity and changes in the spot market exchange rate. The current USD/INR exchange rate was utilized with the latest traded prices of currency futures contracts in the analysis. The RBI gave the most current currency rates, while the National Stock Exchange (NSE) provided futures data for the Indian Rupee versus the US Dollar with expiration dates in the following month. Different methods were used to analyze the volatility pattern of the spot exchange rate with respect to the USDINR. Descriptive statistics were used for simple statistical inference, and econometric tools such as the unit root test, Granger causality test, and GARCH model were used to ascertain whether or not spot and futures price volatility were connected. Evidence was found linking fluctuations in spot exchange rates to activity in the currency futures market and vice versa. Numerous models from the GARCH family of volatility analysis were applied to the USDINR, but only the GARCH (1,2) model was determined

³⁰ Watanabe T., (2010), 'Price volatility, trading volume, and market depth: evidence from the Japanese stock index futures market', —Applied Financial Economics, Vol. 11, pp. 651-658.

³¹ Somnath Sharma, (2011), 'An Empirical Analysis of the Relationship between Currency Futures and Exchange Rates Volatility in India', —The Reserve Bank of India (RBI) WP (DEPR) 1||.

to be a good fit. Cetin Ciner(2011)³² frequency domain studies to study the correlation between currency futures markets for both returns and volatility. Through an analysis of high and low frequency dynamics, this study differentiates between enduring and fleeting relationships in the market. Currency futures contracts on the Chicago Mercantile Exchange were analyzed, specifically the daily closing prices of contracts for the euro, yen, British pound, and Swiss franc. The research included 2736 observations from January 5, 1999 to June 30, 2009. Multiple statistical methods, including the ADF and KPSS tests, co-integration analysis, and bivariate VAR models, were used to the futures market return. Specifically, the results showed that there were large return and volatility spillovers across different currency futures markets. The paper also highlighted the need of differentiating causal linkages at various frequencies rather than relying on a time domain summary statistic. This study demonstrated that there are persistent spillovers of volatility across different currency markets. Moreover, the evidence showed that the most important advances in currency futures markets occurred in the Euro market during the current Euro financial crisis.

Ashima Goyal and Sanchit Arora (2012)³³ We compared the impact of Central Bank communication on exchange rate level and volatility to that of traditional monetary policy measures, like interest rate intervention and other quantitative measures, using dummy variables in the best of a family of GARCH models estimated with daily and monthly data from India. Although India maintains a controlled float for its currency, changes in the Euro/Dollar exchange rate have been demonstrated to have a considerable impact on the level and volatility of the Rupee/Dollar. There is a substantial upward unexpected consequence of the interest rate disparity.

Dhananjay Sahu (2012)³⁴ examined how trading in currency futures affects volatility in the spot market. This study compared the volatility of the INR-EURO exchange rate before and after the establishment of currency futures trading in India. In February of 2010, the EUROINR exchange rate and currency futures were launched, and the author took advantage of both. He studied the EUR/INR exchange rate data every day from January 2,

³² Cetin Ciner, (2011), 'Information Transmission across Currency Futures Markets: Evidence From Frequency Domain Tests', -International Review of Financial Analysis||, Vol. 20, pp. 134–139.

³³ Goyal A. and Arora S., (2012), 'The Indian exchange rate and Central Bank action: An EGARCH Analysis', -Journal of Asian Economics|| Vol. 23, pp. 60–72.

³⁴ Sahu Dhananjay , (2012) 'Dynamics of Currency Futures Trading and Underlying Exchange rate Volatility in India', -Research Journal of Finance and Accounting||, Vol. 3, pp. 15-23

2008, through December 31, 2011. The data warehouse of the Reserve Bank of India was mined for the time series information. The results were derived using a variety of quantitative econometric techniques. Examples include the Unit Root Test and the software packages ARCH, LM, and GJR GARCH (1, 1). From what we can see, futures trading in currencies on the Indian forex market did not calm the market's extreme swings in the spot exchange rate. There has been an increase in volatility due to fresh news, and the influence of old news appears to be waning due to the rise of currency futures trading.

In their study and analysis of the long-term link between spot and future currency values, M.Sriram and M.Senthil (2013)³⁵ (Dollar). From June 1, 2009, to July 10, 2013, data for this study were gathered from the NSE and RBI. The quantitative analysis made use of a wide variety of statistical and econometric techniques, such as the unit root test for Stationary, the Block Exogeneity test to investigate the short-term causality relationship between the spot and futures markets of the currencies, the Johansen's Co integration test to simulate the volatility of exchange rates, and the GARCH(1,1) test to quantify the effect of volatility spillovers. The results demonstrate a long-term correlation between the USDINR spot price and its future values, and it was found that the spot price is what stabilizes the market. A similar conclusion was reached for the currency futures market, where the spot effects the future. It seems that volatility spread from the spot price to the futures price, but not the other way around.

2.2 Literature Review of To examine the dynamic relationship between price volatility, trading magnitude and market deepness for currency futures contracts in India.

In their 1992³⁶ Hendrik Bessembinder and Paul J. Seguin conducted a research to determine the relationship between the volume and open interest of futures trading and the volatility of stocks. The authors have made an attempt to understand whether the volume of futures trading

³⁵ Sriram M. and Senthil M., (2013), „Market Efficiency and Volatility Spill over in Spot & FuturesCurrency Market‘, -International Journal of Management Excellence||, Vol. 1, pp. 45-53

³⁶ Bessembinder H. And Seguin P.J., (1992), „Futures-Trading Activity and Stock Price Volatility‘, -The Journal of Finance||, Vol. 47, pp. 2015-2034.

will have an effect on stock price volatility. The daily data of the S&P 500 index from January 1978 to September 1989 was used to analyze the volatility of the spot market for equities. The volatility in this study was measured using the ARIMA and GARCH models. The trading volumes during that time period in the spot and futures markets were discovered to be positively correlated with equities volatility. Additionally, it was shown that unexpected spot trading volume significantly increases volatility compared to predicted spot trading volume.

Volatility persistence, asymmetries in the volume-volatility connection, and interactions between conditional return means and conditional return volatilities are all factors that may be accounted for with the use of econometric methods. Bessembinder & Seguin (1993)³⁷ studied the correlations between trading volume, volatility, and market depth in eight different futures markets (both physical and financial). The time frame analyzed in this study was from May 1982 to March 1990. There is evidence to suggest that linking volatility and volume may not provide complete information extraction. When looking at the anticipated and unexpected parts of volume, it was revealed that the unexpected parts had a greater effect on volatility. As an added bonus, the connection was asymmetric, with positive unanticipated volume shocks having a larger impact on volatility than negative ones.

Following the technique created by Bessembinder and Seguin (1992, 1993), Rangunathan & Peker (1997)³⁸ In order to learn more about the connection between volume, price volatility, and market depth, data from four futures contracts traded on the Sydney Futures Exchange between January 1992 and December 1994 was examined. He divided the volume and open interest shocks into expected and unanticipated components and then studied the resulting asymmetry. With the skewed link between volume, open interest, and volatility in mind, this study set out to quantify the effects of unexpected trading activity. The results showed that volume shocks in the positive direction had a more significant effect on volatility than volume shocks in the negative direction. When examining open interest shocks, the same result was discovered: a positive shock has a greater potential to affect volatility than a negative shock. It followed that the extent of a market has an impact on the volatility of that market. The currency futures market for the Canadian dollar, German mark, Japanese yen, Pound sterling, and Swiss

³⁷ Bessembinder H. And Seguin P.J., (1993), „Price Volatility, Trading Volume, and Market Depth: Evidence from Futures Markets‘, -The Journal of Financial and Quantitative Analysis||, Vol. 28, pp. 21-39.

³⁸ Rangunathan V. & Peker A., (1997), „Price variability, trading volume and market depth: evidence from the Australian futures market‘, —Applied Financial Economics||, Vol. 7, pp. 447-454.

franc was examined by Hung G. Fung and Gary A. Patterson (1999)³⁹ date range from June 1977 to March 1994. This study examined the dynamic connection between return volatility, trading volume, and market depth across five distinct currency futures markets using vector autoregressive analysis. Since there is a positive link between volume and return volatility, they also performed Granger causality tests to figure out whether the information flowed in just one way. When examining their present values using an F-test, it was shown that volatility, trading volume, and market depth all had strong autoregressive components, suggesting that they have been following a consistent pattern over time. It was also discovered that high levels of trading activity and market depth significantly dampen the effect of return volatility. In addition, it was shown that the relationship between trading volume and return volatility is more robust than that between open interest and return volatility. This finding runs counter to the findings of Chen et al. (1995), who found a robust association between open interest and volatility over the long term and in the here and now. It was shown that neither volume nor depth were determined endogenously due to the imbalance in the lead-lag linkages between the two.

For the key nine national stock indexes from 1973 to 2000, Gongmeng Chen, Michael Firth, and Oliver Rui (2001)⁴⁰ evaluated how changes in return, volume, and volatility are interrelated. The relationship between return rates, trading volumes, and conditional volatility was examined using a wide variety of statistical tools such the quadratic time trend analysis, the Augmented Dickey Fuller test, regression, vector auto regression (VAR), and EGARCH analysis. The data showed that the absolute magnitude of the stock price movement was significantly correlated with the volume of trades. Granger causality tests showed that volume causes returns and returns cause returns in certain nations. Conclusions drawn from this research include that knowing more about the stock market may be attained by evaluating the combination dynamics of stock prices and trading volume than by concentrating on the univariate dynamics of stock prices alone, and that trading volume adds to the returns process. Strong evidence that the patterns of return, trading volume, and volatility seen are universal is provided by the uniformity of the data across all nine stock markets.

³⁹ Fung H.G. and Patterson G.A., (1999), 'The dynamic relationship of volatility, volume, and market depth in currency futures markets', *Journal of International Financial Markets, Institutions and Money*, Vol. 9, pp. 33–59

⁴⁰ Chen G.M., Firth M., and Rui O.M., (2001), 'The Dynamic Relation between Stock Returns, Trading Volume, and Volatility', *The Financial Review*, Vol. 38, pp. 153-174.

Toshiaki Watanabe (2001)⁴¹ For the sample period of 24 August 1990-30 December 1997, we used the approach described by Bessembinder and Seguin (1993) to analyze the relationship between price volatility, trading volume, and open interest for Nikkei 225 stock index futures traded on the Osaka Securities Exchange. (OSE). Due to frequent changes in margin requirements, price range, and quote update intervals, the OSE was investigated for its role in the trading of Nikkei 225 futures. It was determined that the samples collected before and after February 14, 1994, could be studied separately. It was shown that price volatility, volume, and open interest had no association before to February 14, 1994, when the regulation began to slowly increase.

During the Asian and developing market financial crises of the 1990s, Hue Hwa AuYong, Christopher Gan, and Sirimon Treepongkaruna (2004)⁴² We looked at the degree of co-mixing, the existence of change, and the directional causes of foreign currency exchange rates. Fourteen different currencies were used for the analysis: the Hong Kong dollar (HKD), the Japanese yen (JPY), the South Korean won (KRW), the Taiwanese new dollar (TWN), the Chinese renminbi (CHR), the Indonesian rupiah (IDR), the Malaysian ringgit (MYR), the Philippine peso (PHP), the Singapore dollar (SGD), the Thai baht (THB), the Argentine pe (RUR). This data index includes events from January 3, 2001, through December 31, 2001. Using Engle and Granger's unambiguous bivariate investigation and Johansen's multivariate co-mix, we evaluated the foreign exchange rates during the crises that occurred in 1994 in Mexico, 1997 in Asia, 1998 in Russia, and 1999 in Brazil. In addition to the use of the Granger causality test, the paper also makes use of the drive response analysis to evaluate the FX rates' causation structure. According to the research, the Mexican emergency of 1994 saw the disappearance of many pre-Mexican causalities and the emergence of a large number of new causalities, while the Asian disaster of 1997 had far-reaching spillover repercussions on the latter stages of the Russian and Brazilian crises.

⁴¹ Watanabe T., (2001), 'Price volatility, trading volume, and market depth: evidence from the Japanese stock index futures market', —Applied Financial Economics, Vol. 11, pp. 651-658.

⁴² AuYong H.H., Ganb C. and Treepongkaruna S., (2004), 'Cointegration and causality in the Asian and emerging foreign exchange markets: Evidence from the 1990s financial crises', —International Review of Financial Analysis, Vol. 13, pp. 479 – 515.

Otavio Medeiros and Bernardus Van Doornik examined the precise relationship between stock returns, return instability, and trading volume for the Brazilian financial market. (2006)⁴³ in effect from March 1, 2000, to December 28, 2005. Analysis of covariance (ANCOVA), analysis of variance (ANOVA), tests of causality, and correlation analyses were among the statistical approaches used (Granger). The volume of stock trades was positively correlated with stock price returns in a cross-correlation study. Granger-causality was added to the data, but it still showed no evidence that trading volume was related to stock returns. Research employing simultaneous equations, however, demonstrated that stock returns are dependent on trade volume. Our knowledge of the inner workings of developing stock markets is enhanced by this finding.

For Stock Index Futures and Crude Oil Futures contracts traded between 15 December 1995 and 19 January 2001 at the Kuala Lumpur Option and Financial Futures and Commodity and Monetary Exchange, Mahmood & Salleh (2006)⁴⁴ evaluated the connection between profit, trading activity, and market size. They performed an experiment that tested two standard assumptions. Let us start with the question, "Does the sequential introduction of new information into the market impact trading volume and price?" The second one wonders whether information may be considered a mixing variable and so tests the mixture of distribution hypothesis. They used GARCH for analysis, and then ran a battery of diagnostic tests on the data, including the Unit Root Test, the Ljung-Box Test, and the ARIMA model (10, 1, 0). (1, 1).

2.3 Literature Review of To study the price discovery mechanism in Indian currency future markets.

The features of price fluctuations in cash (or spot) markets and futures markets for storable commodities were examined by Kenneth D. Garbade and William L. Silber in 1983⁴⁵. To analyse the price discovery mechanism, the futures and spot closing prices of a variety of commodities, including wheat, corn, oats, orange juice, copper, gold, and silver, were utilised

⁴³ Medeiros O., & Doornik B.V., (2006), 'The Empirical Relationship between Stock Returns, Return Volatility and Trading Volume in the Brazilian Stock Market', -Brazilian Business Review, Vol. 5, pp. 1-17.

⁴⁴ Mahmood W. M. and Salleh S.H.A., (2006), 'The Dynamic Relationship between Price Volatility, Trading Volume and Market Depth: Empirical Evidence from the Malaysian Futures Market', -The Icfai Journal of Derivatives Market, Vol. 3, No. 4, pp. 7-18.

⁴⁵ Garbade K. and Silber W.L., (1983), 'Price Movements and Price Discovery in Futures and Cash Markets', -The Review of Economics and Statistics, Vol. 65, pp. 289-297.

as variables. Cost of carry model, unit root tests, and co-integration for lead-lag relationships were all used in the study's approach. Results for seven commodities were reported. While it was discovered that all markets were highly integrated over a month or two, there was significant slippage between cash and futures markets during shorter time periods, particularly for the grains—corn, wheat, and oats. But even over the course of a single day, the gold and silver markets were found to be very interconnected, and futures markets dominated the cash markets. The research also revealed that wheat, corn, and orange juice cash markets generally serve as satellites of the futures markets for those commodities, with roughly 75% of new information first being integrated into futures prices before moving to cash prices.

Banamber Mishra, Matiur Rahman, and Steve Caples (1990) utilized co-mix and the related blunder remedy model for the British pound, German imprint, Japanese yen, Canadian dollar, and Swiss franc, as well as daily information on forward and future costs of each currency for the period December 1, 1987 to October 16, 1989. (1992)⁴⁶ focused on the weak form of interdependent competence in cash-based industries. Based on the data, it is unlikely that the forward and futures markets for the British pound, the Japanese yen, and the Swiss franc will be successful at a 1% level of significance. The DW and ADF tests, as well as the evaluations of error correction models, are crucial to determining these results. On the other hand, it was discovered that the company sectors for the Canadian dollar and the German mark were consistently weak in competence throughout all regular levels of importance.

In 2004, Maosen Zhong, Ali F. Darrat, and Rafael Otero evaluated the theories that the newly constructed Mexican stock list prospects market adequately meets the cost revelation job and that the display of destinies exchanging has generated instability in the basic spot market.⁴⁷ Two main ideas depict the special relationship between the outcomes on the stock unending list. The central theory, also known as the forecast speculation, proposes that prices in the prospects market may be used to predict future spot prices because of the list fates market's transparent approach to pricing. The analysts made a distinction between the long-term forecast and the short-term expectation. According to the theory of short-term expectation, a one-time

⁴⁶ Mishra M, Rahman M. and Caples S., (1992), 'Co-integration, error-correction, and joint efficiency in forward and futures markets for major foreign currencies', -Global Finance Journal, Vol. 3, pp. 171-180.

⁴⁷ Zhong M., Darrat A.F., and Otero F., (2004), 'Price Discovery and Volatility Spillovers in Index Futures Markets: Some Evidence from Mexico', -Journal of Banking & Finance, Vol. 28, pp. 3037–3054.

shift in futures costs may serve as a proxy for an equally one-time shift in spot prices. Yet, long-term estimating suggests that a given shift in futures prices may anticipate the persistent (super durable) shift in spot prices. A long-term (balancing) link between the expenses in the two company sectors is obviously necessary for future estimates. The Co-mix and vector error correction model (VECM) were used to analyze the persistent and dynamic pattern of behavior between outcomes and spot prices for the purpose of cost disclosure testing. Each hypothesis was put to the test simultaneously using daily data of futures costs beginning with the beginning of the prospectus exchanging of the Mexican Price and Quotations Index within the context of a modified EGARCH model that incorporates short-run elements while preserving the fundamental co-coordinating connection between the two industries in both the restrictive means and the contingent differences. Both hypotheses were supported by the data, suggesting that Mexico's newly established futures market is a valuable tool for price transparency but has also increased uncertainty in the spot market. The results also demonstrated that short-term changes in one market cause uncertainty in the other, and that a departure from the long-term cost balance exacerbates the degree of uncertainty present in both industries.

The effectiveness of currency futures spot basis in forecasting changes in spot rates and currency futures returns was investigated by Ahmet Can Inci and Biao Lu in 2005⁴⁸. It is well known that the cash risk premium is likely to play a far larger role in long-term futures contracts than it does in shorter-term contracts. Long-term development contracts' concept of not being able to predict future changes in spot rates is used to reject UIP (uncovered interest rate parity). No matter what, it has the potential to forecast the monetary returns of futures bets, which are based entirely on the risk premium. Data from the IFM (Institute for Financial Markets) was utilized during the period between 1982 and 2000. This data set included daily settlement cost (in US dollars), exchanging volume, and the futures of the German Mark, Swiss Franc, Japanese Yen, and British Pound. This exact test was conducted on the British Pound, the Japanese Yen, the Swiss Franc, and the German Mark, and it suggests that the gamble premium may not be a major figure deciding the futures spot premium of short-development agreements and that the prospectus spot premium of these agreements may anticipate spot rate changes prior to the development date, supporting the revealed loan fee equality. However, it

⁴⁸ Inci Ahmet Can and Biao Lu., (2005), 'Currency futures-spot basis and risk premium',

-International Financial. Markets, Institution and Money||, Vol. 17, pp. 180–197.

was not shown that a comparable rationale could reliably replace the gamble premium in predicting the gains on cash outcomes.

Leo Chan and Donald Lien (2006)⁴⁹ performed research to see how the inclusion of options might affect how prices were formed for underlying assets. Canadian Dollar, British Pound, Swiss Franc, German Mark, and Japanese Yen futures and spot prices were used to collect the data before and after the introduction of options on these futures markets. Price information for futures was gathered from the Chicago Mercantile Exchange Statistical Yearbook for the years 1982 through 1988. Unit root tests, cointegration tests, and a vector autoregressive model with error correction were only some of the econometric methods used in the investigation. Based on the data, it seems that the spot and futures markets are not very connected. The futures market's price discovery function, sometimes called the futures market's feedback to the spot market, is decreasing on average. These outcomes also supported the dominance of the options markets, which is most likely a result of their lower transaction costs. Options thus acquire a key role in the dissemination of information in currency markets. As a result, it was determined that futures options are not unnecessary, especially in cases when the market for futures contracts is inefficient.

In India, the price discovery and causation link between the Nifty Index and Nifty futures were studied by Kailash Chandra Pradhan and Sham Bhat.K in 2006⁵⁰. The primary data source for this study was the daily closing prices of the S&P CNX Nifty index futures and the Spot Nifty index. From June 12, 2000 through February 24, 2005, we gathered information for all three maturities of S&P CNX Nifty Futures contracts. Several of Johansen's methods, such as the Vector Error Correction Model (VECM) and the Co-integration approach, are used in this study. The Dickey-Fuller and Phillips-Perron tests were used to determine whether the series was stationary. Based on the findings of the research, it was concluded that spot market prices were more influential than futures market prices. In terms of return and volatility, Kedarnath Mukherjee and R.K. Mishra (2006)⁵¹ noticed a potential delay in the Nifty Spot Index's ability to predict Index Futures pricing. There was also an examination of potential alterations and the

⁴⁹ Chan Leo and Lien D., (2006), 'Are options redundant? Further evidence from currency futures markets.', -International Review of Financial Analysis|| Vol. 15. pp. 179 – 188.

⁵⁰ K.C. Pradhan and K. Sham Bhat, (2006), 'An empirical analysis of price discovery, causality and forecasting in the Nifty futures market', -International Research Journal of Finance and Economics (IRJFE)||, Issue. 26, PP 83-92.

⁵¹ Mukherjee K.N. and Mishra R.K., (2006), 'Lead-Lag Relationship between Equities and Stock Index Futures Market and It's Variation around Information Release: Empirical Evidence from India', www. nseindia.com.

dissemination of certain types of data. The research uses minute-by-minute intraday price records for the closest contract of the Nifty Index Futures, the Nifty cash Index, and the prices of the same specific component stocks from April 2004 to September 2004. Using a cross correlation test, we analyzed the lag-lead connection between the cash and futures markets and identified the most likely lag times. Using a VAR strategy and the Granger Causality test, we assessed how much volatility affects the Cash and Futures markets. The study uncovered substantial real-time, two-way communication between the spot market and the futures market, with the Indian spot market serving as the leader in broadcasting information to the futures market. Research also indicates that the Cash market's informational efficiency has improved because to the use of derivative contracts. The investigation of the dependence between the volatility of stock returns in the Spot and Futures markets revealed a symmetric spill over. With an eye toward how each kind of trading contributes to the price discovery of CME floor-traded futures, a comparison was made between electronic GLOBEX futures and electronic retail on-line spot trading in the euro and Japanese yen markets. Yiuman tse, Ju xiang, and Joseph k. W. Fung in 2006⁵². We used techniques such as co-integration and the vector error correction model developed by Johansen (1991). (VECM). Floor-traded futures markets had the least effect on price discovery in the euro and yen markets, the study found. Consistent with previous studies of the stock market conducted by Theissen (2002) and Hasbrouck (2003), which found that electronic trading systems are responsible for a larger share of price discovery than the floor trading method, our results showed that both floor trading and electronic trading contribute to the overall process of price discovery. Traders prefer electronic methods because they are fast and provide anonymity, as shown by the results.

By examining the Price discovery efficiency, Kapil Gupta and Balwinder Singh (2007)⁵³ analyzed how well the Indian Equity Futures Market works. Closing values for the Index futures and S&P CNX Nifty were gathered daily from June 2000 through December 31, 2005. The Phillips-Perron Unit root test and the Johansen Co-integration tests, both useful for examining the Co-integration relationship, were applied to each price series separately. Long-term correlation between spot and futures markets is evidence of the possibility of a causal relationship between the two markets if both price series contribute to the same sort of

⁵² Tse Y, Xiang J. and Fung J.K.W.,(2006) Price discovery in the foreign exchange futures market, -The Journal of Futures Market|| Vol. 26, pp. 1131-1143.

⁵³ Kapil Gupta and Balwinder Singh (2007), _Investigating the Pricing Efficiency of Indian EquityFutures Market', -Management & Labour Studies||, Vol. 32, pp. 486-508.

information. For this purpose, we put the data for these two variables through the Granger Causality Test. The Granger Causality test was used to carry out the examination of causation. The decreased volatility argument was bolstered by research into the processes by which prices in the futures and stock markets are established. Furthermore, this study confirmed that trading on the futures market is more lucrative than trading on the spot market.

The price discovery process and the ad hoc link between spot prices on particular securities and their futures were explored independently by Kailash Chandra Pradhan and K. Sham Bhatt in 2007⁵⁴. 25 securities were chosen for study out of the 31 securities for which data were available. The analysis relied on the daily closing value of the spot and futures on specific assets. Data was collected from November 9, 2002, to September 29, 2005. Consideration was given to the near month futures contract because of its higher liquidity. Several other tests, including the Dickey Fuller, Phillips and Perron, and others, were used to check for data Stationary. In order to confirm the co-integration relationship, Johansen's Co-integration tests were performed. Using the Vector Error Correction Model, the long-term connection between spot and futures prices was studied (VECM). Results showed that both spot markets and futures markets participated in the price discovery process, with spot markets taking the lead in nine situations and futures markets in seven.

Using daily data from the CME website, Shinhua Liu (2007)⁵⁵ looked into the efficient market hypothesis in the currency derivative market in the USA. The examples cover three significant derivative products in nine different currencies that were introduced in two significant currency derivatives markets between 1982 and 1997. For the empirical analysis, the Runs Test and Autocorrelation Test were utilised as part of the methodology. The findings indicate that increasing trading of currency derivatives has improved pricing efficiency in the underlying currency market and that the returns to the underlying currencies have become much more random and hence less predictable. In addition to this, the results showed that the introduction of currency derivatives has made currency exchange rates beneficial for hedging and speculating reasons.

⁵⁴ K.C. Pradhan and K. Sham Bhat, (2007), 'Lead- Lag relationship between the NSE Spot and FuturesMarket', -The ICFAI Journal of Applied Finance, pp. 73-94.

⁵⁵ Shinhua Liu , (2007), 'Currency Derivatives and Exchange Rate Forecastability', -Financial Analysts Journal, Vol. 63, pp. 72-78.

In 2012⁵⁶, The spot and futures markets for the Brazilian real, South African rand, and Russian ruble were analyzed by Maria E. de Boyrie, Ivelina Pavlova, and A. M. Parhizgari. CSI publishes live foreign exchange rates for the South African rand, the Brazilian real, and the Russian ruble (Commodity Systems, Inc.). Used futures contracts are traded on the Chicago Mercantile Exchange (CME). Open-ended multiple primary analysis and the vector error correction model are two methods used (VECM). Within the larger time frame of the informational test, three separate, non-overlapping time intervals were selected for analysis. The results show that the spot market is more influential in the disclosure of prices in the Brazilian genuine than the futures market is in the Russian ruble. Sadly, the South African rand has not fared well. Even more importantly, the expected short-run lead-slack analysis showed that the parts of the three producing cash markets were not equivalent.

The interplay between the spot Turkish Lira-US Dollar exchange rate and Turkish Lira-US Dollar futures contracts traded in Turkish Derivatives Exchanges was studied by Ulas Unlu and Ersan Ersoy in 2012⁵⁷. The information spans the months of January 2007 and December 2011. The Turk DEX-TRY US Dollar futures contract and the spot TRY-USD exchange rate's daily closing values were both utilised. The Augmented Dickey-Fuller (ADF) unit root test, the Cointegration test, and the error correction model were used to look into the connection between the two variables. The results indicated a likely long-term and stable connection between the spot and futures markets for foreign currency. More so, there was a bidirectional causal link between them, both in the immediate and far future.

Kapil Choudhary and Sushil Bajaj (2013)⁵⁸ examined the role of price discovery in the Indian stock market by looking at 41 individual equities and the Nifty. This study looked at the period from November 2001 to August 2010 for individual equities, and from June 2000 to August 2010 for the index, using the daily adjusted closing price of spot and futures prices. Three methods—Engle and Granger's Residual based methodology, Johansen's co-integration test, and vector error correction modeling (VECM)—were used to analyze the function of price

⁵⁶ Maria E. de Boyrie, Ivelina Pavlova, A. M. Parhizgari, (2012), „Price Discovery in Currency Markets: Evidence from Three Emerging Markets’, -International Journal of Economics and Finance||, Vol 4, No 12, pp.61-75

⁵⁷ Ulas Unlu and Ersan Ersoy, (2012), „The Causal Relationship between Foreign Currency Futures and Spot Markets: Evidence from Turkey’, -Investment Management and Financial Innovations||,Vol.9 (2), pp.208-212.

⁵⁸ Choudhary K., Bajaj S.,(2013),Price Discovery Process in Nifty Spot and Futures Markets, -Global Business Review||, Vol. 14., pp. 55-88.

discovery in the market (Vector Error Correction Model). A comparison of the futures price series and the spot price series revealed that the futures series was ahead in the case of Nifty. In terms of causation, 14 stocks demonstrated the feedback causality. Seven equities and 21 stocks, including Nifty, demonstrated the absence of causation and unidirectionality, respectively. The study also discovered that both markets had a significant impact on price discovery, suggesting that futures prices may provide beneficial insight into spot pricing.

The current and future values of the ISE-30 index, which tracks the performance of the Istanbul Stock Exchange, and other foreign currencies, such as the Turkish Lira-US Dollar (TL/USD) and Turkish Lira-Euro (TL/EUR), were compared in a 2013⁵⁹ experiment conducted by Efe Cagli and Pinar E. Mandaci. They looked at the weekly data beginning on February 9, 2005, and ending on October 17, 2012. This timeframe encompassed the most recent financial crisis, therefore it was anticipated that analyses based on structural failures would be particularly relevant. Using the unit root tests developed by Carrion-i-Silvestre et al. (2009) and Maki's (2012) co-integration test allowing for an unknown number of breaks, it was found that the spot and future prices of the underlying assets, including the ISE30 index, USD, and EUR, are co-integrated. These results demonstrate that, despite a number of structural breaks, these markets remain long-run efficient and linked.

Chen, Gau, and Liao (2014)⁶⁰ evaluated the effectiveness of price transparency in the Euro-U.S. Dollar and Japanese Yen-U.S. Dollar markets, and how it relates to futures trading. Electronic Broking Services (EBS) was used to collect data on intraday spot rates for the Euro and Japanese Yen against the US dollar, while the agreements traded on the CME provided weekly data on broker circumstances in Euro and Yen futures contracts. Methods: We used vector error correction models (VECM), cointegration, and connection analysis to delve further into our data. Position data from week to week reveals that examiners' positions increase the informational share of cash rates markets, while hedgers' properties decrease it. We also discovered that hedgers' normal and unexpected conditions have a negative effect on their dedication to the derivatives market, and that data sharing in the prospects market correlates strongly with examiners' normal positions but not with examiners' normal positions.

⁵⁹ Efe Cagli & Pinar E. Mandaci, (2013), 'The Long-Run Relationship between The Spot And Futures Markets Under Multiple Regime-Shifts: Evidence From Turkish Derivatives Exchange', *Expert System with Applications*, Vol. 40., pp. 4206-4212.

⁶⁰ Chen, Gau, & Liao (2014) 'Trading activities and price discovery in foreign currency futures markets', *Review of Quantitative Finance and Accounting* Vol. 46, Issue 4, pp 793–818.

2.4 Conclusion

An empirical analysis of the impact of currency futures on volatility shifts and information efficiency in post-derivatives price discovery is presented here. Several large-scale theoretical and empirical studies have been done all over the world to evaluate the implications of futures and options on the cash market.

We discovered from the above literature reviews that there have been a sufficient number of research undertaken in this area of currency futures and its interactions with the spot market and global volatility. However, when we looked for substantial studies on the Indian currency derivative market, we couldn't find any. It was also pointed out that many research had been conducted to evaluate the effect that derivatives trading had on the underlying market, however these studies tended to concentrate on the performance of developed markets like as the United States and Europe. Only a small number of research have looked at how currency derivatives trading has impacted emerging nations like India. The introduction of currency derivatives serves as a reference point for the numbering of these publications. No significant previous research has been published on the Indian currency futures market; this void served as the study's starting point. Because of this, it was decided that a study of the Indian Currency Futures Market and its relationships with the spot exchange market was warranted. The conditional variance from the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model proposed by Bollerslev (1986) was thought to be the appropriate tools for the investigation of exchange rate series volatility.

The ARCH and GARCH models were favoured by Andersen (1996), Chatrath, Ramchander, and Song (1996) as the best models to gauge spot rate volatility. Generalized Autoregressive Conditional Heteroskedasticity (GARCH) was used by Ioannis Asimakopoulous, David Ayling and Wan Mansor Mahmood in 2000, M. T. Raju and Kiran Karande in 2003, Jussi, Petri and Sami in 2006, Douglas K. Pearce, M. Nihat Solakoglu in 2007, Vivek Bhargava A. and D.K. Malhotra in 2007, Therefore, the same econometrics approaches have been applied in the current work. In addition, Johansson co-integration and the VECM model were found to be effective tools for price discovery research, in line with the recommendations made by Kenneth D. Garbade and William L. Silber in 1983, Banamber Mishra, Matiur Rahman, Steve Caples in 1992, Ahmet Can Inci and Biao Lu in

2005, Leo Chan & Donald Lien in 2006, Kailash Chandra Pradhan and Sham Bhat.K in 2006, Kapil.

CHAPTER-III

A THEORETICAL VIEW

3.1 Introduction

Economic integration of world economy made countries economy interdependent as cross border trade of goods & services. Technology spread has also increased with the capital flow due to cross border transactions. Globalization of Financial Markets has emerged as the most influential segment in world economy integration and gained the strategic attention across the world. International finance came into light to get the requirements of intercontinental trade and investment activities. Later in reference to Globalization with regard to globalization of commodities and labour market only international finance, international investment and global finance market has been seen as global markets. The developed economies have influence on smaller economies therefore globalization opened new avenues of opportunities where global risk was involved.

Health of financial system is the most integral part of economic development of any country. In short and long run investment Capital and Money market are two components of financial system which perform the smooth allocation of finance from investor to entrepreneur. Now flow of Capital funds for investments are taking place globally, removing the barriers of borders and the price of the commodities and services are influenced globally which inflicts the price risk in the process of once currency value translated into another currency value.

As above mentioned the probable benefits of globalization are associated with operating risk when an organization operates in different countries with multiple currencies, also exchange risk get involved in cross border transactions. Ultimately, the risk is a result of future change in relationship between the domestic currency and the currency of foreign nation where the organization is operating. Those changes can be favourable or adverse in nature. Which can result in put impact on economic and accounting cash flow as well as asset & liability values of an organization. Because of this future risk factor Derivative has emerged as useful tool in areas like, stock market, commodity market and currency markets. In recent past endeavours has been put to make Indian capital market at par with international markets in terms of Financial market efficiency to improve transparency restricting unfair trade practices. Indian capital market

has emerged as forerunner amount emerging markets to introduced derivative production in financial markets of India.

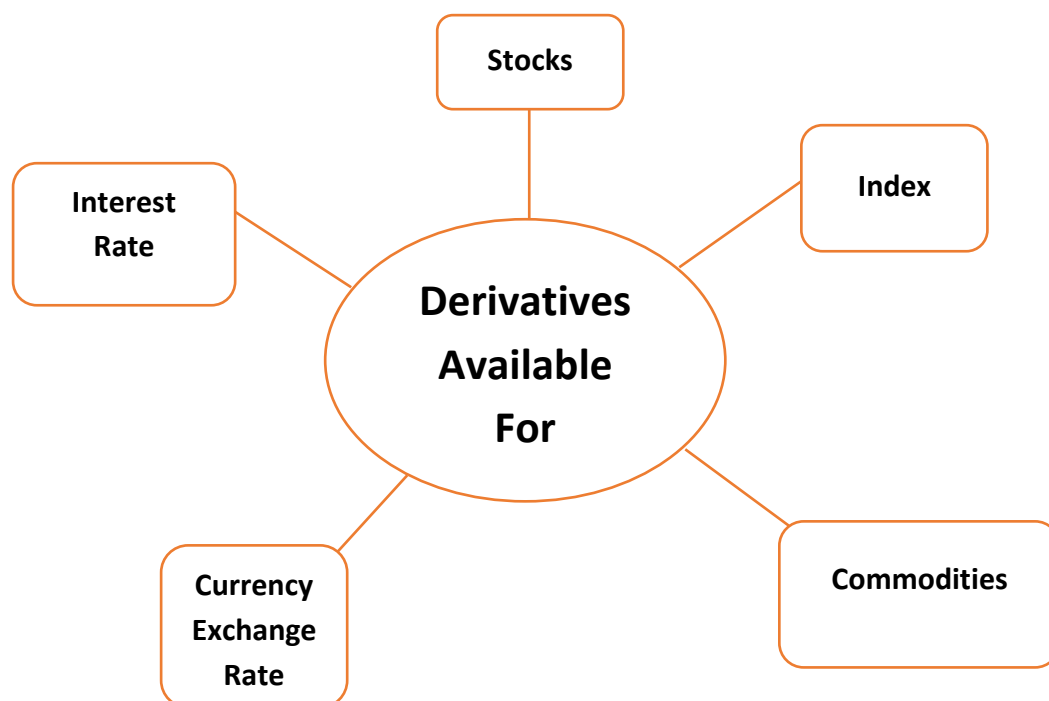
3.2 Derivatives

In mathematics derivative is something which drives its value from some other thing which is assumed to be independent. The same concept is applicable in case of Derivative in finance. In Derivative finance tradable product and services for traded in form of contract those are dependent to their underlying market i.e. spot or cash market. Price of derivative derived from underlying asset traded on underlying market. In case of currency market underlying spot market is exchange rate of currencies i.e. USDINR, EURING, GBPINR and JPYINR and the value of the future currency contracts is derived from these underlying cash/spot exchange rates.

3.3 Types of Derivatives

The prime objective behind introducing derivative market was to give a risk cover to global financial markets stakeholders to secure them from potential losses due to uncertain prices and economic environment, which leads to volatility in exchange rate prices.

Figure 3.1 Types of Derivatives



Since, Financial markets have high degree of volatility and derivative markets are meant to transfer risk partially or fully. For derivative underlying markets are stock interest rate,

currency exchange rate, commodity index. In currency markets derivative contracts are forward contracts, futures contracts, options contract and swaps.

3.3.1 Forwards

Forwards contracts is an arrangement between the two parties viz buyer and seller to buy or sell the forward contract value for the underlying assets at future data on predicated or predetermined agreed value at the time of making contract. Forward contract also called as forward commitments. Forwards contracts are non-standardized and informal contracts which are based on mutually agreed price between buyer and seller. The probability of risk of deny to fulfill his obligation remain there. Since its an informal contract.

3.3.2 Futures

Future contract is abide legally and known as agreement among two parties i.e. buyer and seller to buy or sell the underlying aster on later/future date at predetermined value. These contracts are standardized and are traded on futures exchange, it is subject to the daily settlement price. These contracts are different from forward contracts they are subject to daily settlement price.

3.3.3 Options

Option contracts has features of future and forwards. In option contracts buys have option to or right not to honour the terms of the option agreement contract. Means buyer has option to honour or dispense the contract on execution date if find underlying asset price more lucrative rather than Option Contract value. These contracts are traded on stock exchange as like futures contracts but obligate buyer not to sale before the date. There are two types of Option contracts Call options and puts options. Call option gives right to buy to a buyer and put option give right to buy to buyer, but buyer has no obligation to sell before date.

Warrants:- Options life is up-to one year and maximum contracts are traded for nine-months mean their maturity can be made in three months. Therefore, nine to one year longer maturity options are called as warrants and they are traded on counter exchanges.

Baskets: These are the optioned based on portfolios of underlying assets. Moving average value of a group of assets prices is the underlying assets value.

3.3.4. Swaps

Swaps contracts are private agreements between buyers and sellers of any contract on pre-agreed formula. It can be called portfolio of Forward Contract. There two types of Swaps interest rate swaps and currency swaps.

- 1) **Interest rate swaps:** Interest-only contracts entail the bilateral, in-kind exchange of cash flows between the parties in the same currency at a set interest rate in return for a currency whose exchange rate is subject to market fluctuations.
- 2) **Currency swaps:** Both the money and the interest are transferred back and forth between the two parties. when one party's cash flows are denominated in a currency other than the other party's.

Swaptions: The option to buy or sell a swap that becomes effective when the option is exercised is called a swaption. Therefore, swaption is an option for forward swap. Instead of calls and puts, the swaption market allows recipients and payers to choose swaps. Swaption contract recipients handle fixed and variable payment options. Swaption contract payers have the option of paying fixedly and receiving variable payments.

3.4 Distinction between Forward and Futures Contract

A forward contract is a custom-made contractual arrangement between two parties, namely buyer and seller, who agree to trade certain assets at an agreed-upon price at a future date. Forward contracts are traded privately rather than on the market floor, using an over-the-counter arrangement. A futures contract, on the other hand, is a standardised version of a forward contract that is openly traded on a futures market. A futures contract, like a forward contract, comprises an agreed-upon price and a period in the future to purchase or sell underlying assets such as stocks, bonds, commodities, or currencies.

The primary distinction between the two concepts, forward and futures, is that the former is privately sold, whilst the latter is standardised and openly traded on exchange. However, there are also further distinctions based on the operational characteristics of these two notions.

The contrasts highlighted in this comparison include counterparty risk, daily centralised clearance and mark-to-market, pricing transparency, and efficiency.

The following are the key distinctions between forward and futures contracts:

1. When two parties agree to buy or sell an item at a certain price at a future date, they have entered into a forward contract. A futures contract is a contractual agreement between two or more parties to acquire or sell an asset in certain quantities at an agreed upon future date and price.
2. The parties to a forward contract mutually agree upon its conditions. So, it may be adjusted to suit different needs. On the other hand, a futures contract is one that is standardized in terms of price, time frame, and other features.
3. Both the buyer and the seller have the opportunity to negotiate the terms of the forward contract. This allows it to be flexible in many situations. In contrast, a futures contract has already settled upon the price, delivery date, and quantity.
4. Since forward contracts are OTC, there is no secondary market for them. However, futures contracts trade on a regulated market.
5. Forward contracts settle on a maturity date when it comes to settlement. Future contracts, on the other hand, are marked to market on a daily basis, which means that profits and losses are resolved on a daily basis.
6. When opposed to futures contracts, forward contracts have higher counterparty risks.
7. A forward contract has a significant potential of a party defaulting since the agreement is private in nature, as opposed to a future contract, which involves clearing houses that guarantee the transaction, making the possibility of default nearly negligible.
8. The amount of a forward contract is determined by the contract terms, but the size of a futures contract is set.
9. The maturity of the contract is decided by the contractual provisions in the case of a forward contract, but it is predetermined in the case of a futures contract.
10. In the case of a forward contract, the maturity date is defined by the contractual provisions, but in the case of a futures contract, the maturity date is fixed.
11. There is no need for collateral in forward transactions, but initial margin is required in futures contracts.

12. Unlike futures contracts, which are controlled by the securities exchange, forward contracts are self-regulated.

3.5 Significant contrast between futures and option contracts.

Before examining the distinctions between futures and options, it is necessary to first understand the commonalities between these two contracts. Futures and options have some fundamental similarities in that they are both exchange traded derivative contracts that are traded on stock exchanges in India such as the National Stock Exchange (NSE) and/or the Bombay Stock Exchange (BSE) and are subject to daily settlement. Both derivative products are based on some underlying asset, such as stocks, bonds, commodities, currencies, and so on. In addition, both derivative transactions need a margin account. However, options contracts provide a choice (option), but futures contracts do not, and their performance and execution are necessary. Apart from the obvious similarities between futures and options, the following variances exist between these two:

- 3.5.1 A Futures Contract is a legally binding agreement for the purchase and sale of a financial instrument at a fixed price on a future stated date. Whereas an Options Contract is a contract in which the investor receives the right but not the obligation to purchase or sell a financial asset at a predetermined price on or before a specific date.
- 3.5.2 The buyer of a futures contract is obligated to complete the transaction on the agreed upon date. He has so agreed to be legally bound by its terms. An option contract, on the other hand, just gives the buyer or seller the choice between buying or selling the underlying securities; no obligation is imposed.
- 3.5.3 Futures contracts require performance exclusively on the specified future date, whereas options contracts allow performance at any time up to the expiration date.
- 3.5.4 Risk is higher with futures than with options.
- 3.5.5 Futures do not need any kind of premium payment in advance, other from the fee, whereas options do.
- 3.5.6 Futures allow for limitless profit and loss, whereas options only allow for unlimited gain but a capped loss.

3.6 Market Participants in Derivatives

Different types of players trade in derivatives market according to their motives and further they are classified according to their motives in different categories i.e hedgers, speculators, margin traders and arbitrageurs. Every participants' trade in derivatives market is associated with different type of risk.

3.6.1.1. Hedgers

Objective of these types of investors is to protect themselves from risk exposure prevailing in economic environment and to protect their investments from volatility in the market. Therefore, they are called hedgers because they hedge their assets price against volatility adverse effect on their invested value. These players particularly trade in futures and options trading model.

3.6.2. Speculators

These are who invest to reap the profit of price volatility while hedgers try to transfer their risk by diverting their risk through buying in derivatives but speculators takes risks to make profits. Whereas, some experts believe that market will go up if there will be more participant who feel it will fall. The profile of risk is different for both hedgers and speculators and that makes both different from each other. Speculator are fancy investors they don't stress on associated risk exposures and future volatility. But hedgers takes calculative risk to transfer their probable losses of transactional risk to currency futures investments.

Generally, there are two types of speculators are found in Indian Markets:

Day Traders: Those who tend to take advantage of intra-day volatility in values. Their all trades are get settled by undertaking an opposite trade by the end of each day.

Position Traders: Those traders rely on information, news, trips and some analysis to predict the prices. Position traders invest for longer view, such as for weeks, months to reap profits.

3.6.3. Margin Traders

Many speculators trade through the payment mechanism margin trading in derivative market. It is mandatory to make full payment for position as up front in derivative market. Or it is needed to maintain a fraction of total amount called margin. Therefore margin trading play integral role in derivative market. Through margin trading with small deposit one can hold the big outstanding positions. But the leverage factor is fixed and it is there always. Borrowing amount is limited. Generally, speculator find out the scope in buying through margin trading in futures if they see positive returns over leverage they go for it.

3.6.4. Arbitrageurs

The value of a derivative instrument is derived from the cash market price of the underlying assets. However, there are times when the price of an asset in the cash market is lower or greater than it should be in the derivative market. Arbitrageurs take use of these flaws and inefficiencies to obtain an advantage. Arbitrage is defined as the acquisition of securities in one market while causing a matching in another market at the same time. When the identical assets are quoted at different prices in two different markets, this process occurs.

3.7 Genre of Derivative Market

Derivative contracts trading take place in two forms :1

1. Over the Counter (OTC) Market
2. Exchange Traded Derivatives (ETD) Market

3.7.1. Over the Counter (OTC)

Over the counters is used for easily taken or give on the single counter while following the set of rules set buy other party rather than rules set by the third party.

Financial derivative available on OTC are less regulated and these transaction can be carried out privately. In this process two parties are involved in and executed transaction without interventions of any third party. These two parties have their own set terms and conditions without interventions of govt. regulations. These contracts can take place over the phone calls or internet communications. Maximum financial derivative operations work on over the counter method.

Primary issue under over the counter method is lack of records and transparency which further leads to disputes between two parties and to the counter party risk. Since, settlement takes place between two parties and settlement not governed by no government body so for dispute settlement get never addressed by intervention of govt body. When one party fails to fulfil its promise then other party end up with losses.

Over the counter derivative has many features and shortfalls described as follows:

- Controlling the risk of doing business with another party is a shared responsibility (credit).
- There is no standardized set of rules in place to restrict people's exposure to risk by imposing limits on their leverage or margin.
- There is no generally accepted method for dividing up hazards and responsibilities.

- To safeguard the interests of the market as a whole, no explicit regulations or processes exist.
- Contracts made over the counter are not directly governed by any agency, but are indirectly impacted by national law, financial regulation, and market supervision.

3.7.2. Exchange Traded Derivatives (ETD) Market

Derivatives that are traded on a registered exchange are known as exchange derivatives. As for the loopholes and controversies in OTC trading, derivatives trading tends to shift from forward contracts to standardized and exchange-traded futures. Trading of exchange-traded derivatives is facilitated by the central authority governing the contracts. The inclusion of a central regulator to manage the transaction makes it more formal, binding and transparent. On both sides, the contract is secured by a security or an initial margin set by these trading institutions. Thus, even if only one party breaches the terms of the contract, the other party does not suffer because the settlement body is responsible for fulfilment. Transparency in these transactions becomes one of the important factors to facilitate the search, observation and traceability of transactions. The issue of anonymity and lack of proper documentation for recording OTC transactions was later resolved.

3.8. Economic Function of the Derivative Market

The motive behind trading derivatives is to allow investors (individuals and businesses) to hedge against price risk or speculate and/or profit from a high and frequently changing underlying price. In other words, it can be said that the derivatives market helps speculators increase their exposure to a particular risk, hoping that they will generate higher than normal returns to compensate for the loss. themselves when exposed to these additional risks and help underwriters by reducing their specific level of financial risk, passing those risks on to those willing to bear them for a certain amount. compensation or at a specified cost. This process is called hedging. Despite the fear and criticism with which the derivatives market is often perceived, the derivatives market enjoys the following economic benefits:

- 3.8.1. **Price Discovery:** Speculators' expectations for the future are reflected in the structured derivatives market, which in turn adjusts the spot prices of the underlying commodities to reflect those expectations. At the time a derivative contract matures, the derivative price approaches that of the underlying asset.

Therefore, spot futures' price discovery method is aided by the derivatives market, and vice versa.

- 3.8.2. **Risk Transfer:** The derivatives marketplace facilitates the hedging to the ones members who won't just like the threat and desires to switch their dangers to individuals who are inclined to have threat for a few compensation for them.
- 3.8.3. **Business Growth:** Derivatives are related to the underlying coins markets because of their inherent nature. With the advent of derivatives, the underlying marketplace witnesses better buying and selling volumes due to the participation via way of means of greater gamers who could now no longer have in any other case participated in absence of an association to switch danger or availability of danger control avenues.
- 3.8.4. **Controlled Speculative Trading:** Derivatives marketplace allows a greater managed surroundings for speculative buying and selling. Initially, speculators had been buying and selling withinside the underlying coins markets withinside the absence of a managed and established derivatives marketplace. It turns into extraordinarily tough for the contributors to govern in any manner in such styles of combined markets because of standardized machine of margining, tracking and surveillance of the activities.
- 3.8.5. **Economic Growth:** One of the most important side effects of trading derivatives is the encouragement of innovative new businesses to be started. Records show that the derivatives industry has been drawing a lot of smart, inventive, well-informed people who are eager to try out new ideas and bring about radical changes in the business world thanks to their ingenuity and creativity. They repeatedly inspire others to create new companies, new products, and new job possibilities, the potential benefits of which might be huge. In a nutshell, the derivatives market helps and encourages many people to increase their long-term savings and investments. The volumes of sports are extended through the ability supplied through the spinoff marketplace through making them to switch of hazard which permits members to suppose past the wall.

3.9. The evolution of derivatives globally and in India

The first stage of the use of derivatives is proven long ago in the time of the ancient Greeks and Phoenicians. In the 17th century, a type of derivative in the form of rice futures and options was seen in Japan and the Netherlands respectively, however, the modern history of futures trading dates back to Chicago, United States. United States, early 18th century. Any shortage and surplus of agricultural products leading to unstable fluctuations in the prices of the products required a market system that allowed agribusinesses to industry, grain traders and processors, etc. using the trading mechanism through forward agreements. protect themselves against adverse price changes and allow them to hedge against price changes. However, many futures contracts are not respected by both sellers and buyers. In addition, futures contracts also lack sufficient liquidity, requiring an exchange to facilitate the market to find and gather potential buyers and sellers of a commodity on the market. a single platform.

In 1848, the Chicago Board of Trade (CBOT) opened as the first futures market in the world. The first day of trading for corn futures was March 13, 1851. Financial futures contracts were established. was the first exchange-traded derivatives contract in the United States, yet the term "futures contract" did not appear until after its publication in 1865. Chicago Manufacturing Exchange started in 1874 and became the Chicago Commodity Exchange (CME) in 1898. The reformed Chicago Butter and Egg Board in 1919 also made it possible for businesses to switch hands. Finally, it was digested by the Chicago Mercantile Exchange (CME). In Chicago, you may visit the Chicago Board of Trade (CBOT) or the Chicago Mercantile Exchange, two of the most important controlled futures markets in the world (CME). These stock markets are the largest "monetary" markets in the world right now.

The stock marketer known only as "destiny" made its presentation before the Kansas City Board of Trade. At the moment, the Chicago Mercantile Exchange is trading stock index futures contracts based on the S&P 500 file, one of the most prominent financial exchange records (CME). Financial futures gained prominence as a powerful and dynamic outcome gadget in the latter half of the 1980s because to the larger trading volumes they generated in comparison to their size as compared to other prospects. At the moment, futures contracts involving Treasury charges, the Euro, and the files are the most actively traded on the Chicago Mercantile Exchange (CME). Famous exchanges that deal in the trading of subsidiary goods around the world include the London International Financial Futures and Options Exchange (LIFFE) in England, the Singapore Exchange Limited (SGX) in Singapore, the Deutsche Börse

in Germany, the *Marché aux choixs financières et aux titres* (MATIF) in France, the Tokyo International Financial Futures Exchange (TIFFE) in Japan, and many others.

From the progressive studies of Black Scholes, and Merton withinside the early Nineteen Seventies inspired incredible boom in derivatives marketplace, Information Technology revolution additionally contributed to the big development of by-product marketplace in trendy and destiny marketplace particularly with established order of primary futures exchanges in Chicago. The World Bank (which includes IBM) changed into the primary establishments for growing derivatives and facilitated for swapping of loans on extraordinary currencies. The improvement of by-product devices then accompanied tracks which had been distinctly custom designed such that hobby price and forex products.

3.10. Indian derivatives market development

In India, derivatives markets could not exist at first as the Securities Contracts(Regulations) Act of 1956 was prohibited. (SCRA). The preamble to the law itself talks about prohibiting any kind of options trading. Section 20 of the law also prohibits all stock options. The government even banned all stock futures trading to limit illegal practices and prevent unwanted trading by giving notice in 1969 under this law. The introduction of trading in derivatives is only possible once these bans are lifted.

The Securities Laws (Amendment) Ordinance, 1995, which effectively indicated the repeal of the restriction on alternatives in securities, became the first legal step toward the formation of derivatives trading in India. Because of the absence of a unified regulatory structure to oversee transactions using derivatives, the derivatives market never took off. On November 18, 1996, the Security Exchange Board of India (SEBI) formed a 24-person committee with Dr. L. C. Gupta as its chairman. The purpose of establishing this group changed into to provide the groundwork for a robust derivatives trading regulatory framework in India. On March 17, 1998, the committee issued its report, in which it pushed for a wide range of necessary antecedents to the trading of derivatives in India. According to the recommendations of this committee, derivatives should be labeled "securities" so that the same rules governing the purchase and sale of "securities" would apply to derivatives as well. For the purpose of proposing methods to reduce uncertainty in India's derivatives market, SEBI established yet another committee in June 1998, this time led by Prof. J. R. Varma. In October 1998, Mr. Varma turned in a paper that detailed the procedure for charging preliminary margins, the operating details of the margining device, the broker's net worth, the necessity for a deposit

prior to trading derivatives, and the real-time monitoring mechanism for such transactions. As a result, in December 1999, the Securities Contracts Regulation Act (SCRA) modified to include derivatives throughout its purview as "securities," and a regulatory framework turned into also attached for managing deals in derivatives. This reform put an end to over-the-counter (OTC) derivatives by requiring their trading on a regulated inventory exchange. In March of 2000, the government lifted a ban on futures trading in securities that had been in place for three decades. In May 2000, SEBI gave its final permission to this effect, and in June of that year, derivatives trading began in India. The Securities and Exchange Board of India (SEBI) has granted its blessing for trading and agreement on permitted derivatives contracts to begin on the by-product sections of the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE), as well as their clearing house/company. SEBI first authorized index futures contracts based on the S&P CNX Nifty and the BSE-30 (Sensex) index. Options on both the S&P CNX Nifty and the BSE-30 (Sensex) index, as well as options on individual equities, saw increased trading volume. In June 2001, investors were able to start trading options on indices, but stock market trading did not get going until July of that year. Share futures contracts were first made available in November 2001. Trading and contract terms for by-products are governed by the rules and guidelines established by the relevant exchanges and the clearing house/company for each exchange, as authorized by SEBI and published in the official gazette.

As a long way as forex by-product are concerned, RBI took a vital step within the 12 months 1978 to allow banks to make intraday transaction in forex and therefore financial institution needed to hold rectangular or close to rectangular function on the ultimate time of every change running day. Therefore banks commenced the usage of the Currency danger hedging product consisting of cross-forex alternatives, hobby charge and forex swaps, caps/collars and ahead charge agreements within the global foreign exchange marketplace with the development of a rupee-overseas forex switch marketplace and different hedging devices like overseas forex-rupee alternatives. Cross-forex derivatives comprising rupee on one aspect had been released with a few boundaries within the 12 months 1997 thru Credit Policy through the RBI. Certain financial institutions began offering floating-benchmark Indian National Rupee (INR) Interest Rate Derivatives (IRDs) in 2001, with yields on Indian government bonds serving as the underlying index. In June 2003, interest rate futures (long bond and T-bill) were introduced, and in July 2003, Rupee-forex alternatives became legal. The forex derivatives marketplace in India is particularly transactions primarily based totally marketplace, that is primarily based totally at the forex publicity as underlying as in step

with the requirement of marketplace player. Similarly, Indian forex by-product is extra regulated in maximum of the cases, because it needs the give up of forex belongings in Indian forex marketplace. This marketplace incorporate Authorized Dealers (ADs) commonly banks, a few intermediaries with confined authorization, and quit customers like individuals, corporates, institutional buyers and others. The forex derivatives merchandise that are presently to be had in India may be categorised into 4 foremost sections, viz. forwards, futures, alternatives and forex swaps. Foreign trade derivatives are typically used for the reason of danger control through corporates, for hedging of belongings fee towards the fee danger in global markets and FIIs, NRIs and different foreign places buyers use it to hedge the trade charge risks. Since this piece of studies paintings is targeted to look at the forex by-product, specifically forex futures in India, it's far important to recognise approximately the present day repute of forex by-product in India.

3.11. Currency Derivatives in India

India went thru the financial liberalization at some stage in the 12 months 1990-1991, and which introduced in numerous financial reforms to convey the development in Indian financial system. The financial reforms had been aimed to liberalize the home financial system and open it for the overseas investor to make the funding in India easy, and thereby to enhance the home financial system. These reforms embarked collection of structural adjustments withinside the forex marketplace too. The antique constant alternate price regime become modified and partly floated alternate price machine in March 1992 and ultimately to completely flow in March 1993. However, liberalization coverage modified the face of Indian foreign exchange marketplace in numerous ways. It accelerated large fluctuations in alternate charges because of accelerated call for of funding possibility for overseas investors. This transition segment in alternate price regime attracted large interest and subject from coverage-makers and investors. Although some degree of flexibility in the Indian forex markets and its alternate price fixation became appropriate, excessive volatility became recognized to have an adverse impact on rate discovery, export performance, sustainability of present day account stability, and the state of affairs in stability sheets. It turned into determined that an advanced forex by-product marketplace (each OTC and Exchange-traded) became very lots critical and necessary in the backdrop of bringing the Indian forex business up to global standards.

In the context of a volatile exchange rate regime, increased volatility in the value of money has made it very difficult for many people to estimate their future payments they will

have to pay, the stream of receivables they expect to receive in the future abroad. currency. This significantly affects the negotiation of contracts, especially of an international nature. Similar impacts are of vital importance for players engaged in exporting, importing, shipping or accepting equipment that earn cross-border revenue or enter into long-term international contracts. In order to help financial institutions manage their exposure to money market volatility, the Reserve Bank of India (RBI) announced detailed guidelines on futures, options, and currency swaps in the over-the-counter (OTC) market on April 20, 2007. Meanwhile, the RBI has set up an internal task team to investigate the potential advantages of launching currency futures. The group's report, which recommended the addition of currency futures contracts traded on the exchange, was submitted in April of 2008. Therefore, RBI and SEBI have formed a joint technical committee to analyze the international currency futures and futures markets and recommend regulations for the introduction of currency futures. The Indian Business Academy. On May 29, 2008, the Commission released its findings. Both the Reserve Bank of India and the Securities and Exchange Board of India released circulars on this topic on August 6, 2008. In conclusion, we have financial futures. The Indian financial sector now accommodates exchange-traded currencies. U.S. Dollar Futures Trading Against On August 20, 2008, the Currency Derivatives Division of the National Stock Exchange began trading the Indian Rupee. As of the end of February 2010, the NSE began offering futures contracts for three more foreign currencies (pairs of the Euro, Pound Sterling, and Yen against the Indian rupee). Exchange-traded currency futures, backed by an efficient electronic trading system and risk management system, are anticipated to increase openness and efficiency in pricing, remove counterparty credit risk, make trading possible for all interested parties, standardize products, and create a level playing field for market participants. For the first time, financial institutions may join the Exchange and take advantage of this niche market.

3.12. Currency Derivatives users in India

3.12.1. Importer and Exporter: Typically, both exporters and importers are exposed to currency risk as both are subject to international transactions in goods and services and therefore the former must receive receivables in foreign currencies. and then this business has to accept debts in foreign currency. So these are the people who can use currency derivatives to hedge the risk of their currency's price fluctuations. However, they practice hedging through their bank, but it is not as transparent as through the derivatives exchange.

- 3.12.2. **Small and medium-sized enterprises, traders, corporations:** Small and medium-sized enterprises that make payments or receive payments in cross-border trade are also exposed to the risk of foreign currency fluctuations and can also hedge against currency risk. their currency in exchange-traded currency derivatives.
- 3.12.3. **Foreign Remunerated Professionals:** Professionals such as engineers, doctors, IT specialists and many others provide their services to foreign companies and foreign individuals and receive foreign remuneration. Currencies also have the option of using currency derivatives to hedge their currency risk.
- 3.12.4. **Commodity traders:** Commodity prices are always subject to currency fluctuations. Until recently, there wasn't even a single avenue by which commodity traders could hedge currency exposures into their portfolios. Currency derivatives allow them to isolate currency risk in their portfolios.
- 3.12.5. **Foreign Investment:** In addition to the hedging basis, one can use currency derivatives as an investment opportunity with less investment. This market has huge opportunity with good profit.
- 3.12.6. **International tourists, community of teachers and students, etc. :** international tourists traveling abroad need that country's currency to spend, but the risk of price fluctuations can create problems related to tourists' purchasing power, and the use of Derivatives exchangers can protect their interests against fluctuations in currency prices. .

3.13. National Stock Exchange (NSE) and Currency derivative

Contracts for future delivery of a certain quantity of a given currency at a predetermined price (exchange rate) are known as currency futures or Forex futures, respectively. A futures contract's value at NSE is quoted in terms of Indian Rupees (INR) per other currencies such as the US Dollar. Trades in currency futures contracts let investors protect themselves from fluctuations in exchange rates. Forex futures may be traded in India, although only on four currency pairings at the moment. The US dollar (USD), the Euro (EUR), the British pound (GBP), and the Japanese yen (JPY) are the four main currencies shown (JPY). National Stock Exchange is the first company in India to get approval to run a currency derivatives market from the Security Exchange Board of India (SEBI). The futures market for currencies first

opened for business on August 29, 2008. The Indian rupee was previously solely traded against the US dollar on currency futures contracts, but it was later expanded to trading alongside the euro, British pound, and Japanese yen. On October 29, 2010, currency options were introduced on the NSE. Currency derivatives trading on the NSE is the most dominant and that is why this study selected variables from the NSEC currency derivatives segment. The mechanism for trading CDs on NSE is as follows:

Available Products in CD for Trading:- The Currency Derivatives area of NSE allows for the purchasing and selling of derivative units such as Currency Futures on four currency pairs, Currency Options on US Dollars, and Interest Rate Futures on ten-year, seven-year, and ninety-one-day Treasury Bills.

Trading: NSE facilitate buying and selling via an automatic display screen primarily based totally gadget, up-to- date and absolutely automated that is designed to address buyers throughout the period and breadth of the united states with secure and smooth method of investment. The NSE buying and selling gadget is likewise called 'National Exchange for Automated Trading' (NEAT) that is a totally computerized display screen primarily based totally buying and selling gadget that implements the precept of an order pushed market.

Contract Specifications – (Futures):-The diverse specs associated with forex futures are in brief defined withinside the desk-3.1. Market kind for all forex futures are denoted through —N because of this that Normal Segment. Derivative tool kind for respective forex are represented with quick call FUTCUR as prescribed through NSE for forex futures product. Other matters are defined via desk itself clearly.

Table 3.1

Contract Specifications - Futures & Options on INR pairs

Symbol	USDINR	EURINR	GBPINR	JPYINR
Market Type	N	N	N	N
Instrument Type	FUTCUR	FUTCUR	FUTCUR	FUTCUR
Unit of trading	1 - 1 unit denotes 1000 USD.	1 - 1 unit denotes 1000 EURO.	1 - 1 unit denotes 1000 POUND STERLING.	1 - 1 unit denotes 100000 JAPANESE YEN.

Underlying / Order Quotation		The exchange rate in Indian Rupees for US Dollars	The exchange rate in Indian Rupees for Euro.	The exchange rate in Indian Rupees for Pound Sterling.	The exchange rate in Indian Rupees for 100 Japanese Yen.
Tick size		0.25 paise or INR 0.0025			
Trading hours		Monday to Friday 9:00 a.m. to 5:00 p.m.			
Contract trading cycle		12 month trading cycle.			
Last trading day		Two working days prior to the last business day of the expiry month at 12:30 pm.			
Final settlement day		Last working day (excluding Saturdays) of the expiry month. The last working day will be the same as that for Interbank Settlements in Mumbai.			
Quantity Freeze		10,001 or greater			
Base price		Theoretical price on the 1st day of the contract. On all other days, DSP of the contract.	Theoretical price on the 1st day of the contract. On all other days, DSP of the contract.	Theoretical price on the 1st day of the contract. On all other days, DSP of the contract.	Theoretical price on the 1st day of the contract. On all other days, DSP of the contract.
Price operating range	Tenure upto 6 months	+/-3 % of base price.			
	Tenure greater than 6 months	+/- 5% of base price.			
Position limits		Position Limits for CDS Segment			
Initial margin		SPAN Based Margin			
Extreme loss margin		1% of MTM value of	0.3% of MTM value	0.5% of MTM value	0.7% of MTM value

	gross open position	of gross open position	of gross open position	of gross open position
Calendar spreads	Rs.400 for spread of 1 month Rs.500 for spread of 2 months Rs.800 for spread of 3 months Rs.1000 for spread of 4 months and more	Rs.700 for spread of 1 month Rs.1000 for spread of 2 months Rs.1500 for spread of 3 months and more	Rs.1500 for spread of 1 month Rs.1800 for spread of 2 months Rs.2000 for spread of 3 months and more	Rs.600 for spread of 1 month Rs.1000 for spread of 2 months Rs.1500 for spread of 3 months and more
Settlement	Daily settlement : T + 1 Final settlement : T + 2			
Mode of settlement	Cash settled in Indian Rupees			
Daily settlement price (DSP)	Calculated on the basis of the last half an hour weighted average price across exchanges.			
Final settlement price (FSP)	RBI reference rate	RBI reference rate	Exchange rate published by RBI in its Press Release captioned RBI reference Rate for US\$ and Euro	Exchange rate published by RBI in its Press Release captioned RBI reference Rate for US\$ and Euro

Source: NSE Currency Derivative Segment

3.14. Business Growth in Currency Derivative Segment:

Currency spinoff at NSE has proven a marked boom inside a totally quick span of few years, because the inception of Indian forex futures and Derivative marketplace. A higher functioning forex futures derivatives has the capacity to engross fluctuation withinside the trade price of that united states thereby has a great effect at the economy. This marketplace is newly added in India nearly 39 years after the advent of forex futures at Chicago Mercantile Exchange (CME). In a time span of simply five to six year, the NSE-CD phase has determined a large improvement with the start of latest technology exchanges and might surpass the equities coins phase soon. Following table-3.2 present the boom tale of forex destiny and alternatives settlement in India in phrases of turnover values on National Inventory Exchange (NSE).

Table 3.2

Business Growth in CD Segment

Year	Currency Futures		Currency Options			Total		Average Daily Turnover* (₹ cr.)
	No. of contracts	Turnover (₹ cr.)	No. of contracts	Notional Turnover (₹ cr.)	Premium Turnover** (₹ cr.)	No. of contracts	Turnover* (₹ cr.)	
2020- 2021	74,14,84, 767	59,83,24 2.32	86,36,02, 528	64,16,896. 51	14,874 .56	1,60,50,8 7,295	1,24,00,1 38.83	50,612.81
2019- 2020	66,01,28, 849	51,16,33 1.87	68,01,33, 335	48,47,753. 17	13,346 .56	1,34,02,6 2,184	99,64,085 .04	41,004.47
2018- 2019	65,00,24, 870	46,54,92 7.35	54,83,59, 351	38,63,424. 17	14,615 .62	1,19,83,8 4,221	85,18,351 .52	35,054.94
2017- 2018	39,04,33, 137	25,95,68 5.67	37,45,30, 592	24,32,816. 50	7,572. 55	76,49,63, 729	50,28,502 .17	20,778.93
2016- 2017	36,26,15, 931	24,89,77 8.94	34,98,35, 508	23,67,296. 92	7,153. 09	71,24,51, 439	48,57,075 .85	20,070.56
2015- 2016	40,97,59, 364	27,49,33 2.96	26,38,23, 800	17,52,552. 62	6,059. 00	67,35,83, 164	45,01,885 .58	18,602.83
2014- 2015	35,55,88, 963	22,47,99 2.34	12,50,75, 731	7,75,915.3 2	3,164. 45	48,06,64, 694	30,23,907 .67	12,705.49

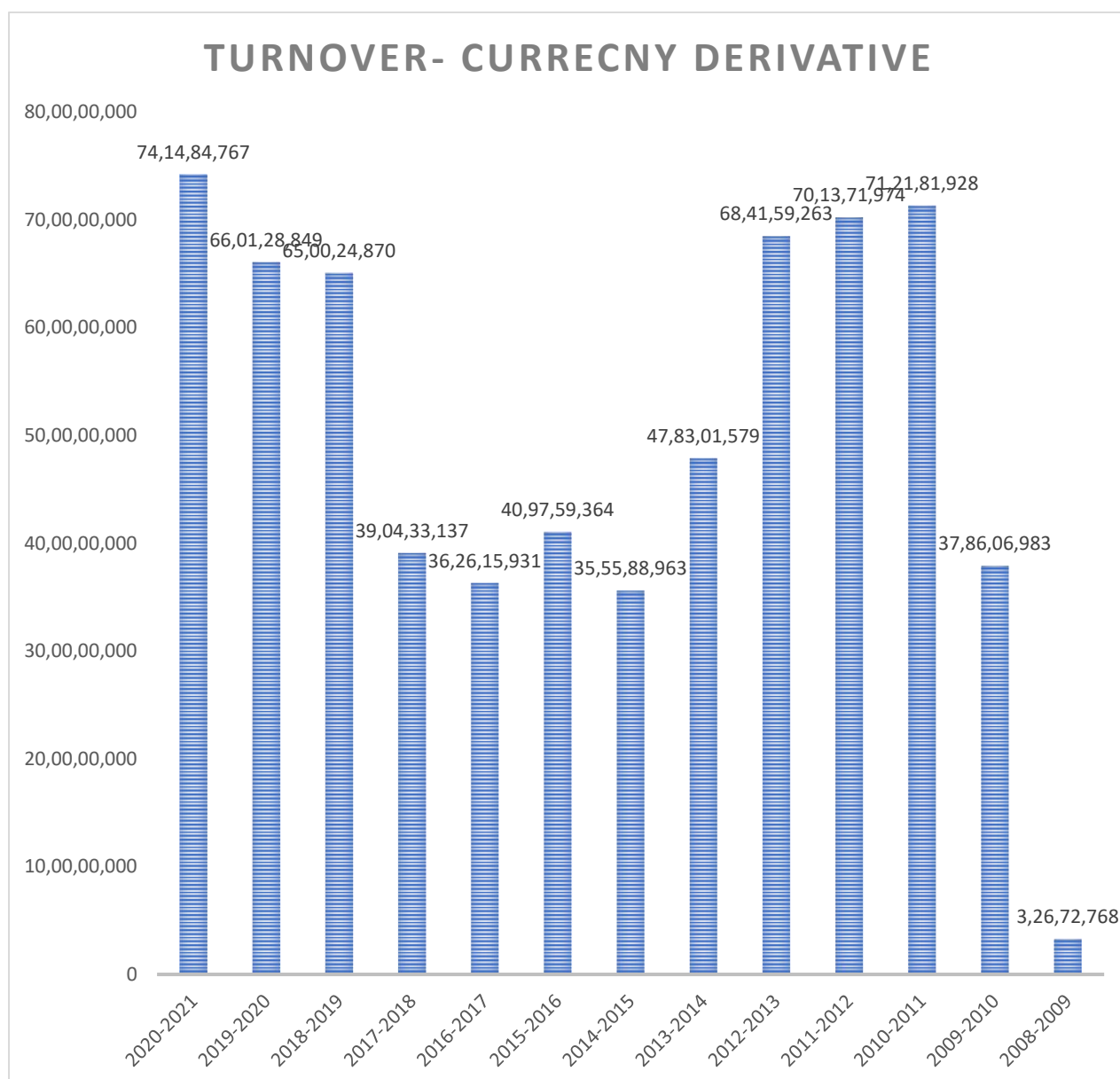
2013- 2014	47,83,01, 579	29,40,88 5.92	18,18,90, 951	10,71,627. 54	7,297. 15	66,01,92, 530	40,12,513 .45	16,444.73
2012- 2013	68,41,59, 263	37,65,10 5.33	27,50,84, 185	15,09,359. 32	10,109 .99	95,92,43, 448	52,74,464 .65	21,705.62
2011- 2012	70,13,71, 974	33,78,48 8.92	27,19,72, 158	12,96,500. 98	7,100. 69	97,33,44, 132	46,74,989 .91	19,479.12
2010- 2011	71,21,81, 928	32,79,00 2.13	3,74,20,1 47	1,70,785.5 9	946.70	74,96,02, 075	34,49,787 .72	13,854.57
2009- 2010	37,86,06, 983	17,82,60 8.04	-	-	-	37,86,06, 983	17,82,608 .04	7,427.53
2008- 2009	3,26,72,7 68	1,62,272 .43	-	-	-	3,26,72,7 68	1,62,272. 43	1,167.4

Source-Data from NSE-CDS,Note:* In case of Option Contracts "Turnover" represents "Notional Turnover"

The above table suggests that the quantity of contracts transacted in foreign money futures marketplace has grown from 3,26,72,768 (inception 12 months 2008-09) to 74,14,84,767 (in the course of 12 months 20-21) and documented nearly 95.59 % increase until 2021. Year 20-21 suggests the best ever quantity of settlement(extent) traded on NSE under the foreign money by-product phase for futures settlement. Whereas, the turnover of foreign money futures has expanded in the course of the length 2008-09 to 2020-21 from 1,62,272,43 Cr. to 59,83,242.32 Cr., maximum ever from the start of buying and selling at CD with the increase of 97.28 %.This suggests significance and the capacity scope of alternate traded foreign money futures settlement marketplace. Likewise, alternative marketplace for foreign money has additionally proven a splendid increase in phrases of extent and turnover both. The documented quantity of volume and turnover of options exchange on were found 86,36,02,528 and Rs. 64,16,896.51cr. respectively. This may be higher understood via the subsequent graphs-3.2.

Graph-3.2

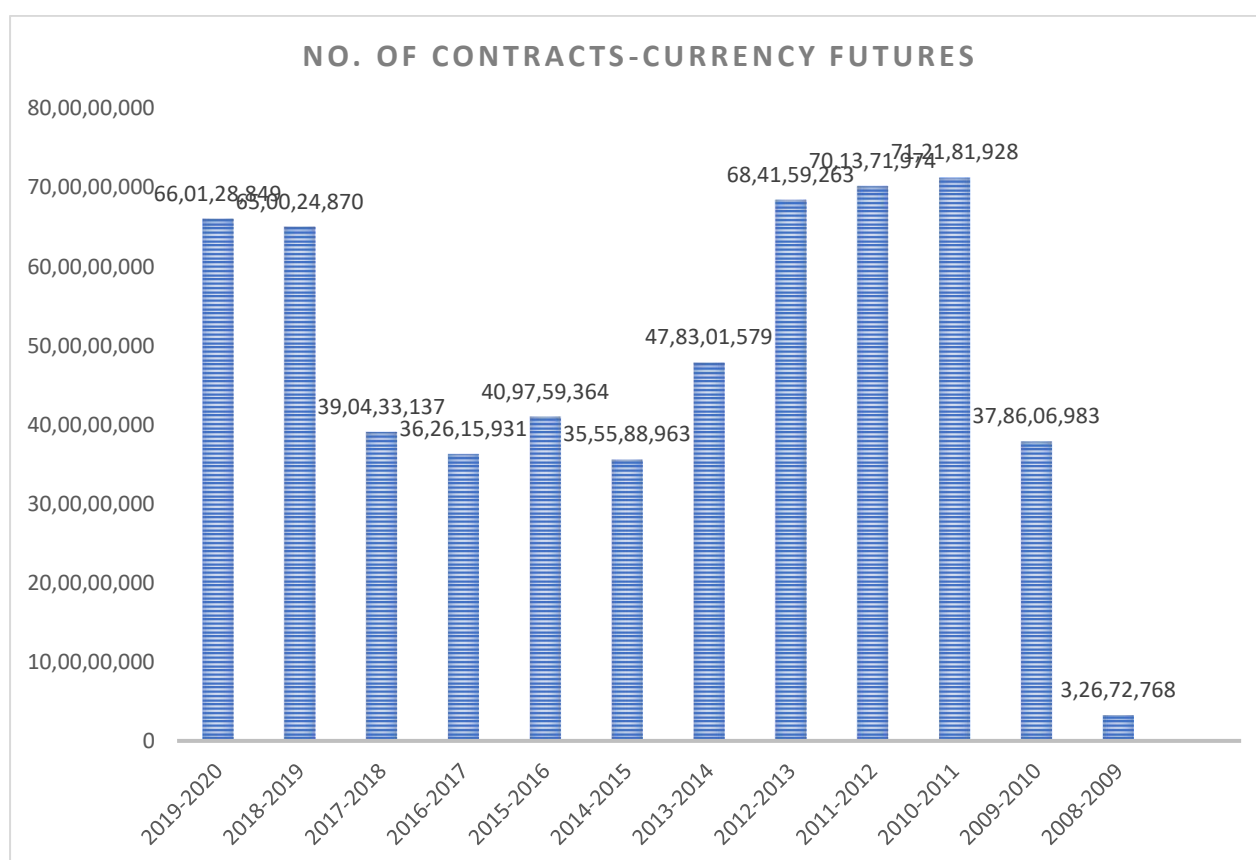
TURNOVER-CURRENCY DERIVATIVES



Graph 3.2 shows that the growth of currency futures in turnover on NSE. It can be seen that there is a continuous growth in currency futures turnover but a halt in growth or stagnant growth can be seen during 2014 to 2018. In 2014 to 2018 in comparison to 2012-2013 growth were negative. The reason was new index came into popularity i.e. NSE-SX number of trade have taken place on NSE-SX.

Graphs-3.3

NO. OF CONTRACTS-CURRENCY FUTURES

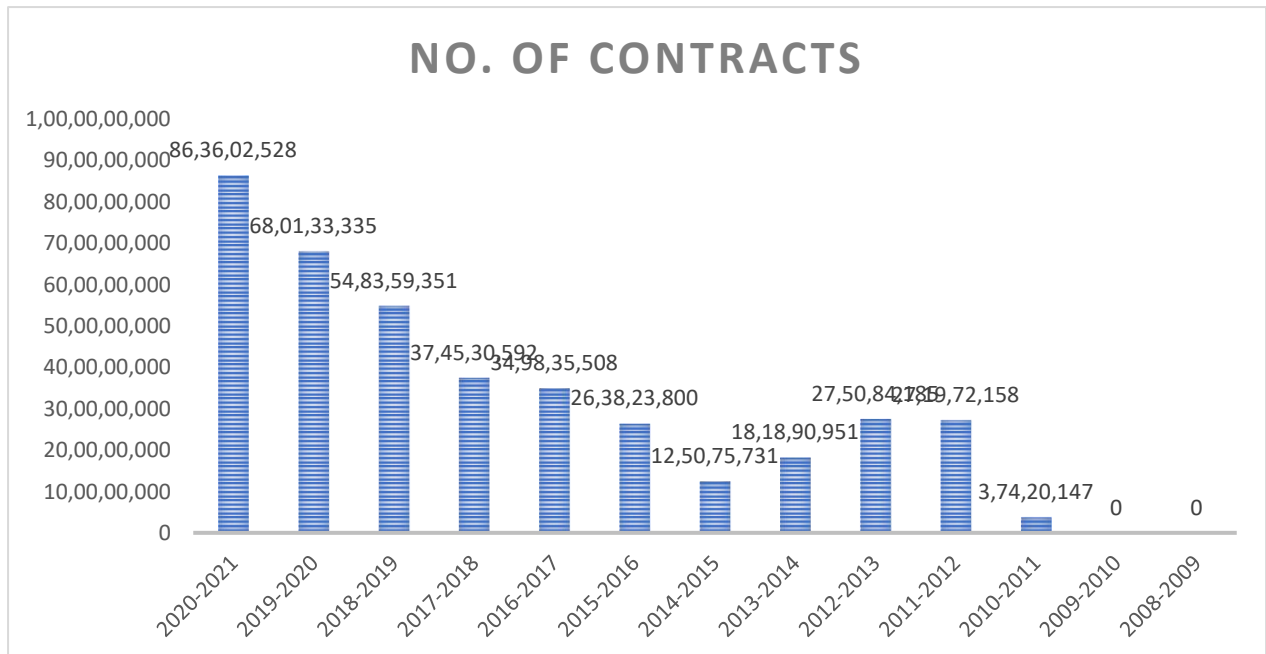


Graph 3.2 shows position of currency futures contract in terms of volume traded on NSE. The Graph 3.2 shows a growth till 2012-23 from 2008-09 and starting from 2013-14 volume traded graph on NSE comes down. But again in year 2018-19 to 2019-20 volume surged. The effect behind slow down was introduction of MCS-SX.

Currency Option Contracts:- Options trading was launched in year 2010 for underlying USINR. Graph 3.4 shows growth in terms of number of contracted traded. Trend in data of number of contract per years shows a continuous growth.

Graph 3.3

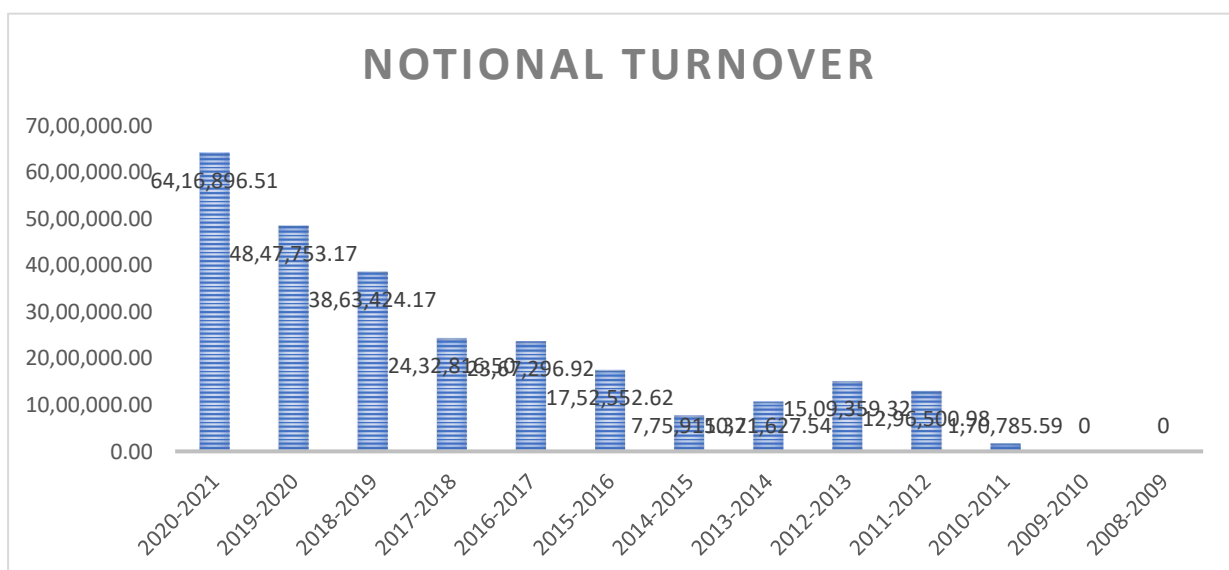
NO OF CONTRACTS



Graph 3.5 shows growth in turnover of Currency traded from 2010. Growth trend in turnover is same as the volumes of option contract was seen in graph 3.4.

Graph-3.5

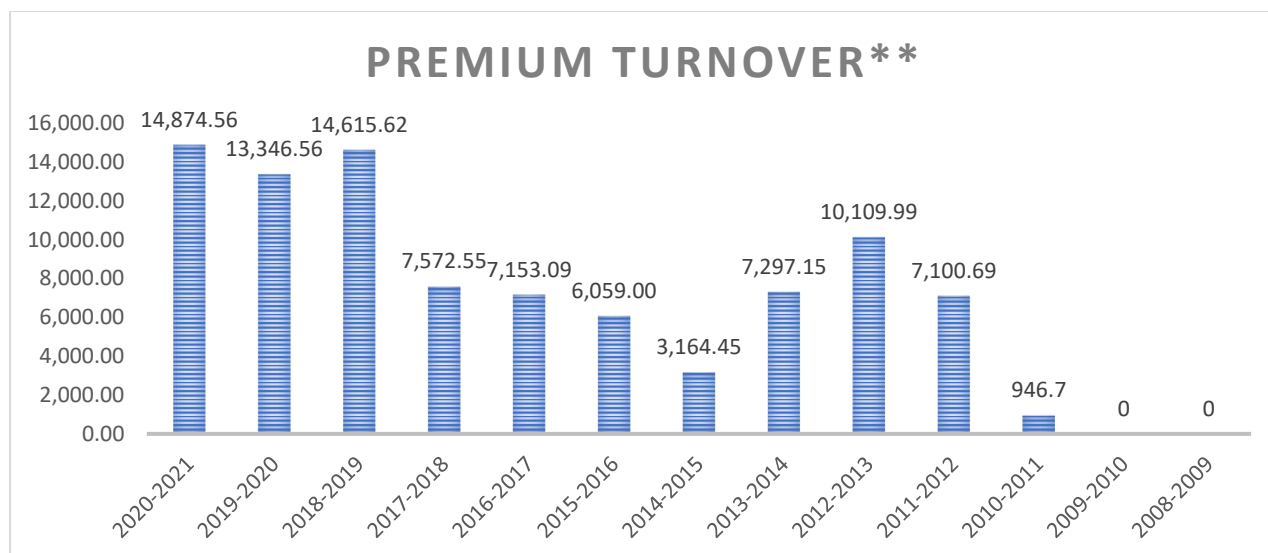
NATIONAL TURNOVER



Graph 3.6 show the growth pattern in term of Currency Option premium turn over traded on NSE.

Graph 3.6

PREMIUM TURNOVER



3.15. Clearing & Settlement Process

In August 1995, the National Stock Exchange (NSE) established the National Securities Clearing Corporation Ltd. (NSCCL), a fully owned subsidiary. It was the first clearing company in India to provide settlement guarantee, and it also claims to be the country's first clearing organization. NSE Clearing & Settlement Company Limited (NSCCL) is responsible for clearing and settling transactions in the NSE's equities and derivatives markets. There are no unusual twists or turns in the normal settlement cycle. It tallies transactions over a certain time frame, nets off positions to ascertain members' liabilities, and verifies cash flow and security holdings to ensure compliance with different commitments.

3.16. Clearing Members

The Clearing Member (CM) of NSCCL (The National Securities Clearing Corporation Ltd.) is responsible for settling and clearing all transactions conducted by the Trading Member (TM) at the National Stock Exchange (NSE). Clearing Member (CM) performs the following responsibilities in general:

3.16.1. Clearing - Clearing Member (CM) is responsible of computing

obligations of all his TM's i.e. determining positions to settle.

3.16.2. Settlement - Clearing Member (CM) execute real settlement. Only funds settlement is allowed at present.

3.16.3. Risk Management - Clearing Member (CM) are also involved in setting position limits based on upfront deposits / margins for each TM.

3.17. Types of Clearing Members

3.17.1. Trading Member Clearing Member (TM-CM): As well as being a Trading Member, this person also acts as a Clearing Member. Trading Members (TMs) and Custodial Participants (CPs) may clear and settle deals with these Clearing Members (CMs), as well as trades for their own customers.

3.17.2. Professional Clearing Member (PCM): A CM who does not act as a Trading Member (TM). Normally, banks and/or custodians join the Professional Clearing Member (PCM) programme in order to provide timely clearing and settlement for Trading Members (TM) and Custodial Participants.

3.18. Clearing Banks

There are thirteen (13) clearing banks in India, including Hub Bank Ltd., Bank of India, Canara Bank, Citibank N.A., HDFC Bank, Hong Kong and Shanghai Banking Corporation Ltd., ICICI Bank, IDBI Bank, IndusInd Bank, Kotak Mahindra Bank, Standard Chartered Bank, State Bank of India, Union Bank of India, and Union Bank of the United States of America (NSCCL). Each Clearing Member is responsible for keeping abreast of and opening accounts with all of the recognized clearing bank branches. Just use these clearing accounts for settlement and clearing.

3.19. Clearing Mechanism

The open position of a Clearing Member is calculated by adding the open positions of all Trading Members (TM) as well as all custodial participants clearings through him.

The open positions of a Trading Member are made up of his own open positions as well as those of his clients.

3.19.1. Proprietary / Clients' Open Position:

When placing orders on the trading system, members must indicate whether the transactions are proprietary (the member's own) or client (the member's client) using the Pro/Cli sign. Each customer's position is determined by adding or subtracting their net and gross holdings, meaning that a sale will cancel out a purchase and a purchase will cancel out a sale.

3.19.2. Open Position:

When determining open positions, proprietary positions are computed independently of client positions.

3.20. Settlement Schedule:

Daily mark to market (MTM) settlements occur on a T+1 day basis, whereas final settlements occur on a T+2 day basis. Those members who have commitments that need payment must have the funds in their main clearing account by 8:30 am on the settlement day. Following that, the monies are credited to the members' primary clearing account.

Settlement Price: There are two type of settlement price. They are

- Daily Settlement Price for mark to market settlement of futures contracts
- Final Settlement Price for mark to market settlement of futures contracts:

3.21. Mark-to-market settlement price for futures contracts on a daily basis

On a trading day, a contract's closing price becomes its settlement price for that day. Futures closing prices are computed using the weighted average price of the previous trading day's last half-hour trade. The theoretical daily settlement price is set for those futures contracts that are still unexpired (haven't been traded in the last half hour), and it is computed using the following formula:

$$F_p = S_p e^{(r - r_f) T}$$

Where:

F_p = Theoret. Futures price, S_p = Spot price of the
underlyingr = Cost of financing using interest rate
(relevant MIFOR rate)

r_f = Foreign risk free interest rate (relevant
LIBOR rate), T = Time to expiration, $e = 2.71828$

3.22. Final Settlement Price for mark to market of futures contracts The foundation for final price settlement is the Final Settlement Price of futures contracts for various underlying currencies; alternatively, the competent body might specify it from time to time.

TABLE 3.3

SETTLEMENT MECHANISM

	USDINR	EURINR	GBPINR	JPYINR
Final settlement price	RBI reference rate	RBI reference rate	Exchange rate published by RBI in its Press Release captioned RBI reference Rate for US\$ and Euro	Exchange rate published by RBI in its Press Release captioned RBI reference Rate for US\$ and Euro

Settlement Mechanism:

The settlement mechanism makes it easier for participants to modify their profit or loss on a daily basis when they trade futures through the NSCCL's marked to market process. It consists of two types of settlements: the first is the Daily Mark-to-Market Settlement, and the second is the Final Settlement. This is explained as follows:

3.23. Settlement of futures contracts on currency

3.23.1. Daily Mark-to-Market Settlement:

At the close of trading each day, individuals' future holdings are "put aside to spotlight," or "made public," based on the daily settlement cost. The net gain or loss in value of a fated transaction is calculated as the difference between the settlement cost on the previous day and the settlement cost on the current day. Anyone who does not come out on top of a clearing should send the imprint to-showcase loss total to NSCCL, which will then redistribute the funds to those who did. Consistently, a process called as "mark-to-showcase settlement"

takes place. As shown above, the formula $F_p = S P e^{(r-r_f) T}$ is used to calculate the hypothetical daily settlement costs for extraordinary destiny contracts.

Each day, clearing agents are responsible for collecting and settling the assets related to the imprint to market and the benefits/losses procured/suffered by TMs and their clearing and settling customers. On day T+1 (T = Trade Day), you will get your first installment and complete the imprint to exhibit settlement. There is a regular stamp in the clearing ledger of the clearing section that shows losses or credits to it.

3.23.2. Final Settlement:

In the event that a futures contract has an expiry date, NSCCL is responsible for the final settlement, which entails marking all clearing members' (CM) positions to the final settlement price and paying the profit or loss in cash. In order to calculate settlement profits or losses, the latest trading day's RBI reference rate for that futures contract is subtracted from the transaction price (or settlement price of the previous day's, as the case may be, issued by the relevant authorities). On T+2 (T being the final trading day), the clearing CM's bank account is updated to reflect any losses or profits.

Positions in settled futures contracts are closed at the close of trade on the last trading day.

3.23.3. Conclusion

When the world is full of uncertainty, the advent of the derivative market makes perfect sense, especially for individuals who want to engage in the financial market but are afraid of the risk involved. Derivative markets entice people to come in and engage, allowing them to become potential market participants. Derivative markets have created a wide range of products that make risk transfer as a risk management tool easier in the financial sector. The derivative market isn't a new notion any longer. During the year 2000, the Chicago Mercantile Exchange (CME) in the United States and the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE) in India all opened for futures trading. This market is expanding at a rapid pace. In India, the derivative market received its first formal and legal standing in the years 2000-2001 for index and stock derivatives, followed by currency derivatives in 2008. Derivative trading, which is recognised as one of the fastest growing risk management systems, is now fully integrated into the Indian financial market. In India, exchange traded derivatives are largely standardised, resulting in clear and smooth transaction processes for investors. The regulatory authorities for this segment of the financial market, including currency derivatives, are SEBI and RBI. Price discovery, risk transfer, controlled speculative trading, and

contribution to economic growth are all vital aspects of a robust derivatives market. These characteristics of the derivative market have propelled the Indian financial sector to new heights. While more participation in the derivatives market may have positive effects like risk hedging, increased market efficiency, and better price discovery, it also seems to have negative effects like increased debt and a lack of applicable accounting rules. Allowing derivatives should not be done without stressing the significance of fostering and building robust accounting procedures for these markets.

CHAPTER-IV

RESEARCH METHODOLOGY

4.1. Introduction

This section consists of the methodology followed to carried out presented research work, to analysis of data, to test hypothesis to meet our research objectives. This section explains the data & sample and variable taken for the presented research work and analytical tools being used. Specifically, the econometric tools are described under this section and their application.

4.2. Methodology Applied

4.2.1. Data and Sample

In presented research work includes daily closing prices for currencies futures of USINR, EUROINR, GBPINR and JPYINR from NSE derivative segments. Spot exchange rate data of currency which have their currency futures in India have been taken from RBI (Reserve Bank of India) website to trace our objective of ascertain volatility trend, if any, in spot market after the introduction of currency futures in India. Also, to conduct presented research work and to achieve objectives data like currency future prices, Volume traded and Open interest have collected of all four currencies. Ultimately, spot exchange rates have been used for volatility modelling by non-liner volatility model viz ARCH, GARCH. Data have been collected for different time periods according to the need of objectives. Visibility from a neutral perspective Exchange rate data of USD-INR, EUR-INR, GBP-INR, and JPY-INR for the research period of February, 2004 to August, 2020 were collected from the RBI's website to investigate the pattern of spot exchange rate changes after the introduction of currency futures in India's foreign exchange market (Reserve Bank of India). The USDINR futures market opened for trading on August 29, 2008, and in October of same year, the EURINR, GBPINR, and JPYINR futures markets were created. For objective two i.e. To study the price discovery mechanism in Indian currency future markets, the data of underlying market and currency futures USDINR has taken from RBI website and NSE 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 NSE. Second, to observe the spillover effect in both the time series data. Further

for objective three i.e. Daily data on money prospects' closing value, volume, and open revenue have been used to examine the special relationship between price volatility, trading size, and market depth for cash futures contracts in India. Sample data covers the period for USDINR from 29th October, 2010 to 31st August, 2020 and same for other three currencies like EUROINR, JPYINR and GBPINR. Objective four i.e. To forecast the currency spot price in Indian foreign exchange market, currency spot rate price volatility done through ARCH and GARCH data of USDINR collected from 29th October, 2010 to 31st August, 2020.

4.2.2. Data Analysis: To carry out presented research work there has been used several econometric tools and analysis such as Unit root test, LM test for heteroskedasticity, Granger causality test, Johansson Co-integration test for establishment of long run relationship, Vector Error correction model for test of short run relationship, Impulse response function for shock effect analysis, and volatility model to model the spot rate volatility. Along with econometric tools, basic statistics also helped to analysis to do fundamental work of data. Also, graphical representation is used as and when required.

The return of time series data was calculated by following formula:

$$R_t = \text{Log}\left(\frac{P_t}{P_{t-1}}\right) \quad (1)$$

Where, P_t = Price at time t (Natural Log Value),

P_{t-1} = price at time $t - 1$ (Natural Log Value)

4.3. Initial Analysis

As we begin to inside investigation of efficacy of futures on spot exchange rate and their interactions. It is essential to know the nature of data necessary for analysis to apply econometrical tools. To understand the basic nature of the data descriptive analysis and graphs are being used. It was imperative to check of Stationary of the raw data before applying VECM, Volatility modelling tools ARCH and GARCH model through ADF test.

4.4. Prime Analysis

In process of undertaking the systematic literature review we have found that many research articles are ready available which have shown the volatility of in underlying

derivatives after introduction of futures and options. Hodson *et al.* (1991)⁶¹ and Thenmozhi (2002)⁶² shown volatility by standard deviation analysis. In presented research work new models to observe volatility has been adopted such as GARCH model keeping in view heteroskedasticity effect in returns.

Presented research work is based on econometric tools of analysis in respect of time series data. Steps are involved in the process of this analysis are Stationary test which is imperative and the first step. Stationary test is a test where mean and the variance are constant.

4.5. Unit Root: To check Stationary of a time series data can be don't through applying of Following methods:

Dicky Fuller Test and Augmented Dickey Fuller Test

The data used in this study are time series, which are notoriously non-stationary and whose non-Stationary can lead to erroneous conclusions. To mitigate this problem, the researchers have used the Augmented Dickey Fuller test (ADF) and the Phillips Peron test (PP) to verify the presence of a unit root in the data.

4.5.1. Augmented Dickey Fuller (ADF) test

Even though the estimated errors are implicitly presumed to be statistically independent and homoscedastic by the Augmented Dickey Fuller (1979)⁶³ and there can no effect found of heteroskedasticity in unit root results. But the presence of auto correlation in the computed error term (ε_t) creates a problem to make results spurious. Random walk is fit to explain non-stationary in unit root. It is conceivable for a unit root to exist in a time series under three different scenarios. First, time series data may have a random walk structure. A random walk with drift and trend is third in the data set. The three prerequisites are described by the following equations:

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

$$\Delta Y_t = a_0 + a_1 Y_{t-1} + \sum_{j=1}^p \beta_j \Delta Y_{t-j} + \varepsilon_t \quad (3)$$

⁶¹ Hodgson, A, Nicholls, D., (1991), 'The impact of index futures on Australian share-market volatility', -Journal of Business Finance & Accounting||, Vol. 18(2), pp. 267-280.

⁶² Thenmozhi M. (2002), 'Futures Trading, Information and spot price volatility of NSE-50 Index Futures Contract', -NSE Research Publications||, <https://www.nseindia.com/content/research/Paper59.pdf>.

⁶³ Dickey D. A. And Fuller W. A. (1979), 'Distribution of the Estimators for Autoregressive TimeSeries with a Unit Root', -Journal of the American Statistical Association||, Vol. 74, pp. 427-431.

$$\Delta Y_t = a_0 + a_1 Y_{t-1} + a_2 t + \sum_{j=1}^p \beta_j \Delta Y_{t-j} + \varepsilon_t \quad (4)$$

Where, residual in the series data shows as ε_t that is called noise. The residuals must be free from the autocorrelations and the lowest number of error term ε_t that ascertain the extra lagged difference terms. In econometric methodology tests are available to determine the number of lags when noise is present in the time series data they are called the lag length criteria' such as AIC (Akaike Information Criterion) or SIC (Schwartz Bayesian Criterion). We apply these tests to test null hypothesis i.e. (H_0): Y_t is not I (O) and if ADF t-statistics value is less than their respective critical value given in the table then we accept the null hypothesis and series is called non-stationary.

4.5.2. Phillips-Peron (PP) Test

The assumption underlying distribution theory and the Dickey-fuller tests is that the error term is statistically independent and that constant variance exists. As a result, while running the ADF test, the researcher must ensure that the errors term (ε_t) is not correlated (auto-correlated) and that the constant variance remains constant throughout time. Phillips and Perron (1988)⁶⁴ improved the ADF test by generalising the processes and allowing for slightly lower assumptions about error distribution. The following is the regression equation for the Phillips and Perron test:

$$\Delta Y_{t-1} = a_0 + a_1 Y_{t-1} + \varepsilon_t \quad (5)$$

In Phillips and Peron (PP) test it is imperative that test does rectifications to the Y t-statistic from AR (1) regression to consider for the serial-correlation in error term (ε_t). Whereas, ADF test rectifies the higher order autocorrelation by adjoining differencing terms on the right hand side. All the statistics are modelled to test the hypothesis $\{(H_0) = 0\}$, i.e. there are existence of unitroot. Therefore, the Phillips and Perron (PP) tests are nothing but just reforms of the ADF t-statistics that brings –the less restrictive nature of the error process– into consideration.

4.6. Johansen's Co-Integration Test and Johansen's Vector Error Correction Model

⁶⁴ Phillips P.C.B. and Perron P., (1988), 'Testing for a Unit Root in Time Series Regression', -Biometrika|| Vol. 75, No. 2, pp. 335-346.

(VECM)

When two or more time series components (such as spot value (Sp) and futures value (Ft)) must be synchronized, and when the two costs are variable at level but fixed immediately in contrast, they are considered an integral part of request 1. Thus, anything is said to be co-ordinated if it involves a number of time series components that are thought to be coordinated in the same order of distinction and the direct mix of those details is not thought to be fixed. The existence of a long-term connection between the components is shown by the occurrence of such a direct mix among time series information. Granger (1981)⁶⁵ was the first to introduce the concept of co-integration to statistical analysis, and his 1986 refinement of the idea made it widely used. Engle and Granger identified the equilibrium connection between short-run and long-run connections among variables. (1987)⁶⁶. Since the adjusting process through the Error Correction Model would eventually lead to equilibrium, the role of the co-integration test in predicting the short term or disequilibrium becomes very important. The co-integration test has helped analysts establish the stability of relationships between variables across extended and brief time frames. (Granger1986)⁶⁷.

Soren Johansen (1991)⁶⁸ invented the Johansen co-integration test, which includes more than one equation for co-integrating relationships between two or more variables, which was missing from the Engle Granger co-integration test. The ADF test for unit root in the residual was used to support Engle Granger co-integration, which advocates for a single co-integrating connection. In order to determine whether there is a lasting relationship between spot and futures prices in the Indian Currency futures market, the same Johansen co-integration test is used (1991). The specific vector number in co-integrating equation is computed by maximum likelihood that is based on the trace statistics (λ_{trace}) and Eigen value ((λ_{max})) developed and enhanced by Johansen 1991 and 1995.

⁶⁵ Granger Clive (1981), 'Some properties of time series data and their use in econometric model specification', -Journal of Econometrics, Vol. 16, pp. 121-130.

⁶⁶ Robert F. Engle; C. W. J. Granger, (1987), Co-Integration and Error Correction: Representation, Estimation, and Testing', -Econometrica, Vol. 55, No. 2, pp. 251-276.

⁶⁷ Granger Clive, (1986), 'Developments in the Study of Cointegrated Economic Variables', -Oxford Bulletin of Economics and Statistics, Vol. 48, Issue 3, pp. 213-28.

⁶⁸ Johansen Søren, (1991), 'Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models' -Econometrica, Vol. 59, No. 6, pp. 1551-1580.

The method of Johansen has a process of giving the rank (Π) into two matrices i.e. α and β and two matrices become $k \times r$ matrices here, $k < \infty$ in a way that $\Pi = \alpha \beta'$ so that rows for β can be explained as where r is different the co-integration vectors. Following that, the appropriate co-integrating vector would be assigned based on the Eigen value (Johansen 1995). Johansen recommended a trace test for knowing the co-integrating rank r therefore it become $(\lambda_{trace}) = -T \sum_{i=r+1}^k \ln(1 - \lambda_i)$. He also recommends using the likelihood ratio (LR) test to see if the maximum number of co-integrating vectors exist against $r+1$ in a way that shows $\lambda \max(r, r + 1) = -T \ln(1 - \lambda_t)$.

Granger was the first to introduce the notion of co-integration for the purpose of statistical analysis between the two time series (1981)⁶⁹. Granger and Engle proposed explicit criteria for verifying the co-integration hypothesis in 1987. The regression analysis is carried out at the level of the original series to determine the residuals, which can be interpreted as equilibrium pricing mistakes. During that time, residuals from the regression were subjected to a co-integration test, which was accomplished using the ADF test. The co-integration regression equation is shown below, and it is based on two time series variables, S_t (currency spot price) and F_t (currency futures price), both of which have the same value.

$$S_t = \alpha_0 + \alpha_1 F_t + \varepsilon_t \dots \dots \dots (6)$$

Here, S_t is spot price regressed on a constant α_0 and F_t is futures price and α_1 is a coefficient of the regression and ε_t error term.

Granger and Engle (1987)⁷⁰ provide a co-integration test based on a first-rate integration result and OLS estimation to locate the co-integrating vectors with parameter estimates. The co-integrating vectors with estimators (maximum likelihood) for an autoregressive (AR) process were created by Johansen (1988)⁷¹ and Juselius & Johansen (1990). For calculating the numbers of co-integrating vectors, they employed the technique of independent Gaussian errors in combination with the likelihood ratio test. The approaches established by Johansen & Juselius have the benefit of taking into account the error structure

⁶⁹ Granger Clive (1981), 'Some properties of time series data and their use in econometric model specification', -Journal of Econometrics, Vol. 16, pp. 121-130

⁷⁰ Robert F. Engle; C. W. J. Granger, (1987), Co-Integration and Error Correction: Representation, Estimation, and Testing', -Econometrica, Vol. 55, No. 2, pp. 251-276.

⁷¹ Johansen, (1988), 'Statistical analysis of co-integration vectors', -Journal of Economic Dynamics and Control, Vol. 12, pp. 231-254.

of the underlying process. This approach is capable of incorporating both short and long term relationships in the system of variables under investigation. When computing deviations in short run equilibrium, it allows researchers to evaluate and estimate the equilibrium point between two or more non stationary data series. As a result, when the equation model is appropriately stated, it provides a superior and more impactful method.

To assess the long run connection between the two data series, the Johansen co-integration (1988, 1991)⁷² technique is utilised. This exam determines whether or not they are co-integrated. The following equation is used to estimate the Vector Error Correction Model-VECM (Johansen, 1988):

$$\Delta X_t = \Pi X_{t-1} + \varepsilon_t: \frac{\varepsilon_t}{\Omega_{t-1}} \sim (0, H_t) \dots \dots \dots (7)$$

Where, X_t denote vector of spot exchange and future price in terms of 2 x 1. On the other hand Δ denotes as first order change operator. (ε_t) denote 2 x 1 residual comprising futures and spot $(\varepsilon_{st}, \varepsilon_{ft})$ i.e. observed as conditional distribution with 0 mean and covariance matrix (H_t) . The measurement of VECM consist of adjustments for short run and long run to variations in (X_t) by the parameters computed of Γ_i and Π that can be stated as $(I - \Pi_1 - \Pi_2 - \dots - \Pi_p)$ and $-(I - \Pi_1 - \Pi_2 - \dots - \Pi_p + 1)$. Π_1 by Π_{p+1} are 2x2 matrices of co-efficient. The term, which is known as the co-integrating constant in the system of VAR model, represents the co-integration in the system of equations, whether it is co-integrated and, if so, to what extent.

In 1990⁷³ Juselius and Johansen specified that coefficient matrix that shows through Π has the essential information of the existence of long run relationship between spot prices and futures prices and specifically when rank is equal to 0 i.e. $(\Pi = 0)$, there Π becomes 2 x 2=0 that shows that the matrix has no presence of co-integration in spot price and future prices.

Johansen (1988) was the first to propose this alternative approach, which was subsequently updated by Juselius and Johansen in 1990 using the maximum likelihood method. Among the many strategies available today for assessing the equilibrium connection in the long run as well as the short run, Johansen co-integration techniques are thought to be the best and one of the most potent tools. The test is executed through considering the Π matrix through the Eigen

⁷² Ibid 104 & 105.

⁷³ 105, Vol. 52, Issue 2, pp. 169–210

Value technique to check the co-integration among the two variables. In Johansen's procedure follow the descending order for managing of the Eigen values.

$$\lambda_1 \geq \lambda_2 \geq \lambda_3 \geq \dots \dots \dots \geq \lambda_n$$

Where, λ_1 depicts the highest value and λ_n the minimum value.

When using the maximum likelihood technique, the Johansen's approach adopts two specific approaches to assess the co-integration:

4.6.1. Lamda Max (λ_{max}) Test

The technique used in Max Eigen test H_0 for either co-integrating rank as same as r in opposite of alternative H_1 either the co-integrating rank is equal to $r+1$. This model is applied as follows:

$$\lambda_{max}(r, r + 1) = -T \ln(1 - \lambda_r + 1) \dots \dots \dots (8)$$

Where, λ_1 depicts the Eigen Value.

This method is estimated over and over upto $r=1 \dots \dots k$, until the H_0 is rejected.

4.6.2. Lamda Trace (λ_{trace}) Test

The trace statistics is to check the $H_0 = r$ even if co-integration rank is as it is r in opposite to the H_1 even it the co-integration reached k or greater than r . This method is executed in reverse order $r=k, k-1, k-2$ viz $=0$. Its equation is as follows:-

$$\lambda_{trace} = -T \sum_{i=r+1}^k \ln(1 - \lambda_i) \dots \dots \dots (9)$$

r in equation 8 & 9 shows the number of vectors of cointegration among the series & λ_i depicts calculated figure of i^{th} organized Eigen figure in derived by Π matrix. Co-integration model examines the existence of Stationary linear connection of non-stationary variables of equilibrium connection between variables. The connected relationship if later utilized for ECM (Error Correction Model). ECM is a tool which depicts the relationship between financial dynamics in the variables that reinstate equilibrium position where disequilibrium appears. It even known as causality must exist series. Even if there is a co-integration relationship exists spot and futures and then the causal relationship can be analyzed by VECM model: -

$$\Delta S_t = a_{s,0} + \sum_{i=1}^{p-1} a_{s,i} \Delta S_{t-1} + \sum_{i=1}^{p-1} b_{s,i} \Delta F_{t-i} + a_s Z_{t-1} + \varepsilon_{s,t} \dots \dots \dots (10)$$

$$\Delta F_t = a_{F,0} + \sum_{i=1}^{p-1} a_{F,i} \Delta F_{t-1} + \sum_{i=1}^{p-1} b_{s,i} \Delta F_{t-i} + a_F Z_{t-1} + \varepsilon_{F,t} \dots \dots \dots (11)$$

The Error Correction Model (ECM) would show dynamic correlations as well as causalities among their returns whenever spot price and futures price are discovered to be co-integrated. The oscillation points in the futures price will lead to the oscillation points in the spot price, or futures prices granger causes spot prices, when the coefficient on the lagged futures price returns back in the equation for spot prices and is also seen to be significant. When the prices of two assets move in lockstep and their spreads are mean reverting, there must be a causal relationship between them, but this relationship may shift over time.

The significance of the ECM coefficient is tested using the T-test, and the significance of the estimated coefficients as a whole is tested using the F-test (lagged values). The number of lags needed for the study using Co-integration and the VECM model is fixed using the AIC and SIC criterion. When both spot and futures are determined to be important, it suggests a two-way or feedback link between the two markets. The important results from and make it possible to forecast the causality's orientations, the rate of equilibrium adjustment, and the market's tendency to lead or lag.

4.7. Granger Causality Test

With the help of Granger Causality, a statistical approach created by W. J. Granger in 1969, one may infer the relationship between many time series and their potential causes. The foundation of Granger causality is the straightforward tenet that influence cannot come before cause. The bivariate regression model serves as the foundation for this suggested statistical concept:

$$S_t = \sum_{i=1}^n a_i F_{t-1} + \sum_{j=1}^n \beta_j S_{t-j} + \mu_{1t} \dots \dots \dots (12)$$

$$F_t = \sum_{i=1}^n \lambda_i F_{t-1} + \sum_{j=1}^n \delta_j S_{t-j} + \mu_{2t} \dots \dots \dots (13)$$

Where, F_t shows future series return price and return price of spot series shown as S_t . Also λ_t δ_j a_i & β_t shows the coefficients of the related variables. μ_{1t} and μ_{2t} are error terms not

correlated to each other. When coefficient of eq. 13 of F_t in regression of S_t viz a_t for $i=1 \dots i$ are seen to be significant viz H_0 of futures prices not cause spot prices rejected. Also it can be said that there is presence of causality in the director form of futures prices to spot prices. It is characterised as a one-way or unidirectional causal relationship when just one variable influences the second variable, but a bidirectional or feedback causal relationship is when both the futures and spot variables influence one another. The F-statistic support is used to determine the importance of the coefficient.

4.8. ARCH Model

Ordinary least square (OLS) regression typically assumes constant error variance; however, if heteroskedasticity occurs in the data series, the OLS result is ineffective. The fact that financial data exhibits volatility clustering tendency, particularly in time series data, is crucial. In general, it can be shown from financial data series that greater returns are followed by even higher returns, and lower returns are followed by even lower returns in the future. The notion of volatility clustering uses the same reasoning, where big series fluctuations typically follow other large fluctuations and smaller series fluctuations typically follow other smaller series fluctuations. As a result, the estimate of OLS is inadequate and ineffective in studying the volatility due to the presence of heteroskedasticity in the series. Significant observations concerning the existence of heteroskedasticity in the stock return have been made by Mandelbrot (1963)⁷⁴, Fama (1965)⁷⁵, and Bollerslev (1986)⁷⁶ in their investigations. The ARCH and GARCH family models have also been used in the current research to analyse the volatilities in currency spot prices. If the data are showing the existence of heteroskedasticity, it becomes important to explore such techniques that address the concerns linked to heteroskedasticity.

The Autoregressive Conditional Heteroskedasticity-ARCH model, initially presented

⁷⁴ Mandelbrot Benott, (1963), 'The Variation of Certain Speculative Prices' -Journal of Business 36|| Vol. 394-419. Pp. 394-419.

⁷⁵ Eugene F. Fama. (1965) 'The Behavior of Stock-Market Prices', -The Journal of Business||, Vol. 38, No. 1, pp. 34-105.

⁷⁶ Tim Bollerslev(1986), 'Generalized Autoregressive Conditional Heteroskedasticity', -Journal of Econometrics|| Vol. 31, pp. 307-327.

by the Engel, deals with conditional variance and heteroskedasticity (1982)⁷⁷. The variance is modeled as a linear combination of earlier squared errors at a fixed delay in the ARCH model. To put it another way, we may say that volatility is modeled by allowing the conditional variance of the error component to vary with the squared errors that have happened in the preceding period.

After generalizing the ARCH model in 1986, Bollerslev came up with the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, which uses two distributed lags to explain variance. First, prior squared error to arrest news and high frequency effect are calculated as squared residual's lag from mean equation and are connected to the volatility of previous date. Second, lagged values from its own variance to account for long-term impacts

A GARCH (p,q) model can be computed by the following equation.

$$Y_t = \beta_1 + \beta_1 X_1 + \varepsilon_t \dots \dots \dots (14)$$

$$\varepsilon_t / \psi_{t-1} \sim (0, h_t)$$

$$H_t = a_0 + \sum_{t=1}^p a_1 \varepsilon_{t-1}^2 + \sum_{j=1}^q a_2 h_{t-1} + v_t \dots \dots \dots (15)$$

Where, Y_t is conditional mean with constant function β_0 exogenous variable X_i and error term ε_t in eq 14. Constant variance H_t is given in eq.15. H_t depicts the equation to forecast variance for a period ahead. H_t constitute of ARCH term and GARCH term to get the conditional variance for a period ahead i.e. $-H_t$. ARCH term is specified by $(\varepsilon^2 t_{-1})$ which has lagged squared residual calculated from the mean equation. The GARCH term is (h_{t-1}) known as lagged value of variance. Error Term is specified as v_t that also known as noise. Therefore conditional variance equation (H_t) becomes the function of a_0 constant $\varepsilon_2 t_{-1}$

⁷⁷ Robert Engle 1982. Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation, -Econometrica||, Vol. 50, issue 4, pp. 987-1007.

(ARCH), h_{1-1} (GARCH) & v_t as noise. p depicts degree of ε_t t_{-1} (ARCH) and q used for h_{1-1} (GARCH) in variance equation.

The size of the parameters a_1 and a_2 shows the dynamics for the time series variables' short-term volatility. More shocks have been experienced by the conditional variance if the degree coefficient of parameter a_2 is larger. Volatility has long-lasting effects, since its effects take time to fade. In order to assess the results of currency futures' introduction in India, GARCH (1, 1) has been applied to the spot market's volatility.

The primary approaches employed in this study are econometric models, which have previously been determined by several academics to be appropriate for making in-depth studies as stated in the literature review chapter.

The Auto-Regressive Conditional Heteroscedastic (ARCH) model was established by Engle (1982)⁷⁸ to represent the clustering of volatility in financial data. The following might be used to inscribe an ARCH method with order q :

$$\varepsilon_t = z_t \sigma_t$$

$$\sigma_t^2 = \omega + \sum_{i=1}^q a_i \varepsilon_{t-i}^2 \dots \dots \dots (16)$$

Where z_t is an i.i.d process (independently and identically distributed) along with mean $E(z_t) = 0$ and the variance $\text{Var}(z_t) = 1$, the model anticipated that ε_t is not auto-correlated and mean remain zero with time varying conditional variance σ_t^2 . It is adequate to enforce $\omega > 0$ and $a_i \geq 0$ to confirm that σ_t^2 remain positive during all the t which explain time duration. As the conditional variance of ε_t is an upward function of ε_{t-1}^2 , the ARCH model would explain the volatility clustering. Subsequently, if ε_{t-1} is big in total value, σ_t^2 and thus ε_t is also anticipated to be big in total value too. The unconditional variance of ε_t occurs when $\omega > 0$ and $\sum_{i=1}^q a_i < 1$,

and is specified through $\sigma^2 = E\left[\frac{\varepsilon_t^2}{\sigma_t^2}\right] = \frac{\omega}{1 - \sum_{i=1}^q a_i}$. Explanatory variables (e.g.

central bank interferences and policies related news declarations etc.) may be added in the conditional variance equation.

⁷⁸ Ibid. 113.

4.9. Generalized Autoregressive Conditional Heteroskedasticity (GARCH) Model

The Autoregressive Conditional Heteroskedasticity (ARCH) model, which Engle (1982)⁷⁹ introduced, is one of the most significant methods frequently employed for time series analysis in the financial literature. According to this ARCH method, the squared error terms from the prior period are what determine the residual variance at time t. The conditional normal distribution should be used as the basis for the error term ε_t , which should be free of auto-correlations. The ARCH model's use of the "conditional mean and conditional variance," the two key conditions for the study of financial variables, is a positive. These methods are well-established and well-defined.

4.9.1. GARCH (1,1)

One of the most beneficial generalisations of the ARCH model was the GARCH parameterization. Bollerslev (1986)⁸⁰ developed the GARCH model, which is based on the premise that the lagged variance of an asset affects the estimation of its time-varying variance, from Engle's ARCH (1982) model. The variance of the conditional return distributions shows long-term memory when the GARCH model specification is more durable when the return distribution is still leptokurtic. In comparison to the conventional standard statistical models, the GARCH approach specifications therefore become more accurate. As a result, any unanticipated growth or drop in the returns series at time t' will cause an increase in the expected inconsistency in the period that follows. Najand and others have shown that the GARCH (1,1) model performs well in the majority of the applicable situations.

One of the most fundamental and comprehensive models, the GARCH (1, 1) approach, may be stated as follows:

$$R_t = a + bR_{t-1} + \varepsilon_t \dots \dots \dots (17)$$

$$\frac{\varepsilon_t}{\sqrt{h_{t-1}}N(0, h_t)}$$

$$h_{it} = a_0 + \sum_{i=0}^p \beta_i h_{t-1} + \sum_{j=1}^q \lambda_j \mu^2_{t-1} \dots \dots \dots (18)$$

⁷⁹ Ibid. 113.

⁸⁰ Ibid. 113.

Where, R_t specified as realized return and h_{it} shows the conditional variance, i.e. proxied through R_{t-1} , & a, β and λ signs of coefficient that has to be estimated. The degree of coefficient β and λ shows the short term dynamic forces summarized as volatilities in time series. The sign λ computes h_t parameter defined by on-previous values and on-past values. The parameter β depicts to the previous time forecast variance. The informative consequences of the conditional variance are explained by the increased value of the GARCH term coefficient.

4.9.2. T-GARCH Model

Positive and negative market announcements have been seen to have an influence on volatility. The market's volatility is affected differently by news of the same size that is both good and negative. The leverage effect is used to explain this quality, according to Black (1976)⁸¹. Similar to this, Engle and Ng found that when market shocks of the same size are both positive and negative, the negative shock induces more volatility than the positive shocks (1993)⁸². Another expansion of the threshold GARCH model was developed by Glosten, Jagannathan and Runkle (1993)⁸³ and Zakoian (1994)⁸⁴ from the older GARCH model. This T-GARCH technique's main goal is to stop asymmetric behaviour in response to negative and positive shocks. To test if there is a statistically significant difference when positive and negative shocks are provided, it includes extra variables in the form of dummy for positive and negative news throughout the regression. The following is an explanation of the conditional variance for the threshold GARCH equation:

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

$$\frac{\varepsilon_t}{l_{t-1}N(0, h_t)}$$

⁸¹ Black, F. (1976), 'Studies of Stock Market Volatility Changes', -Proceedings of the 1976 Meetings of the American Statistical Association, Business and Economic Statistics Section, pp. 177-181.

⁸² Robert f. Engle and Victor k. NG, (1993), 'Measuring and Testing the Impact of News on Volatility', -The Journal of Finance, Vol. 48, Issue 5, pp. 1749-1778.

⁸³ Glosten L. R., Jagannathan Ravi and Runkle David E. (1993), 'On the Relation between the Expected Value and the Volatility of the Nominal Excess Return on Stocks', -The Journal of Finance, Vol. 48, pp. 1779-1801.

⁸⁴ Zakoian J.M., (1994), 'Threshold heteroskedastic models', -Journal of Economic Dynamics and Control, Vol. 18, Issue 5, pp. 931-955

$$h_{it} = a_0 + \sum_{i=0}^p \beta_i h_{t-1} + \sum_{j=1}^q \lambda_j \mu^2_{t-j} + \delta_1 \mu^2_{t-1} d_{t-1} \dots \dots \dots (19)$$

Identifying good news and bad news have distinct effects because ε_t takes the value of 1 if t is negative and 0 otherwise.

4.9.3. E-GARCH Model

The exponential GARCH model was proposed in 1991⁸⁵ by Nelson. According to Cao and Nelson (1992)⁸⁶, the linear GARCH approach severely restricts the non-negative constraints. The GARCH model imposes non-negative constraints on the parameters β_j and λ_j in this GARCH approach, but none are placed on the exponential GARCH parameters in the model. In the EGARCH model, the conditional variance, h_t , transforms into an asymmetric function with respect to the lagged disturbances, h_{t-1} . According to Nelson, "The E-GARCH approach reveals the conditional variance in logarithmic form, meaning it is not necessary to implement estimate restrictions in order to avoid negative variance" (1991).

The mean and variance equation is explained by the exponential GARCH model as follows:

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

$$\frac{\varepsilon_t}{\sqrt{h_{t-1} N(0, h_t)'}}$$

$$\log(h_t) = \alpha_0 + \sum_{j=1}^q \beta_j \left| \frac{\mu_{t-j}}{\sqrt{h_{t-j}}} \right| + \sum_{j=1}^q \lambda_j \frac{\mu_{t-j}}{\sqrt{h_{t-j}}} + \delta_1 h_{t-1} \dots \dots \dots (20)$$

Here, δ' stops the asymmetric effect. Even when there are negative parameter values, the conditional variance always stays positive because to the exponential properties of the E-GARCH approach. As a result, it is not necessary to apply non-negativity limitations on the parameter values.

4.10. Conclusion

⁸⁵ Daniel B Nelson, (1991), 'Conditional Heteroskedasticity in Asset Returns: A New Approach', -Econometrica, Vol. 59, issue 2, pp. 347-70.

⁸⁶ Daniel B. Nelson and Charles Q. Cao, (1992), 'Inequality Constraints in the Univariate GARCH Model', -Journal of Business & Economic Statistics, Vol. 10, No. 2, pp. 229-235.

This study aims to investigate how derivatives affect the underlying spot market, or exchange rate, in particular how the introduction of currency futures has affected it. Although numerous research have been done to determine how a derivative affects its underlying, the majority of them dealt with derivatives that were tied to stocks and indexes. Currency futures and the broader currency derivatives market are the focus of this investigation. The impact of derivatives trading on volatility and information flow in underlying spot markets have been investigated in order to better understand how these variables would shift in the post-derivatives era. All the tools and techniques you will need to analyze your data thoroughly and draw conclusions relevant to your study's stated objective are outlined in this section. A number of statistical tests, including the unit root test, the Johansson co-integration test, the Vector error correction model (VECM) test, and the GARCH family of models with a focus on time variation, were used in this study. Whenever possible, graphs were used to illustrate data, and descriptive statistics were used to help make sense of the raw data (Mandelbrot, 1963). The ADF and Philip Perron tests, descriptive statistics for understanding the structure of the data, the Arch LM test, and volatility clustering have all been used often to identify the existence of a unit root in a series. The GARCH model was implemented by calculating the Arch effect in the disturbance term using an ARCH family model.

CHAPTER-V

TO EXPLORE THE MOVEMENT-PATTERN OF SPOT EXCHANGE RATE AFTER INTRODUCTION OF CURRENCY FUTURES IN FOREIGN EXCHANGE MARKET IN INDIA

4.1. Introduction

With regard to the USD-INR, EURO-INR, GBP-INR, and JPY-INR pairs, this research was carried out to identify the Impact of currency futures on cash market or Spot exchange rates volatility. Daily closings have been collected from the RBI website for use in the research. The data's Stationary has also been checked using the augmented Dicky and Fuller (ADF) test of unit root. Generalized autoregressive conditional heteroskedasticity (GARCH) models have been used to simulate the movement of currency prices (I,I). Using statistical methods, we can observe that the volatility of exchange rate returns before and after currency futures trading began was notably different, and that volatility decreased when India's economic and financial system underwent reforms in 1991. Futures and options on individual securities were established shortly after the introduction of index futures in the equities market in the year 2000. These developments were made with the relevance of derivative products for a robust financial system in mind. Futures contracts on the US dollar appeared in 2008, and similar contracts on the euro, pound, and yen soon followed. With the introduction of currencies futures made currency derivative market as a useful tool risk management and cost effectiveness in currencies management or import & export business. But the literature reviews shows that there can be seen a visible impact of currencies futures on their underlying markets in different periods. A school of scholars emphasized that after the introduction of currency futures brought an instability in spot exchange rate volatility, second school of scholars says currency futures has improved the overall capital and equity markets. Therefore is it necessary to conduct an assessment of to observe the pre and post effect on underlying currencies of futures to check the volatility effect.

4.2. Data

The research period is from February, 2004 to August, 2020, and the RBI's website provided the USD-INR, EUR-INR, GBP-INR, and JPY-INR exchange rate data used in the analysis (Reserve Bank of India). On August 29, 2008, currency futures in USDINR were listed, and in October of the same year, EURO-INR, GB-INR, and JPY-INR futures were established. The primary purpose of the presented study is broken down into two parts: the period before the introduction of the USD-INR exchange rate (from 3rd February, 2004 to 31st December 2007), and the period after the introduction (from 1st January, 2006 to 31st January, 2010) for the EURO-INR, GBP-INR, and JPY-INR exchange rates. Post Introduction period data is from 1st February, 2010 to 30th September 2014 of Currencies EURO-INR, GB-INR & JPYINR and for USD-INR from 01st September, 2008 to 30th August 2013.

4.3. Research Methodology

There are two ways to make sense of the effect that trading currency futures has on the swings in the current exchange rate. The first step is to evaluate how the cash market fluctuated before and after the debut of currency futures. The literature on this topic is extensive (Bolongna & Cavallo, 2002; Edwards, 1988; Jochum & Kodre, 1998). Second, how the amount of future trade will affect trading in the spot exchange market. This research was the first to examine the effect of currency futures on the volatility of spot exchange rates for all four currencies before and after their entrance to the India Capital Market. The values of the exchange rate time series have been transformed into natural logarithms. Then, the series' return is calculated by using the initial difference between logarithms. Multiple empirical tests in the research made use of logarithmic returns. Descriptive statistics such as mean, median, mode, skewness, kurtosis, Jarque and Bera are employed over three time intervals (i.e., pre-post and entire period of time series return data) to get a deeper understanding of the time series. Stationary at the level is recognized to be a requirement for high-level statistical methods to be applied to time series data. The Stationary of the return series has been tested by using Augmented Dicky-Fuller (ADF) for unit root testing. The term "stationary" is used to describe a time series in which both the mean and variance are zero.

Non-stationary time series exhibit irregular patterns and have a unit root. The results imply that there is no value in applying sophisticated statistical tests to time series; instead, basic Stationary of the time series is all that is required. Daily USD INR, ERO INR, GBP INR, and

JPY INR exchange rates were used as time series variables, and the ADF test was performed on them using the equation below. -

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

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

$$\Delta Y_t = \alpha_0 + a_1 Y_{t-1} + a_2 t + \sum_{j=1}^p \beta_j \Delta Y_{t-j} + \varepsilon_t \dots \dots \dots (3)$$

Time series data has been further evaluated for the existence of heteroskedasticity using the Lagrange Multiplier (LM) method, and this is what is being looked at here. There is a fallacy in the Lagrange Multiplier (LM) that there is no effect of autoregressive conditional heteroskedasticity (ARCH). If the incorrect hypothesis is disregarded, then the period series should be heteroskedastic. Due to the assumption of constant blunder change, normal least square (OLS) regression assessments are inefficient when applied to a heteroskedastic time series. The ARCH model may be used to detect heteroskedasticity in time data. In 1986, Bollerslve introduced the GARCH (p, q) standard, which proposes that the sensitivity to change in profits is a direct capability of slack restrictive difference and previous squared blunder term. The equation of standard GARCH is as follows:

$$R_t = c + \beta_1 R_{t-1} + \varepsilon_t \dots \dots \dots (4)$$

$$h_t = \omega + \alpha_{t-1}^2 + \beta_1 h_{t-1} \dots \dots \dots (5)$$

It is possible to separate the influence of currency futures on cash market rate volatility from those of other variables affecting spot exchange rate volatility by using the CNX nifty's lagging values as an independent variable in the mean return calculation (Sahu, 2012). Thus, the equation is as follows:

$$R_t = c + \beta_1 R_{t-1} + \beta_2 R_{nifty,t-1} + \varepsilon_1 \dots \dots \dots (6)$$

Since the typical GARCH model of volatility cannot tell the difference between good and bad news, it conceals the asymmetric influence in the volatility. The volatility response to both good and negative news is assumed to be the same in this model. However, the link shown by the GARCH model might be deceiving in the case of asymmetric volatility. The extended GARCH (TARCH) model, also known as the GJR model (Glosten, Jagannathan, & Runkle,

1993), is used to address this shortcoming of the normal GARCH model. The positive effect of pleasant information is denoted by a , whereas the negative effect may be calculated as $a + g$ in the TARCH model. An asymmetrical effect of the news occurs if and only if g is not equal to zero. And if g is greater than zero, then unfavorable information tends to increase volatility. TARCH model variance can be expressed as:

$$\alpha_t^2 = \omega + (\alpha + \gamma I_{t-1}) \epsilon_{t-1}^2 + \beta \alpha_{t-1}^2 \dots \dots \dots (7)$$

Before and after currency futures were introduced, as well as during the whole research period, the asymmetric response of volatility in exchange rate series was analyzed separately. Performing this research is necessary because it will show if volatility has changed its behavior between the pre- and post-introduction times. Testing for asymmetric response throughout the whole time period helps zero in on the most useful GARCH model for dissecting the impact of currency futures trading on the volatility of spot exchange rates.

4.4. Empirical Results

The outcomes of transparent measurement are shown in Table 1. This indicates that the post-presentation time period now has a larger standard deviation. As a result, one might claim that the degree of uncertainty increased after the four different monetary outcomes were shown. Until we learn what led to the increase in volatility after the introduction of currency futures, we will not be able to understand why it happened.

More research is needed to form a fundamental suspicion about the relationship between the behavior of swapping scale returns and the prediction of future exchange rates. The unpredictability of time series data may be significantly influenced by a number of factors. The median value of all four currencies has also increased significantly. Table 1 shows that there is a negative skew in trade rates before the presentation time and a clear skew after the presentation period. Swap-scale return findings from the jarque-Bera test over all time periods are quite massive. Dispersion of the swapping scale value is not routinely given as has been corrected with comparable examinations done earlier, as shown by the worth of sknewnes, kurtosis, and Jarque-Bera proportions for the review period. Restoration of Stationary in the rescaling time series is fundamental to gaining a deeper insight into our evaluation. Each of the

three cash matches, regardless of catch, pattern, or block, must pass the ADF Stationary test at level pre-post and during all periods. After ensuring that the exchange rates are stationary, the return series is examined for the existence of an ARCH impact. Deeper investigation calls for determining whether or not the data has Stationary, i.e., whether or not the swapping scale time series information is fixed. Table-2 displays the results of using the ADF trial of unit root at several intensities and for varying time durations to achieve this aim. The ARIMA (p,d,q) model was used to estimate the average condition, and the request for "p" and "q" for inspecting the correlation matrix were selected. Part (p) is the autoregressive portion, and Part (q) is the moving midpoints portion; the applied ARIMA AR (1) and MA (1) terms discovered that the AR(1) portion is very large, and the MA(1) portion is also eminently important for move midpoints.

After examining AR(1) and MA(1), a Heteroskedasticity Test is conducted to examine H_0 : to see whether there is an ARCH influence. There is no effect of ARCH on the expected free time or on hypothesis 1. The amount of cushion between schedules is subject to an ARCH effect. Because we obtained a significance level of $p < 0.05$, we may be confident in the existence of the ARCH effect. There is just need for a single ARCH, but the percentage is 5%, so it is a big one. To get rid of the negative gaps later on, we used a Simplified GARCH model with a single variable to analyze the volatility of earnings in each of the four currencies. Regardless of how a series is perceived, clusters of unpredictability may be seen in both the pre- and post-period financial data. You can tell it is a Leptokurtic distribution—characterized by a high recurrence series with a fat tail—by looking at the histogram and the granular details. As a result, the series exhibits unstable bunching, with periods of large changes followed by other large changes and periods of little changes followed by other small changes.

When we apply GARCH (1,1) to the returns of the spot cash series, we see where the subordinate components are drawn from the pre-post and all-out periods, consistent with the existence of ARCH influence.

Convergence in Futures of Currency Presentation Table 10 displays the results of 12 USDINR Pre, 13 EUROINR Pre, 13 GBPINR Pre, and 19 JPYINR Pre cash mix presentations. At the period before the announcement of cash outcomes on the Indian Exchange Market, the ARCH and GARCH coefficients are both positive and enormous at the 1% level. Similarly,

prior to the display of cash destiny in the money trade market, data demonstrates that in each of the four monetary forms, all coefficients of the contingent change detail fulfill the strength states of 0b 11, 0_1, and b 1+ 11. However, b1+Q1 >1 in the EURINR and GBPINR exchange rates reveals substantial uncertainty in the foretelling of monetary destinies. These findings outline the existence of time-shifting dependent unpredictability of profits of cash spot costs at pre-post and all-out time of money fortunes presentation in the cash trade market.

The effects of ARCH were examined using the results of an LM test, which were calculated after the returns were transformed from their original scale format into the fixed data of each of the four monetary units.

After conducting the ARMA test, we conducted the LM test to each time series with the incorrect hypothesis that there would be no ARCH effect, and we discovered its existence. Since ARCH effects already exist, the GARCH (1,1) Model may be used.

Table 5.1 :

Descriptive Statistics and Normality of USD/INR, Euro/INR, GBP/INR & JPY/INR

Date: 11/10/21 Time: 22:11												
Sample: 2/03/2004 8/31/2020 USD_INR SP				Sample: 2/03/2004 8/31/2020 EURO_INR SP			Sample: 2/03/2004 8/31/2020 GBP_INR SP			Sample: 2/03/2004 8/31/2020 JPY_INR SP		
	PRE	POST	TOTAL	PRE	POST	TOTAL	PRE	POST	TOTAL	PRE	POST	TOTAL
Mean	43.988 37	58.59 184	55.10 754	59.46 405	74.90 991	68.60 603	79.35 125	92.41 289	85.50 595	42.86 896	60.83 877	53.500 31
Median	44.320 00	61.51 850	53.08 550	58.12 000	75.27 615	69.12 430	79.96 530	92.30 055	84.72 400	40.75 500	60.71 000	55.070 00
Maximum	46.950 00	76.80 840	76.80 840	71.06 000	91.46 820	91.46 820	89.42 080	106.0 281	106.0 281	55.96 000	72.12 000	72.120 00

Minimum	39.2700	39.27000	39.27000	51.84000	58.63000	51.84000	65.64710	79.85630	65.64710	32.69000	50.98000	32.69000
Std. Dev.	2.011328	10.07268	10.81490	4.873470	6.510339	9.613328	5.387385	6.294579	8.748130	6.332025	5.197431	10.50637
Skewness	-0.961839	-0.204370	0.251860	0.658612	-0.199065	0.049060	-0.351488	-0.010423	0.157066	0.548903	0.143267	-0.309121
Kurtosis	2.966299	1.729923	1.574535	2.326527	2.390808	1.843972	2.190421	1.888051	2.342050	1.992954	2.209663	1.919998
Jarque-Bera	147.6041	226.5261	381.9949	149.2839	52.38856	224.9551	101.5953	97.40307	88.83984	151.4686	69.87823	258.8144
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	42096.87	178939.5	221036.3	97342.65	177836.1	275178.8	168304.0	174660.4	342964.4	70219.36	144370.4	214589.7
Sum Sq. Dev.	3867.441	309754.2	469017.9	38856.16	100578.4	370588.4	61530.71	74845.44	306884.4	65634.75	64075.52	442639.1
Observations	957	3054	4011	1637	2374	4011	2121	1890	4011	1638	2373	4011

Table 5.2:
Unit Root Test

Augmented Dicky-Fuller Test Statistics				
Exchange Rate Data (Spot Rate)				
	USD_INR SP	EURO_INR SP	GBP_INR SP	JPY_INR SP
	With Intercept	With Intercept	With Intercept	With Intercept

Period	t-statistics	Prob.	t-statistics	Prob.	t-statistics	Prob.	t-statistics	Prob.
Pre-Period	0.14537 3	0.9689	- 1.68973 1	0.4363	- 1.68973 1	0.4363	- 0.62578 5	0.862 4
Post-Period	- 1.227825	0.6646	- 1.70967 3	0.4262	- 1.70967 3	0.4262	- 1.93458 2	0.316 5
Total-Period	- 0.040844	0.9537	- 1.00117 6	0.7550	- 1.00117 6	0.7550	- 1.07299 8	0.728 5
Augmented Dicky-Fuller Test Statistics								
Exchange Rate Data (Spot Rate)								
	USD_INR SP		EURO_INR SP		GBP_INR SP		JPY_INR SP	
	With Trend and Intercept		With Trend and Intercept		With Trend and Intercept		With Trend and Intercept	
Period	t-statistics	Prob.	t-statistics	Prob.	t-statistics	Prob.	t-statistics	Prob.
Pre-Period	- 0.867898	0.9576	- 2.24587 7	0.4631	- 2.24587 7	0.4631	- 1.80651 4	0.701 4
Post-Period	- 2.641545	0.2617	- 2.21699 0	0.4793	- 2.21699 0	0.4793	- 2.09905 7	0.545 5
Total-Period	- 2.553242	0.3022	- 2.97689 9	0.1388	- 2.97689 9	0.1388	- 2.43362 0	0.361 8

Augmented Dicky-Fuller Test Statistics								
Exchange Rate Data (Spot Rate)								
	USD_INR SP		EURO_INR SP		GBP_INR SP		JPY_INR SP	
	Without Trend and Intercept		Without Trend and Intercept		Without Trend and Intercept		Without Trend and Intercept	
Period	t-statistics	Prob.	t-statistics	Prob.	t-statistics	Prob.	t-statistics	Prob.
Pre-Period	-1.42541 1	0.1438	0.175462	0.7371	0.175462	0.7371	0.626790	0.8516
Post-Period	1.952827	0.9883	1.033451	0.9214	1.033451	0.9214	0.484381	0.8197
Total - Period	1.714167	0.9795	0.998064	0.9166	0.998064	0.9166	0.733874	0.8731

Table-5.3:**ADF Test on Return Series obtained Stationary in Time Series**

Augmented Dicky-Fuller Test Statistics								
Exchange Rate Return Data (Spot Rate)								
	USD_INR SP		EURO_INR SP		GBP_INR SP		JPY_INR SP	
	Without Trend and Intercept		Without Trend and Intercept		Without Trend and Intercept		Without Trend and Intercept	
Period	t-statistics	Prob.	t-statistics	Prob.	t-statistics	Prob.	t-statistics	Prob.
Pre-Period	-- 30.41035	0.0000	- 40.88307	0.0000	- 34.74697	0.0000	- 42.74499	0.0001
Post-Period	- 55.06619	0.0001	- 46.12490	0.0001	- 41.33486	0.0000	- 48.84284	0.0001
Total-Period	- 29.69763	0.0000	- 61.76807	0.0001	- 61.19628	0.0001	- 64.25992	0.0001

Table:5.4:**ARMA Results of Pre-Introduction of Currency Futures of USDINR_SP, EUROINR_SP, GBPINR_SP & JPYINR_SP**

USD_INR SP					EURO_INR SP				GBP_INR SP				JPY_INR SP			
Dependent Variable: PRE-USDINR_SP RETURN					Dependent Variable: PRE-EUROINR_SP RETURN				Dependent Variable: PRE-GBPINR_SP RETURN				Dependent Variable: PRE-JPYINR_SP RETURN			
Method: ARMA Maximum Likelihood (BFGS)					Method: ARMA Maximum Likelihood (BFGS)				Method: ARMA Maximum Likelihood (BFGS)				Method: ARMA Maximum Likelihood (BFGS)			
Date: 12/02/21 Time: 18:54					Date: 12/02/21 Time: 19:01				Date: 12/02/21 Time: 19:04				Date: 12/02/21 Time: 19:09			
Sample: 2 957					Sample: 2/04/2004 10/28/2010				Sample: 2/04/2004 10/29/2012				Sample: 2/04/2004 10/29/2010			
Included observations: 956					Included observations: 1636				Included observations: 2120				Included observations: 1637			
Convergence achieved after 21 iterations					Convergence achieved after 29 iterations				Convergence achieved after 18 iterations				Convergence achieved after 17 iterations			
Coefficient covariance computed using outer product of gradients					Coefficient covariance computed using outer product of gradients				Coefficient covariance computed using outer product of gradients				Coefficient covariance computed using outer product of gradients			
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000146	9.99E-05	1.458206	0.1451	5.26E-05	0.000157	0.335588	0.7372	2.22E-05	0.000156	0.142084	0.8870	0.000153	0.000203	0.753574	0.4512
AR(1)	0.461769	3.494591	0.132138	0.8949	0.508930	0.535227	0.950868	0.3418	-0.460269	0.264632	-1.739278	0.0821	0.543517	0.144592	3.758962	0.0002
MA(1)	-0.466726	3.493886	-0.133584	0.8938	-0.529183	0.529411	-0.999570	0.3177	0.499887	0.258528	1.933591	0.0533	-0.606900	0.137015	-4.429453	0.0000
SIGMA ² SQ	9.28E-06	2.51E-07	36.96799	0.0000	4.30E-05	9.26E-07	46.38959	0.0000	4.53E-05	7.53E-07	60.18362	0.0000	8.27E-05	1.72E-06	48.15086	0.0000

Table:5.5 ARCH effect Results of Pre-Introduction of Currency Futures of USDINR SP, EUROINR SP, GBPINR SP & JPYINR SP

USD_INR SP					EURO_INR SP				GBP_INR SP				JPY_INR SP			
Test Equation:					Test Equation:				Test Equation:				Test Equation:			
Dependent Variable: RESID^2					Dependent Variable: RESID^2				Dependent Variable: RESID^2				Dependent Variable: RESID^2			
Method: Least Squares					Method: Least Squares				Method: Least Squares				Method: Least Squares			
Date: 12/02/21 Time: 18:56					Date: 12/02/21 Time: 19:02				Date: 12/02/21 Time: 19:05				Date: 12/02/21 Time: 19:10			
Sample (adjusted): 3 957					Sample (adjusted): 2/05/2004 10/28/2010				Sample (adjusted): 2/05/2004 10/29/2012				Sample (adjusted): 2/05/2004 10/29/2010			
Included observations: 955 after adjustments					Included observations: 1635 after adjustments				Included observations: 2119 after adjustments				Included observations: 1636 after adjustments			
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.
C	5.81E-06	7.39E-07	7.855949	0.0000	3.74E-05	2.65E-06	14.09823	0.0000	4.04E-05	2.88E-06	14.03404	0.0000	5.51E-05	5.05E-06	10.91665	0.0000
RESID^2(-1)	0.374698	0.030033	12.47606	0.0000	0.129788	0.024538	5.289244	0.0000	0.109027	0.021604	5.046515	0.0000	0.334884	0.023309	14.36711	0.0000

Table:5.6:

ARMA Results of Post-Introduction of Currency Futures of USDINR SP, EUROINR SP, GBPINR SP & JPYINR SP

USD_INR SP					EURO_INR SP				GBP_INR SP				JPY_INR SP			
Dependent Variable: RETURN					Dependent Variable: RETURN				Dependent Variable: RETURN				Dependent Variable: RETURN			
Method: ARMA Maximum Likelihood (BFGS)					Method: ARMA Maximum Likelihood (BFGS)				Method: ARMA Maximum Likelihood (BFGS)				Method: ARMA Maximum Likelihood (BFGS)			
Date: 12/02/21 Time: 19:56					Date: 12/02/21 Time: 20:02				Date: 12/02/21 Time: 20:07				Date: 12/02/21 Time: 20:12			
Sample: 1/02/2008 8/31/2020					Sample: 11/01/2010 8/31/2020				Sample: 10/31/2012 8/31/2020				Sample: 11/02/2010 8/31/2020			
Included observations: 3053					Included observations: 2373				Included observations: 1889				Included observations: 2372			
Convergence achieved after 27 iterations					Convergence achieved after 20 iterations				Convergence achieved after 16 iterations				Convergence achieved after 29 iterations			
Coefficient covariance computed using outer product of gradients					Coefficient covariance computed using outer product of gradients				Coefficient covariance computed using outer product of gradients				Coefficient covariance computed using outer product of gradients			
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000204	9.14E-05	2.237238	0.0253	0.000147	0.000130	1.129299	0.2589	6.51E-05	0.000163	0.398948	0.6900	9.79E-05	0.000151	0.647676	0.5173
AR(1)	0.320573	1.815869	0.176540	0.8599	-0.092677	0.298661	-0.310308	0.7564	0.444682	0.254175	1.749511	0.0804	-0.830506	0.237672	-3.494336	0.0005
MA(1)	-0.325956	1.812239	-0.179864	0.8573	0.147242	0.297412	0.495078	0.6206	-0.395188	0.260850	-1.515000	0.1299	0.818596	0.245185	3.338682	0.0009
SIGMASQ	2.48E-05	3.51E-07	70.60441	0.0000	3.54E-05	6.80E-07	52.09623	0.0000	4.04E-05	5.96E-07	67.80326	0.0000	5.42E-05	1.00E-06	53.97440	0.0000

Table:5.7:
ARCH effect Results of Post-Introduction of Currency Futures of USDINR SP, EUROINR SP, GBPINR SP & JPYINR SP

USD_INR SP					EURO_INR SP				GBP_INR SP				JPY_INR SP			
Test Equation:					Test Equation:				Test Equation:				Test Equation:			
Dependent Variable: RESID^2					Dependent Variable: RESID^2				Dependent Variable: RESID^2				Dependent Variable: RESID^2			
Method: Least Squares					Method: Least Squares				Method: Least Squares				Method: Least Squares			
Date: 12/02/21 Time: 19:56					Date: 12/02/21 Time: 20:02				Date: 12/02/21 Time: 20:07				Date: 12/02/21 Time: 20:12			
Sample (adjusted): 1/03/2008 8/31/2020					Sample (adjusted): 11/02/2010 8/31/2020				Sample (adjusted): 11/01/2012 8/31/2020				Sample (adjusted): 11/03/2010 8/31/2020			
Included observations: 3052 after adjustments					Included observations: 2372 after adjustments				Included observations: 1888 after adjustments				Included observations: 2371 after adjustments			
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.
C	1.94E-05	1.23E-06	15.79228	0.0000	2.82E-05	1.71E-06	16.56198	0.0000	3.67E-05	3.16E-06	11.63105	0.0000	4.31E-05	2.68E-06	16.07163	0.0000
RESID^2(-1)	0.215111	0.017683	12.16488	0.0000	0.202552	0.020115	10.06948	0.0000	0.091942	0.022929	4.009815	0.0001	0.204674	0.020110	10.17774	0.0000

Table:5.8:
ARMA Results of Total Period USDINR SP, EUROINR SP, GBPINR SP & JPYINR SP

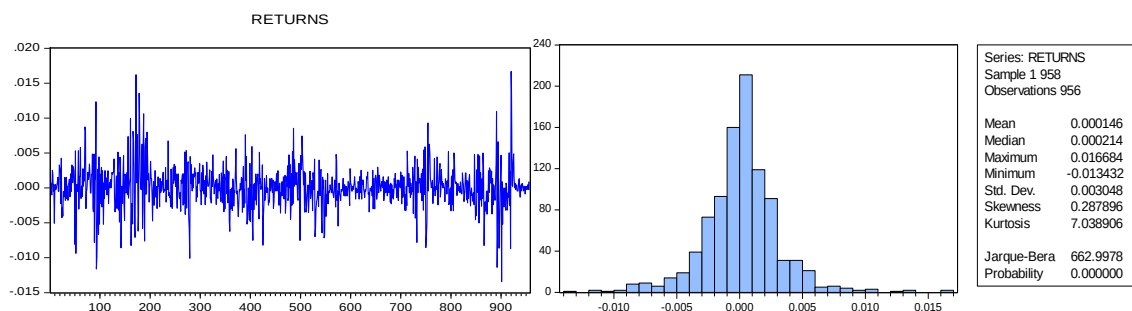
USD_INR SP					EURO_INR SP				GBP_INR SP				JPY_INR SP			
Dependent Variable: RETURN					Dependent Variable: RETURN				Dependent Variable: RETURN				Dependent Variable: RETURN			
Method: ARMA Maximum Likelihood (BFGS)					Method: ARMA Maximum Likelihood (BFGS)				Method: ARMA Maximum Likelihood (BFGS)				Method: ARMA Maximum Likelihood (BFGS)			
Date: 12/02/21 Time: 20:23					Date: 12/02/21 Time: 20:32				Date: 12/02/21 Time: 20:37				Date: 12/02/21 Time: 20:42			
Sample: 2 4011					Sample: 2/04/2004 8/31/2020				Sample: 2/04/2004 8/31/2020				Sample: 2/04/2004 8/31/2020			
Included observations: 4010					Included observations: 4010				Included observations: 4010				Included observations: 4010			
Convergence achieved after 27 iterations					Convergence achieved after 21 iterations				Convergence achieved after 17 iterations				Convergence achieved after 21 iterations			
Coefficient covariance computed using outer product of gradients					Coefficient covariance computed using outer product of gradients				Coefficient covariance computed using outer product of gradients				Coefficient covariance computed using outer product of gradients			
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000121	7.23E-05	-1.674742	0.0941	0.000110	0.000101	1.085222	0.2779	4.32E-05	0.000109	0.394641	0.6931	0.000121	0.000124	0.975458	0.3294
AR(1)	0.332509	2.228110	0.149234	0.8814	-0.253752	0.419073	-0.605506	0.5449	-0.185376	0.294422	-0.629625	0.5290	0.505893	0.206122	2.454341	0.0142
MA(1)	-0.336181	2.226608	-0.150983	0.8800	0.280515	0.417380	0.672085	0.5016	0.221825	0.292447	0.758514	0.4482	-0.538915	0.201256	-2.677754	0.0074
SIGMASQ	2.11E-05	2.45E-07	86.09669	0.0000	3.85E-05	5.39E-07	71.50776	0.0000	4.31E-05	4.67E-07	92.15968	0.0000	6.60E-05	8.65E-07	76.24278	0.0000

Table:5.9:**ARCH effect Results of Total Period USDINR_SP, EUROINR_SP, GBPINR_SP & JPYINR_SP**

USD_INR SP					EURO_INR SP				GBP_INR SP				JPY_INR SP			
Test Equation:					Test Equation:				Test Equation:				Test Equation:			
Dependent Variable: RESID^2					Dependent Variable: RESID^2				Dependent Variable: RESID^2				Dependent Variable: RESID^2			
Method: Least Squares					Method: Least Squares				Method: Least Squares				Method: Least Squares			
Date: 12/02/21 Time: 20:28					Date: 12/02/21 Time: 20:33				Date: 12/02/21 Time: 20:37				Date: 12/02/21 Time: 20:42			
Sample (adjusted): 3 4011					Sample (adjusted): 2/05/2004 8/31/2020				Sample (adjusted): 2/05/2004 8/31/2020				Sample (adjusted): 2/05/2004 8/31/2020			
Included observations: 4009 after adjustments					Included observations: 4009 after adjustments				Included observations: 4009 after adjustments				Included observations: 4009 after adjustments			
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Err	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.	Coefficient	Std. Error	t-Statistic	Prob.
C	1.62E-05	9.50E-07	17.00033	0.0000	3.23E-05	1.49E-06	21.70934	0.0000	3.86E-05	2.13E-06	18.15081	0.0000	4.67E-05	2.62E-06	17.85136	0.0000
RESID^2(-1)	0.233756	0.015360	15.21842	0.0000	0.163054	0.015586	10.46143	0.0000	0.102697	0.015714	6.535338	0.0000	0.291745	0.015110	19.30807	0.0000

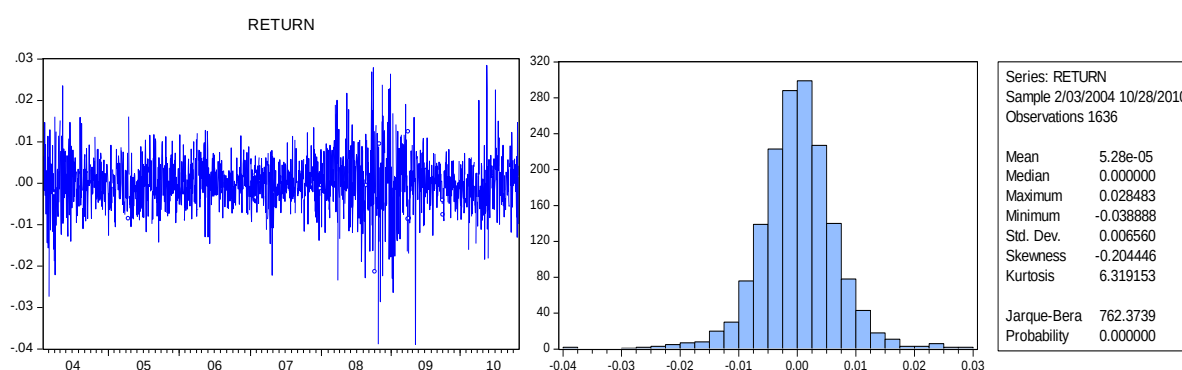
GRAPH:5.1:

Pre-USDINR_SP Stationary Graph & Leptokurtic Has fat tails



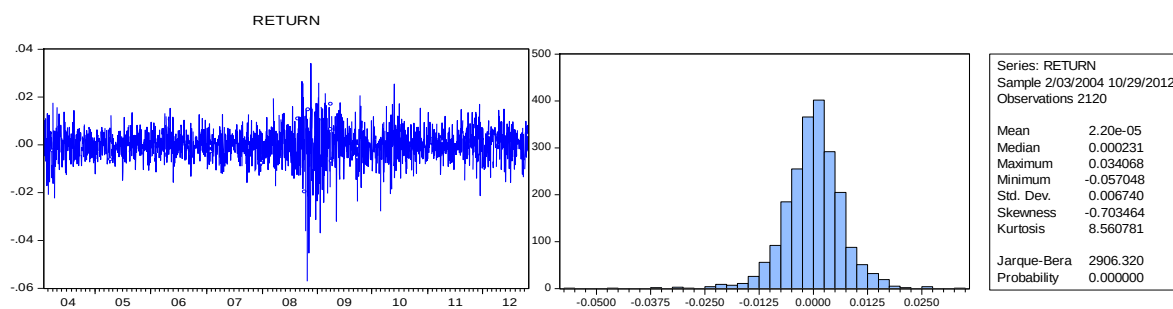
GRAPH 5.2:

Post EUROINR_SP Stationary Graph & Leptokurtic Has fat tails



GRAPH 5.3:

Post GBPINR_SP Stationary Graph & Leptokurtic Has fat tails



GRAPH 5.4:

Post JPYINR_SP Stationary Graph & Leptokurtic Has fat tails

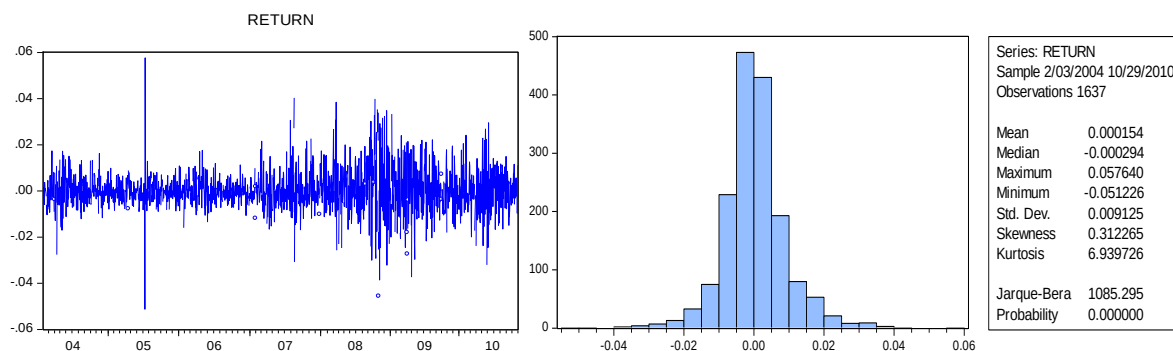
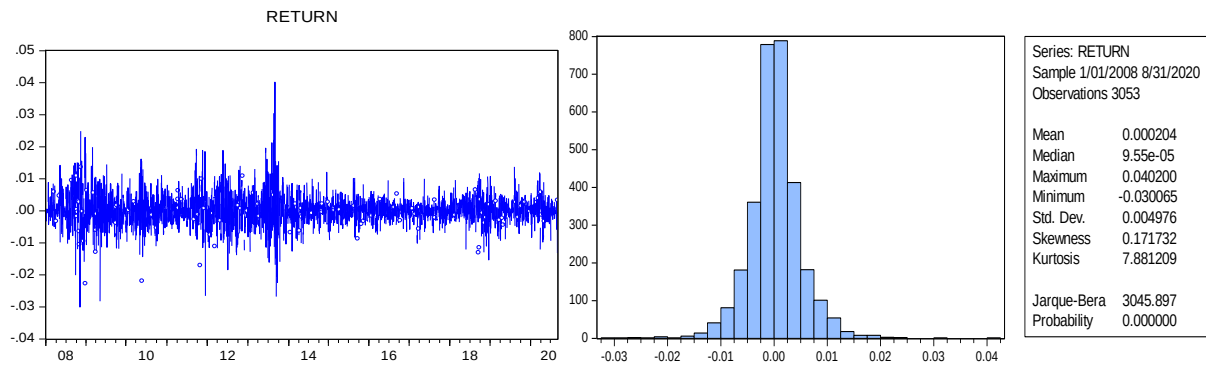


Table:5.10:**GARCH (1,1) Results of Pre USDINR SP, EUROINR SP, GBPINR SP & JPYINR SP**

USD_INR SP					EURO_INR SP				GBP_INR SP				JPY_INR SP			
Dependent Variable: RETURNS					Dependent Variable: RETURN				Dependent Variable: RETURN				Dependent Variable: RETURN			
Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)					Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)				Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)				Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)			
Date: 12/05/21 Time: 20:54					Date: 12/06/21 Time: 19:50				Date: 12/06/21 Time: 20:08				Date: 12/06/21 Time: 20:21			
Sample (adjusted): 3 957					Sample (adjusted): 2/05/2004 10/28/2010				Sample (adjusted): 2/05/2004 10/29/2012				Sample (adjusted): 2/05/2004 10/29/2010			
Included observations: 955 after adjustments					Included observations: 1635 after adjustments				Included observations: 2119 after adjustments				Included observations: 1636 after adjustments			
Convergence achieved after 12 iterations					Convergence achieved after 13 iterations				Convergence achieved after 13 iterations				Convergence achieved after 19 iterations			
Presample variance: backcast (parameter = 0.7)					Presample variance: backcast (parameter = 0.7)				Presample variance: backcast (parameter = 0.7)				Presample variance: backcast (parameter = 0.7)			
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)					GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)				GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)				GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)			
Variable	Coefficient	Std. Error	z-Statistic	Prob.	Coefficient	Std. Error	z-Statistic	Prob.	Coefficient	Std. Error	z-Statistic	Prob.	Coefficient	Std. Error	z-Statistic	Prob.
C	5.14E-05	6.17E-05	0.832371	0.4052	4.34E-06	0.000133	0.032562	0.9740	1.79E-05	0.000123	0.145688	0.8842	-6.07E-05	0.000183	-0.331596	0.7402
RESID^2(-1)	-0.000744	0.035767	-0.020787	0.9834	0.003432	0.026148	0.131245	0.8956	0.038359	0.023154	1.656642	0.0976	-0.028202	0.026279	-1.073176	0.2832
Variance Equation					Variance Equation				Variance Equation				Variance Equation			
C	5.11E-07	1.03E-07	4.942818	0.0000	3.34E-07	1.04E-07	3.209376	0.0013	4.85E-07	1.24E-07	3.906051	0.0001	1.95E-06	2.64E-07	7.384252	0.0000
RESID(-1)^2	0.332739	0.036976	8.998808	0.0000	0.047477	0.006463	7.346421	0.0000	0.048852	0.006098	8.010884	0.0000	0.111911	0.013145	8.513403	0.0000
GARCH(-1)	0.653216	0.029783	21.93236	0.0000	0.944569	0.006753	139.8668	0.0000	0.938788	0.007593	123.6416	0.0000	0.865457	0.014233	60.80570	0.0000

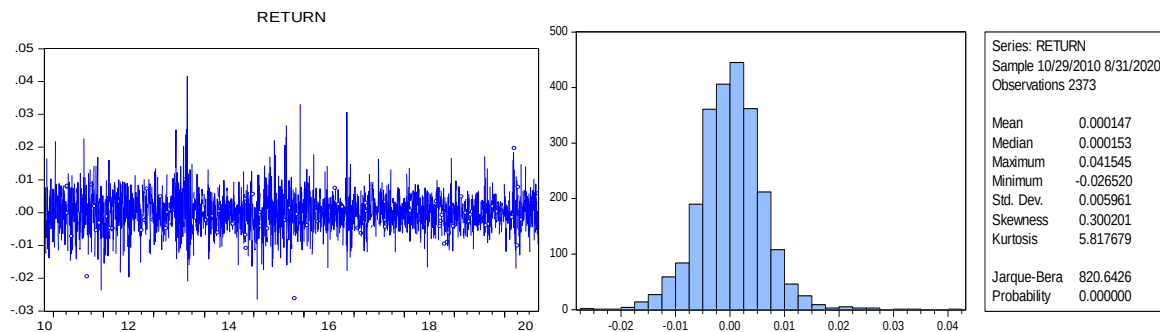
GRAPH 5.5:

Post-USDINR_SP Stationary Graph & Leptokurtic Has fat tails



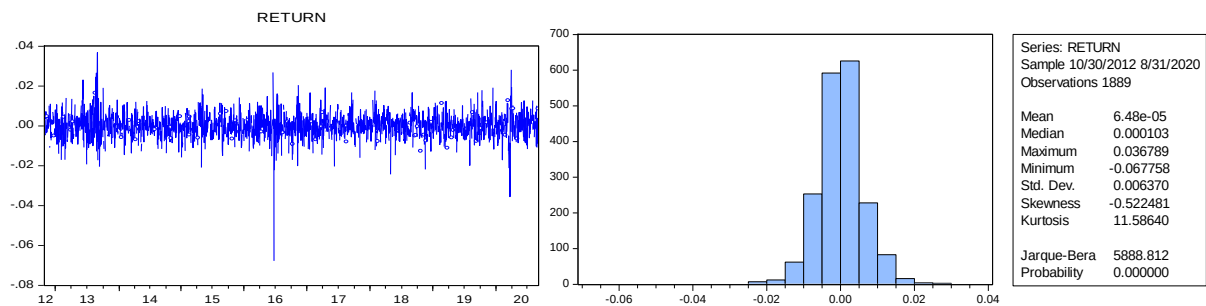
GRAPH 5.6:

Post-EROINR_SP Stationary Graph & Leptokurtic Has fat tails



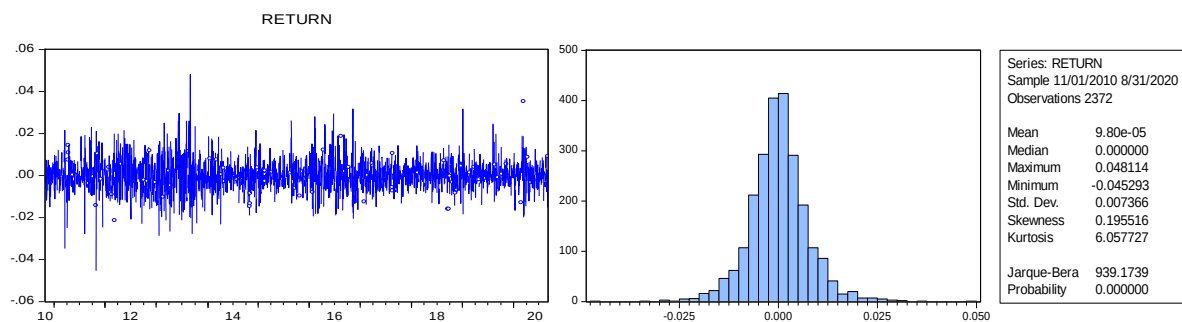
GRAPH 5.7:

Post-GBPINR_SP Stationary Graph & Leptokurtic Has fat tails



GRAPH 5.8:

Post-GBPINR_SP Stationary Graph & Leptokurtic Has fat tails



Convergence was reached after 13 USDINR, 15 EUROINR, 27 GBPINR, and 11 JPYINR integrations, respectively, following the introduction of currency futures, as shown in Table 11. In the time after currency futures were introduced to the Indian Exchange Market, the ARCH and GARCH parameters, as well as the coefficients of the constant's variance term, were all positive and statistically significant at the 1% level. In addition, data collected after the introduction of currency futures on the currency exchange market demonstrates that all four currencies' coefficients on the conditional variance specification are stable at the levels of 0b 11,0 1, and b 1+ 11. However, since the introduction of currency futures, $b1+Q1 >1$ in the EUR/INR exchange rate indicates substantial volatility. The results of this study unambiguously demonstrate the existence of conditional volatility of returns of currency spot prices at Post-post and during the whole duration of currency futures introduction in the foreign exchange market.

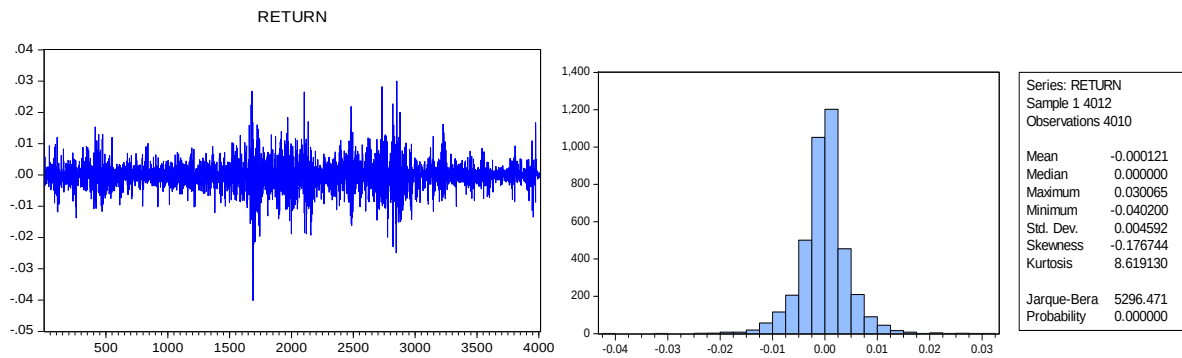
GARCH (1,1) Results of Post USDINR SP, EUROINR SP, GBPINR SP & JPYINR SP

Table:5.11:

“USD_INR SP					EURO_INR SP				GBP_INR SP				JPY_INR SP			
Dependent Variable: RETURN					Dependent Variable: RETURN				Dependent Variable: RETURN				Dependent Variable: RETURN			
Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)					Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)				Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)				Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)			
Date: 12/06/21 Time: 21:10					Date: 12/06/21 Time: 21:18				Date: 12/06/21 Time: 21:24				Date: 12/06/21 Time: 21:31			
Sample (adjusted): 1/03/2008 8/31/2020					Sample (adjusted): 11/02/2010 8/31/2020				Sample (adjusted): 11/01/2012 8/31/2020				Sample (adjusted): 11/03/2010 8/31/2020			
Included observations: 3052 after adjustments					Included observations: 2372 after adjustments				Included observations: 1888 after adjustments				Included observations: 2371 after adjustments			
Convergence achieved after 13 iterations					Convergence achieved after 15 iterations				Convergence achieved after 27 iterations				Convergence achieved after 11 iterations			
Presample variance: backcast (parameter = 0.7)					Presample variance: backcast (parameter = 0.7)				Presample variance: backcast (parameter = 0.7)				Presample variance: backcast (parameter = 0.7)			
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)					GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)				GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)				GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)			
Variable	Coefficient	Std. Error	z-Statistic	Prob.	Coefficient	Std. Error	z-Statistic	Prob.	Coefficient	Std. Error	z-Statistic	Prob.	Coefficient	Std. Error	z-Statistic	Prob.
C	5.80E-05	7.04E-05	0.823940	0.4100	0.000111	0.000110	1.006898	0.3140	-3.37E-05	0.000133	-0.252305	0.8008	-1.56E-05	0.000130	-0.119985	0.9045
RESID^2(-1)	0.015553	0.018941	0.821109	0.4116	0.043631	0.020001	2.181441	0.0292	0.007424	0.025830	0.287409	0.7738	-0.003977	0.021754	-0.182840	0.8549
Variance Equation					Variance Equation				Variance Equation				Variance Equation			
C	6.08E-07	7.28E-08	8.348266	0.0000	8.37E-07	1.38E-07	6.082738	0.0000	4.17E-06	8.94E-07	4.662642	0.0000	2.42E-06	3.40E-07	7.122090	0.0000
RESID(-1)^2	0.137718	0.011214	12.28093	0.0000	0.054992	0.005213	10.54944	0.0000	0.108194	0.015965	6.776877	0.0000	0.103272	0.009068	11.38847	0.0000
GARCH(-1)	0.839903	0.011252	74.64395	0.0000	0.921464	0.006181	149.0816	0.0000	0.787633	0.035297	22.31453	0.0000	0.854163	0.012798	66.73946	0.0000

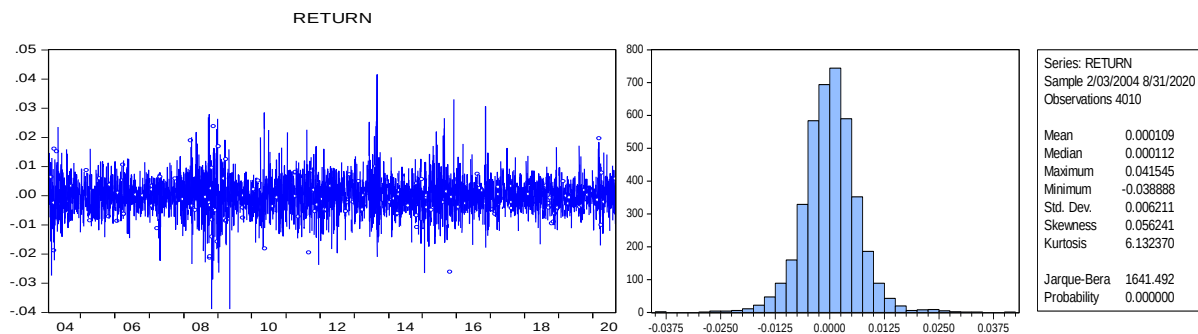
GRAPH 5.9:

Total-USDINR_SP Stationary Graph & Leptokurtic Has fat tails



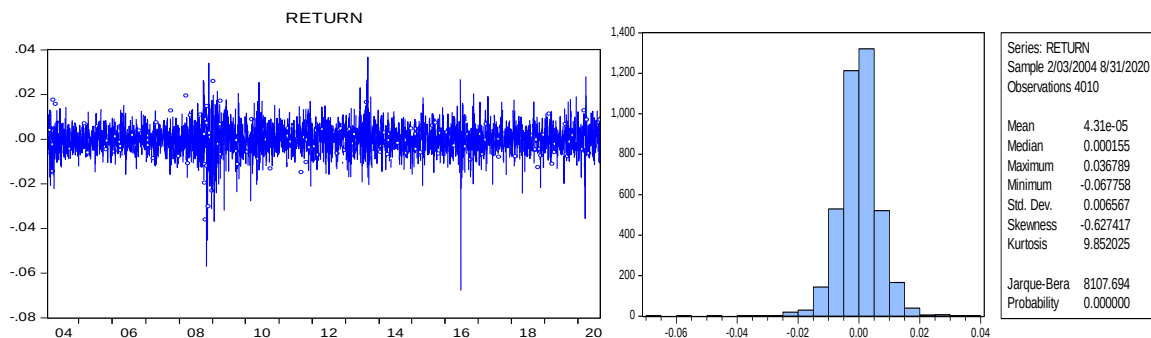
GRAPH 5.10:

Total-EUROINR_SP Stationary Graph & Leptokurtic Has fat tails



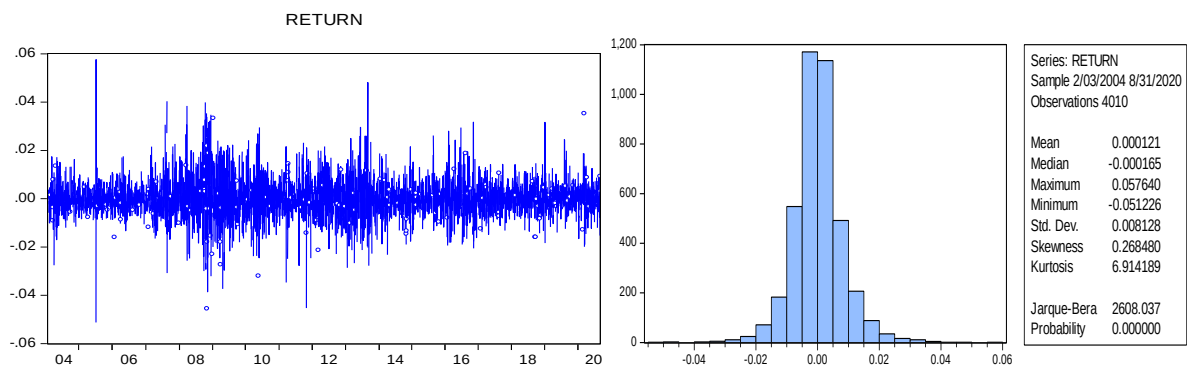
GRAPH 5.11

Total-GBPINR_SP Stationary Graph & Leptokurtic Has fat tails



GRAPH 5.12:

Total-JPYINR_SP Stationary Graph & Leptokurtic Has fat tails



In sum, the reintroduction of currency is the union's final destiny. This was done after the presentation of money possibilities in various currencies (as shown in Table 11), which required 13 USDINR Total, 15 EUROINR Total, 27 GBPINR Total, and 11 JPYINR Total mixtures. At the 1% significance level, the ARCH and GARCH coefficients for the steady's change term are positive and very large for the whole presentation period of cash fates on the Indian Exchange Market. Furthermore, the comprehensive depiction of cash destinies in the money trade market demonstrates that across all four monetary forms, the coefficients of the contingent change detail satisfy the strong states of 0b 11, 0_1, and b 1+ 11. These findings outline clearly the existence of time-shifting dependent unpredictability of profits of cash spot costs at all out endlessly all out time of money fortunes presentation in the cash trade market.

Table:5.12:
GARCH (1,1) Results of Total USDINR SP, EUROINR SP, GBPINR SP & JPYINR SP

USD_INR SP					EURO_INR SP				GBP_INR SP				JPY_INR SP			
Dependent Variable: RETURN					Dependent Variable: RETURN				Dependent Variable: RETURN				Dependent Variable: RETURN			
Method: ML ARCH - Normal distribution (Marquardt / EVIEWS legacy)					Method: ML ARCH - Normal distribution (Marquardt / EVIEWS legacy)				Method: ML ARCH - Normal distribution (Marquardt / EVIEWS legacy)				Method: ML ARCH - Normal distribution (Marquardt / EVIEWS legacy)			
Date: 12/06/21 Time: 21:45					Date: 12/06/21 Time: 21:51				Date: 12/06/21 Time: 21:56				Date: 12/06/21 Time: 22:02			
Sample (adjusted): 3 4011					Sample (adjusted): 2/04/2004 8/31/2020				Sample (adjusted): 2/05/2004 8/31/2020				Sample (adjusted): 2/05/2004 8/31/2020			
Included observations: 4009 after adjustments					Included observations: 4010 after adjustments				Included observations: 4009 after adjustments				Included observations: 4009 after adjustments			
Convergence achieved after 13 iterations					Convergence achieved after 7 iterations				Convergence achieved after 19 iterations				Convergence achieved after 15 iterations			
Presample variance: backcast (parameter = 0.7)					Presample variance: backcast (parameter = 0.7)				Presample variance: backcast (parameter = 0.7)				Presample variance: backcast (parameter = 0.7)			
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)					GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)				GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)				GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)			
Variable	Coefficient	Std. Error	z-Statistic	Prob.	Coefficient	Std. Error	z-Statistic	Prob.	Coefficient	Std. Error	z-Statistic	Prob.	Coefficient	Std. Error	z-Statistic	Prob.
C	1.70E-05	4.51E-05	0.376691	0.7064	-2.74E-20	8.39E-10	-3.26E-11	1.0000	1.44E-06	9.07E-05	0.015852	0.9874	-3.25E-05	0.000104	-0.311826	0.7552
RESID^2(-1)	-0.009818	0.016896	-0.581072	0.5612	1.000000	4.724677	0.211655	0.8324	0.023592	0.016954	1.391529	0.1641	-0.013716	0.016665	-0.823032	0.4105
Variance Equation					Variance Equation				Variance Equation				Variance Equation			
C	3.70E-07	5.08E-08	7.282071	0.0000	4.44E-37	3.69E-38	12.02613	0.0000	1.43E-06	2.09E-07	6.857482	0.0000	2.10E-06	1.91E-07	11.02055	0.0000
RESID(-1)^2	0.188997	0.012422	15.21478	0.0000	0.150000	0.013127	11.42645	0.0000	0.075791	0.005509	13.75786	0.0000	0.106507	0.007382	14.42846	0.0000
GARCH(-1)	0.807842	0.010176	79.38748	0.0000	0.600000	0.026946	22.26638	0.0000	0.889298	0.009477	93.83617	0.0000	0.862067	0.008939	96.43402	0.0000"

4.5. Conclusion

Increased capital flows into our nation may be attributed to the introduction of currency futures in the currency exchange market. The derivatives may be used for a variety of purposes, including risk management, foreign currency hedging, and hedging. Government authority is bolstered by currency derivatives, leading to more standardized dealings in the foreign exchange market. This study looks at how the USDINR, EURINR, JPYINR, and GBPINR spot exchange markets might react to the introduction of currency futures. The currency pairs used in the study were determined based on the daily closing values obtained from the RBI website. We used the ARCH and GARCH (1,1) models and discovered clustering in the volatility distribution. According to the data, there is a marked difference between the volatility of the pre-futures and the volatility of the post-futures, and the volatility of the overall time is more steady.

CHAPTER-VI

TO STUDY THE PRICE DISCOVERY MECHANISM IN INDIAN CURRENCY FUTURE MARKETS

The research work presented is an endeavor establish relationship between spot rate data of USDINR & Currency Future rate USDINR data of NSE. The daily closing data has been collected from RBI website and NSE website to conduct the research work presented. The data has been checked for Descriptive Statistics, ADF Stationary 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 Stationary 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.

The research work presented is an endeavor establish relationship in spot rate data of USDINR & currency futures data NSE 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.

6.1. Data

The data of underlying market and currency futures USDINR has taken from RBI website and NSE 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 NSE. Second, to observe the spillover effect in both the time series data.

6.2. 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 Stationary of times series on first level is needed.

$$\Delta Y_t = \alpha_1 Y_{t-1} + \sum_{j=1}^p \beta_j \Delta Y_{t-j} + \varepsilon_t \dots \dots \dots (1)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t=1} + \sum_{j=1}^p \beta_j \Delta_{t-j} \varepsilon_t \dots \dots \dots (2)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 t + \sum_{j=1}^p \beta_j \Delta Y_{t-j} + \varepsilon_t \dots \dots \dots (3)$$

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:

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

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

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

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

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

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

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

$$R_t = \alpha + bR_{t-1} + \varepsilon_t \varepsilon_t / I_{t-1} N(0, h_t),$$

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

6.3. Empirical Results

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

Table:6.1:

Descriptive Statistics

	USDINR_ FT	GBPINR_ _FT	EURINR_ FT	JPYINR_F T	US_DOLL AR	POUND_S TERLING	EURO	JAPANES E_YEN
Mean	64.11798	92.27670	77.46749	63.01017	62.24305	88.15466	73.84740	60.19809
Median	66.00125	92.71500	78.02250	62.94500	64.06830	88.87100	74.58140	59.90000
Maximum	81.71250	114.0750	98.84000	76.32750	76.80840	106.0281	91.46820	72.12000
Minimum	43.94850	69.42840	58.67000	51.18250	43.94850	65.64710	56.07000	46.93000
Std. Dev.	8.525526	9.066436	7.278265	5.439584	8.249849	9.557904	7.368588	5.549723
Skewness	-0.682778	-0.303529	-0.212218	0.072817	-0.646757	-0.427905	-0.310446	0.089481
Kurtosis	2.615276	2.541507	2.329982	2.159618	2.616380	2.315464	2.362756	2.254804
Jarque-Bera	2403.062	690.9610	751.0564	868.5168	179.9862	127.9566	84.33705	62.57669
Probability	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	1837237.	2644097.	2219753.	1805493.	147702.8	225411.5	188827.8	153926.5
Sum Sq. Dev.	2082632.	2355284.	1517839.	847815.6	161438.3	233499.6	138780.8	78723.34
Observations	28654	28654	28654	28654	2373	2557	2557	2557

ADF Test and Results

To determine whether or not the two time series are stationary, an ADF test was conducted, and the results confirmed that the null hypothesis of the ADF test was correct: both time series had a unit root at the level. This indicates that series are not level-stationary but are instead found-stationary at the first difference.

Table-6.2:

Unit Root Test at Level

Futures/Spot	Intercept		With Intercept & Trend		Without Intercept and Trend	
	t-stats	Prob.*	t-stats	Prob.*	t-stats	Prob.*
USDINR_FT	0.260203	0.9762	-1.778549	0.7154	-2.249304	0.0236
EURINR_FT	-1.74003	0.5470	-2.173870	0.5037	-1.198981	0.2116
GBPINR_FT	-0.844997	0.8057	-1.218268	0.9059	-1.045362	0.2674
JPYINR_FT	-1.983453	0.2944	-2.045553	0.5756	-0.863751	0.3420
USDINR_SP	-0.009546	0.9566	-2.075980	0.5584	-2.110903	0.0335
EURINR_SP	-1.815615	0.3732	-2.296596	0.4351	-1.214153	0.2065
GBPINR_SP	-1.34852	0.6089	-1.755950	0.7258	-0.923273	0.3166
JPYINR_SP	-2.138302	0.2297	-2.337040	0.4130	-0.981355	0.2927

Table-6.3:**Unit Root Test 1st Different**

Futures/Spot	Intercept		With Intercept & Trend		Without Intercept and Trend	
	t-stats	Prob.*	t-stats	Prob.*	t-stats	Prob.*
USDINR_FT	-28.53240	0.0000	-28.55059	0.0000	-28.43193	0.0000
EURINR_FT	.25.39958	0.0000	-25.40005	0.0000	-25.37702	0.0000
GBPINR_FT	-28.31804	0.0000	-28.32900	0.0000	-28.30150	0.0000
JPYINR_FT	-29.42651	0.0000	-29.42636	0.0000	-29.41844	0.0000
USDINR_SP	-48.91477	0.0001	-48.91945	0.0000	-48.83218	0.0001
EURINR_SP	-48.02545	0.0001	-48.01747	0.0000	-48.01641	0.0001
GBPINR_SP	-47.98289	0.0001	-47.97525	0.0000	-47.98016	0.0001
JPYINR_SP	-51.03191	0.0001	-51.02192	0.0000	-51.03023	0.0001

6.4. 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_NSE.

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 2 and 2lag have used in Johansen's test and in Vector Error Selection model.

Table-6.4:**VAR Lag Order Selection Criteria**

VAR Lag Order Selection Criteria						
Endogenous variables: USDINR_FT USDINR_SP						
Exogenous variables: C						
Date: 06/02/22 Time: 22:41						
Sample: 1 30858						
Included observations: 2369						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-12605.60	NA	143.7484	10.64382	10.64869	10.64559
1	-2920.059	19346.56*	0.040540*	2.470290*	2.484905*	2.475610*
2	-2916.184	7.733062	0.040544	2.470396	2.494753	2.479263
3	-2912.949	6.450397	0.040571	2.471042	2.505142	2.483456
4	-2912.115	1.661618	0.040679	2.473715	2.517558	2.489676
Endogenous variables: EURINR_FT EURINR_SP						
Exogenous variables: C						
Date: 06/02/22 Time: 22:49						
Sample: 1 30636						

Included observations: 2553						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-14714.19	NA	348.2045	11.52854	11.53312	11.53020
1	-5318.996	18768.30	0.222196	4.171560	4.185297*	4.176542
2	-5309.704	18.54773*	0.221277*	4.167414*	4.190309	4.175717*
3	-5308.203	2.994240	0.221711	4.169372	4.201424	4.180996
4	-5306.340	3.712415	0.222082	4.171046	4.212256	4.185991
Endogenous variables: GPINR_FT GBPINR_SP						
Exogenous variables: C						
Date: 06/02/22 Time: 22:53						
Sample: 1 30636						
Included observations: 2553						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-15289.80	NA	546.6031	11.97948	11.98406	11.98114
1	-5833.039	18891.30	0.332373	4.574257	4.587994*	4.579239
2	-5823.316	19.40846*	0.330886*	4.569773*	4.592668	4.578076*
3	-5821.425	3.770060	0.331434	4.571426	4.603479	4.583050
4	-5818.678	5.474891	0.331759	4.572408	4.613618	4.587353
Endogenous variables: JPYINR_FT JPYINR_SP						
Exogenous variables: C						
Date: 06/02/22 Time: 22:55						
Sample: 1 30636						
Included observations: 2553						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-13519.51	NA	136.5775	10.59265	10.59723	10.59431
1	-4802.389	17413.76*	0.148243*	3.766854*	3.780591*	3.771836*
2	-4801.372	2.029856	0.148590	3.769191	3.792086	3.777494
3	-4800.939	0.863084	0.149006	3.771985	3.804038	3.783610
4	-4799.815	2.240274	0.149342	3.774238	3.815449	3.789184
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

6.5. 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 NSE 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-6.5:
(Johansen Test of Cointegration)

Date: 06/02/22 Time: 23:10 Sample (adjusted): 3 2373 Included observations: 2371 after adjustments Trend assumption: Linear deterministic trend Series: USDINR_FT USDINR_SP Lags interval (in first differences): 1 to 1 Unrestricted Cointegration Rank Test (Trace)	Date: 06/02/22 Time: 23:15 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Trend assumption: Linear deterministic trend Series: EURINR_FT EURINR_SP Lags interval (in first differences): 1 to 2 Unrestricted Cointegration Rank Test (Trace)								
Hypothesized	Trace	0.05			Hypothesized	Trace	0.05		
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.062948	154.1571	15.49471	0.0001	None *	0.042524	114.3804	15.49471	0.0001
At most 1	1.71E-06	0.004053	3.841466	0.9480	At most 1	0.001329	3.396531	3.841466	0.0653
Trace 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					Trace 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 Cointegration Rank Test (Maximum Eigenvalue)					Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05		Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.062948	154.1530	14.26460	0.0001	None *	0.042524	110.9839	14.26460	0.0001
At most 1	1.71E-06	0.004053	3.841466	0.9480	At most 1	0.001329	3.396531	3.841466	0.0653
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					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				
Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Trend assumption: Linear deterministic trend Series: GPINR_FT GPINR_SP Lags interval (in first differences): 1 to 2 Unrestricted Cointegration Rank Test (Trace)					Sample (adjusted): 3 2557 Included observations: 2555 after adjustments Trend assumption: Linear deterministic trend Series: JPYINR_FT JPYINR_SP Lags interval (in first differences): 1 to 1 Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05		Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.040026	106.3250	15.49471	0.0001	None *	0.039395	106.9373	15.49471	0.0001
At most 1	0.000781	1.995557	3.841466	0.1578	At most 1 *	0.001661	4.247504	3.841466	0.0393
Trace 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					Trace test indicates 2 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 Cointegration Rank Test (Maximum Eigenvalue)					Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05		Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.040026	104.3295	14.26460	0.0001	None *	0.039395	102.6898	14.26460	0.0000
At most 1	0.000781	1.995557	3.841466	0.1578	At most 1 *	0.001661	4.247504	3.841466	0.0393
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					Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				

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% so rejected 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.

6.6. VECM Model

Table-6.6:
Vector Error Correction Estimates

Vector Error Correction Estimates Date: 06/04/22 Time: 23:01 Sample (adjusted): 3 2373 Included observations: 2371 after adjustments Standard errors in () & t-statistics in [] Cointegrating Eq: USDINR_FT(-1) 1.000000 USDINR_SP(-1) -0.098871 (0.01358) [-7.28101] C -69.74907 Error Correction: D(USDINR_FT) D(USDINR_SP) CointEq1 -0.130636 0.005385 (0.01046) (0.00408) [-12.4912] [1.31877] D(USDINR_FT(-1)) 0.004719 -0.00494 (0.02051) (0.00801) [0.23005] [-0.61682] D(USDINR_SP(-1)) -0.142838 -0.005034 (0.05263) (0.02055) [-2.71389] [-0.24496] C -0.001724 -0.012265 (0.01476) (0.00576)			Vector Error Correction Estimates Date: 06/03/22 Time: 00:02 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Standard errors in () & t-statistics in [] Cointegrating Eq: EURINR_FT(-1) 1.000000 EURINR_SP(-1) -0.287613 (0.03092) [-9.30335] C -63.91695 Error Correction: D(EURINR_FT) D(EURINR_SP) CointEq1 -0.090232 0.009242 (0.00871) (0.00361) [-10.3648] [2.55991] D(EURINR_FT(-1)) -0.005675 -0.006136 (0.01992) (0.00826) [-0.28483] [-0.74276] D(EURINR_SP(-1)) -0.012228 0.009236 (0.01980) (0.00821) [-0.61751] [1.12472] D(EURINR_SP(-1)) -0.158463 0.053174 (0.04765) (0.01976)			Vector Error Correction Estimates Date: 06/03/22 Time: 00:08 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Standard errors in () & t-statistics in [] Cointegrating Eq: GPINR_FT(-1) 1.000000 GBPINR_SP(-1) -0.04116 (0.02374) [-1.73416] C -92.25186 Error Correction: D(GPINR_FT) D(GBPINR_SP) CointEq1 -0.08893 0.007529 (0.00872) (0.00473) [-10.2041] [1.59103] D(GPINR_FT(-1)) -0.025959 0.003657 (0.01995) (0.01083) [-1.30108] [0.33761] D(GPINR_FT(-1)) -0.010789 0.017135 (0.01978) (0.01074) [-0.54542] [1.59532] D(GBPINR_SP(-1)) -0.121434 0.051250 (0.03644) (0.01978)			Vector Error Correction Estimates Date: 06/03/22 Time: 00:11 Sample (adjusted): 3 2557 Included observations: 2555 after adjustments Standard errors in () & t-statistics in [] Cointegrating Eq: JPYINR_FT(-1) 1.000000 JPYINR_SP(-1) -0.116439 (0.03640) [-3.19859] C -63.58345 Error Correction: D(JPYINR_FT) D(JPYINR_SP) CointEq1 -0.079918 0.009532 (0.00805) (0.00440) [-9.92371] [2.16663] D(JPYINR_FT(-1)) -0.016805 -0.000472 (0.01981) (0.01082) [-0.84814] [-0.04356] D(JPYINR_SP(-1)) -0.039796 -0.010927 (0.03622) (0.01979) [-1.09885] [-0.55225] C -0.00114 -0.006992 (0.01661) (0.00908)		
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	[-0.11680]	[-2.12781]		[-3.32553]	[2.69101]		[-3.33271]	[2.59046]		[-0.06863]	[-0.77035]
R-squared	0.068460	0.000794	D(EURINR_S P(-2))	0.001470	-0.023189	D(GBPINR_S P(-2))	0.015560	0.017695	R-squared	0.041015	0.001997
Adj. R-squared	0.067279	-0.000473		(0.04774)	(0.01980)		(0.03650)	(0.01982)	Adj. R-squared	0.039887	0.000823
Sum sq. resids	1220.604	186.1054		[0.03079]	[-1.17126]		[0.42630]	[0.89286]	Sum sq. resids	1798.790	536.8719
S.E. equation	0.718106	0.280402	C	-0.003767	-0.008968	C	-0.00192	-0.008826	S.E. equation	0.839721	0.458754
F-statistic	57.98436	0.626660		(0.02106)	(0.00874)		(0.02035)	(0.01105)	F-statistic	36.36769	1.701163
Log likelihood	-2577.172	-347.4974		[-0.17884]	[-1.02666]		[-0.09436]	[-0.79875]	Log likelihood	-3177.065	-1632.427
Akaike AIC	2.177285	0.296497	R-squared	0.049672	0.007031	R-squared	0.051148	0.005705	Akaike AIC	2.490070	1.280960
Schwarz SC	2.187021	0.306233	Adj. R-squared	0.047807	0.005082	Adj. R-squared	0.049286	0.003754	Schwarz SC	2.499222	1.290112
Mean dependent	3.27E-05	-0.012203	Sum sq. resids	2885.277	496.1675	Sum sq. resids	2693.757	794.1485	Mean dependent	-0.000833	-0.006912
S.D. dependent	0.743554	0.280335	S.E. equation	1.064128	0.441280	S.E. equation	1.028204	0.558279	S.D. dependent	0.856986	0.458943
Determinant resid covariance (dof adj.)		0.040502	F-statistic	26.63577	3.608303	F-statistic	27.47000	2.923843	Determinant resid covariance (dof adj.)		0.148254
Determinant resid covariance		0.040366	Log likelihood	-3779.712	-1531.601	Log likelihood	-3692.002	-2132.247	Determinant resid covariance		0.147791
Log likelihood	-2923.419		Akaike AIC	2.964536	1.204073	Akaike AIC	2.895852	1.674430	Log likelihood	-4808.248	
Akaike information criterion	2.474415		Schwarz SC	2.978268	1.217806	Schwarz SC	2.909584	1.688162	Akaike information criterion	3.771623	
Schwarz criterion	2.498755		Mean dependent	-0.002328	-0.009238	Mean dependent	-0.00091	-0.00949	Schwarz criterion	3.794502	
Number of coefficients	10		S.D. dependent	1.090515	0.442406	S.D. dependent	1.054519	0.559330	Number of coefficients	10	
			Determinant resid covariance (dof adj.)		0.220448	Determinant resid covariance (dof adj.)		0.329446			
			Determinant resid covariance		0.219414	Determinant resid covariance		0.327899			
			Log likelihood		-5310.989	Log likelihood		-5824.022			
			Akaike information criterion		4.169921	Akaike information criterion		4.571669			
			Schwarz criterion		4.201963	Schwarz criterion		4.603711			
			Number of coefficients		14	Number of coefficients		14			

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. $D(US_DOLLAR) = C(1)*(US_DOLLAR(-1) - 10.1303260216*USDINR_FT_NSE(-1) + 706.678390458) + C(2)*D(US_DOLLAR(-1)) + C(3)*D(USDINR_FT_NSE(-1)) + C(4)$ in system equation model 8 coefficient will be calculated. C1 is the coefficient of cointegration model. UD_dollar is our targeted variable:

TABLE 6.7:

Dependent Variable: D(USDINR_FT) Method: Least Squares (Gauss-Newton / Marquardt steps) Date: 06/04/22 Time: 23:08 Sample (adjusted): 3 2374 Included observations: 2372 after adjustments D(USDINR_FT) = C(1)*(USDINR_FT(-1) - 0.0988707163928 *USDINR_SP(-1) - 69.7490735175) + C(2)*D(USDINR_FT(-1)) + C(3)*D(USDINR_SP(-1)) + C(4)					Dependent Variable: D(EURINR_FT) Method: Least Squares (Gauss-Newton / Marquardt steps) Date: 06/03/22 Time: 00:03 Sample (adjusted): 4 2558 Included observations: 2555 after adjustments D(EURINR_FT) = C(1)*(EURINR_FT(-1) - 0.287613184188 *EURINR_SP(-1) - 63.9169519899) + C(2)*D(EURINR_FT(-1)) + C(3)*D(EURINR_FT(-2)) + C(4)*D(EURINR_SP(-1)) + C(5) *D(EURINR_SP(-2)) + C(6)					Dependent Variable: D(GPINR_FT) Method: Least Squares (Gauss-Newton / Marquardt steps) Date: 06/03/22 Time: 00:08 Sample (adjusted): 4 2558 Included observations: 2555 after adjustments D(GPINR_FT) = C(1)*(GPINR_FT(-1) - 0.0411603342532 *GBPINR_SP(-1) - 92.2518603762) + C(2)*D(GPINR_FT(-1)) + C(3)*D(GPINR_FT(-2)) + C(4)*D(GBPINR_SP(-1)) + C(5) *D(GBPINR_SP(-2)) + C(6)					Dependent Variable: D(JPYINR_FT) Method: Least Squares (Gauss-Newton / Marquardt steps) Date: 06/03/22 Time: 00:12 Sample (adjusted): 3 2558 Included observations: 2556 after adjustments D(JPYINR_FT) = C(1)*(JPYINR_FT(-1) - 0.116439388723*JPYINR_SP(-1) - 63.5834545701) + C(2)*D(JPYINR_FT(-1)) + C(3) *D(JPYINR_SP(-1)) + C(4)					
	Coefficient	Std. Error	t-Statistic	Prob.		Coefficient	Std. Error	t-Statistic	Prob.		Coefficient	Std. Error	t-Statistic	Prob.		Coefficient	Std. Error	t-Statistic	Prob.	
	C(1)	0.130661	0.010456	-12.4962	0	C(1)	0.090269	0.008704	10.37101	0						C(1)	0.079981	0.00805	9.935727	0
	C(2)	0.004774	0.020508	0.232775	0.816	C(2)	0.005571	0.019919	-0.279671	0.7798	C(1)	0.088927	0.008714	-10.20499	0	C(2)	0.016715	0.019809	0.843817	0.3989
	C(3)	0.142836	0.052622	-2.714369	0.0067	C(3)	0.012146	0.019798	-0.613499	0.5396	C(2)	0.025848	0.019949	-1.295719	0.1952	C(3)	0.039564	0.036204	-1.09281	0.2746
	C(4)	0.001625	0.014756	-0.110106	0.9123	C(3)	-0.15852	0.047643	-3.327261	0.0009	C(3)	0.010709	0.019779	-0.54146	0.5882	C(4)	0.001023	0.016609	0.061625	0.9509
						C(3)	0.001555	0.047736	0.032572	0.974	C(4)	0.121321	0.036432	-3.33004	0.0009					
						C(3)	-	0.021058	-0.169708	0.8653	C(5)	0.015568	0.036495	0.42657	0.6697					
											C(6)	-	0.020345	-0.082283	0.9344					
											0.001674									
R-squared	0.068475	Mean dependent var		0.000153	R-squared	0.049689	Mean dependent var		-0.00211	R-squared	0.051111	Mean dependent var		-0.000696	R-squared	0.041067	Mean dependent var		-0.000661	
Adjusted R-squared	0.067295	S.D. dependent var		0.74342	Adjusted R-squared	0.047825	S.D. dependent var		1.090357	Adjusted R-squared	0.049249	S.D. dependent var		1.054369	Adjusted R-squared	0.039939	S.D. dependent var		0.856862	
S.E. of regression	0.71797	Akaike info criterion		2.176908	S.E. of regression	1.063964	Akaike info criterion		2.964227	S.E. of regression	1.028077	Akaike info criterion		2.895604	S.E. of regression	0.839577	Akaike info criterion		2.489726	
Sum squared resid	1220.66	Schwarz criterion		2.18664	Sum squared resid	2885.52	Schwarz criterion		2.977954	Sum squared resid	2694.148	Schwarz criterion		2.909331	Sum squared resid	1798.877	Schwarz criterion		2.498875	
Log likelihood	-2577.812	Hannan-Quinn criter.		2.18045	Log likelihood	-3780.799	Hannan-Quinn criter.		2.969205	Log likelihood	-3693.134	Hannan-Quinn criter.		2.900582	Log likelihood	-3177.87	Hannan-Quinn criter.		2.493044	
F-statistic	58.0228	Durbin-Watson stat		1.999735	F-statistic	26.65591	Durbin-Watson stat		2.000303	F-statistic	27.45961	Durbin-Watson stat		1.999809	F-statistic	36.43013	Durbin-Watson stat		2.000355	
Prob (F-statistic)	0				Prob(F-statistic)	0				Pro b(F-statistic)	0				Prob (F-statistic)	0				

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 run causality in USDINR spot and USDINR_FT_NSE. 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 NSE and USINR_spot.

Table:6.8:
Wald Test

USDINR_FT Wald Test: Equation: Untitled				EURINR_FT Wald Test: Equation: Untitled				GBPINR_FT Wald Test: Equation: Untitled				JPYINR_FT Wald Test: Equation: Untitled			
Test Statistic	Value	df	Probability	Test Statistic	Value	df	Probability	Test Statistic	Value	df	Probability	Test Statistic	Value	df	Probability
F-statistic	58.02280	(3, 2368)	0.0000	F-statistic	3.813938	(3, 2549)	0.0097	F-statistic	3.824018	(3, 2549)	0.0095	F-statistic	36.43013	(3, 2552)	0.0000
Chi-square	174.0684	3	0.0000	Chi-square	11.44181	3	0.0096	Chi-square	11.47205	3	0.0094	Chi-square	109.2904	3	0.0000
Null Hypothesis: C(1)=C(2)=C(3)=0 Null Hypothesis Summary:				Null Hypothesis: C(3)=C(4)=C(5)=0 Null Hypothesis Summary:				Null Hypothesis: C(3)=C(4)=C(5)=0 Null Hypothesis Summary:				Null Hypothesis: C(1)=C(2)=C(3)=0 Null Hypothesis Summary:			
Normalized Restriction (= 0)	Value	Std. Err.		Normalized Restriction (= 0)	Value	Std. Err.		Normalized Restriction (= 0)	Value	Std. Err.		Normalized Restriction (= 0)	Value	Std. Err.	
C(1)	-	0.130661	0.010456	C(3)	-	0.012146	0.019798	C(3)	-	0.010709	0.019779	C(1)	-	0.079981	0.008050
C(2)	-	0.004774	0.020508	C(4)	-0.15852	0.047643		C(4)	-	0.121321	0.036432	C(2)	-	0.016715	0.019809
C(3)	-	0.142836	0.052622	C(5)	0.001555	0.047736		C(5)	-	0.015568	0.036495	C(3)	-	0.039564	0.036204
Restrictions are linear in coefficients.				Restrictions are linear in coefficients.				Restrictions are linear in coefficients.				Restrictions are linear in coefficients.			

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

TABLE 6.9:

USDINR					EUROINR					GBPINR					JPYINR				
Breusch-Godfrey Serial Correlation LM Test:					Breusch-Godfrey Serial Correlation LM Test:					Breusch-Godfrey Serial Correlation LM Test:					Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	0.296234	Prob. F(2,2366)		0.7436	F-statistic	2.022622	Prob. F(2,2547)		0.1325	F-statistic	1.813921	Prob. F(2,2547)		0.1632	F-statistic	0.300703	Prob. F(2,2550)		0.7403
bs*R-squared	0.593822	Prob. Chi-Square(2)		0.7431	Obs*R-squared	4.051515	Prob. Chi-Square(2)		0.1319	Obs*R-squared	3.634061	Prob. Chi-Square(2)		0.1625	Obs*R-squared	0.602679	Prob. Chi-Square(2)		0.7398
Test Equation: Dependent Variable: RESID Method: Least Squares Date: 06/05/22 Time: 00:25 Sample: 3 2374 Included observations: 2372 Presample missing value lagged residuals set to zero.					Test Equation: Dependent Variable: RESID Method: Least Squares Date: 06/05/22 Time: 00:40 Sample: 4 2558 Included observations: 2555 Presample missing value lagged residuals set to zero.					Test Equation: Dependent Variable: RESID Method: Least Squares Date: 06/05/22 Time: 00:46 Sample: 4 2558 Included observations: 2555 Presample missing value lagged residuals set to zero.					Test Equation: Dependent Variable: RESID Method: Least Squares Date: 06/05/22 Time: 00:55 Sample: 3 2558 Included observations: 2556 Presample missing value lagged residuals set to zero.				
Variable	Coeff	Std.Err	z-Stat	Prob.	Variable	Coefft	Std.Err	z-Stat	Prob	Variable	Coeff	Std.Err	z-Stat	Prob	Variable	Coeff	Std.Err	z-Stat	Prob.
C(1)	-0.00787	0.048769	-0.16137	0.8718	C(1)	0.167799	0.148817	1.127547	0.2596	C(1)	0.123661	0.141995	0.870881	0.3839	C(1)	-0.006397	0.07222	0.08858	0.9294
C(2)	-0.01883	0.314018	-0.05997	0.9522	C(2)	1.121827	1.450065	0.773639	0.4392	C(2)	0.682998	1.325871	0.515132	0.6065	C(2)	-0.108155	0.840227	0.12872	0.8976
C(3)	-0.00013	0.052818	-0.00245	0.998	C(3)	0.501429	0.268986	1.864149	0.0624	C(3)	0.521281	0.276616	1.884497	0.0596	C(3)	-0.000709	0.037059	0.01914	0.9847
C(4)	3.96E-06	0.01476	0.000268	0.9998	C(4)	0.047728	0.064854	0.735935	0.4618	C(4)	0.007466	0.037036	0.201603	0.8402	C(4)	-8.86E-05	0.016628	0.00533	0.9957
RESID(-1)	0.026731	0.361751	0.073894	0.9411	C(5)	0.223066	0.257064	0.867745	0.3856	C(5)	0.102968	0.181394	0.567652	0.5703	RESID(-1)	0.114341	0.912095	0.12536	0.9002
RESID(-2)	0.018174	0.023633	0.768992	0.442	C(6)	0.005878	0.021833	0.269199	0.7878	C(6)	0.001743	0.020506	0.085019	0.9323	RESID(-2)	-0.018657	0.027523	0.67789	0.4979
					RESID(-1)	-1.289928	1.596003	-0.80822	0.419	RESID(-1)	-0.806638	1.465108	0.55057	0.582					
					RESID(-2)	-0.548039	0.296407	-1.84894	0.0646	RESID(-2)	-0.554926	0.291348	1.90469	0.0569					
R-squared	0.00025	Mean dependent var	-8.98E-17		R-squared	0.001586	Mean dependent var	1.45E-16		R-squared	0.001422	Mean dependent var	6.80E-17		R-squared	0.000236	Mean dependent var	-1.62E-16	
Adjusted R-squared	-	S.D. dependent var	0.717516		Adjusted R-squared	-0.001158	S.D. dependent var	1.06292		Adjusted R-squared	-0.001322	S.D. dependent var	1.02707		Adjusted R-squared	-0.001725	S.D. dependent var	0.839084	
S.E. of regression	0.718184	Akaike info criterion	2.178344		S.E. of regression	1.063538	Akaike info criterion	2.96421		S.E. of regression	1.027749	Akaike info criterion	2.89575		S.E. of regression	0.839807	Akaike info criterion	2.491055	
Sum squared resid	1220.354	Schwarz criterion	2.192943		Sum squared resid	2880.944	Schwarz criterion	2.98251		Sum squared resid	2690.316	Schwarz criterion	2.91405		Sum squared resid	1798.452	Schwarz criterion	2.504778	
Log likelihood	2577.515	Hannan-Quinn criter.	2.183658		Log likelihood	-3778.772	Hannan-Quinn criter.	2.97084		Log likelihood	-3691.315	Hannan-Quinn criter.	2.90238		Log likelihood	-3177.568	Hannan-Quinn criter.	2.496032	
F-statistic	0.118494	Durbin-Watson stat	2.000197		F-statistic	0.577892	Durbin-Watson stat	2.00115		F-statistic	0.518263	Durbin-Watson stat	2.00178		F-statistic	0.120281	Durbin-Watson stat	2.00074	
Prob(F-statistic)	0.988332				Prob(F-statistic)	0.774464				Prob(F-statistic)	0.821399				Prob(F-statistic)	0.987926			
Heteroskedasticity Test: Breusch-Pagan-Godfrey					Heteroskedasticity Test: Breusch-Pagan-Godfrey					Heteroskedasticity Test: Breusch-Pagan-Godfrey					Heteroskedasticity Test: Breusch-Pagan-Godfrey				
F-statistic	72.86648	Prob. F(4,2367)		0	F-statistic	31.59484	Prob. F(6,2548)		0	F-statistic	31.95636	Prob. F(6,2548)		0	F-statistic	23.4445	Prob. F(4,2551)		0
Obs*R-squared	260.0587	Prob. Chi-Square(4)		0	Obs*R-squared	176.9266	Prob. Chi-Square(6)		0	Obs*R-squared	178.8094	Prob. Chi-Square(6)		0	Obs*R-squared	90.63013	Prob. Chi-Square(4)		0
Scaled explained SS	1560.467	Prob. Chi-Square(4)		0	Scaled explained SS	1115.294	Prob. Chi-Square(6)		0	Scaled explained SS	1235.087	Prob. Chi-Square(6)		0	Scaled explained SS	679.3407	Prob. Chi-Square(4)		0
Test Equation: Dependent Variable: RESID^2 Method: Least Squares Date: 06/05/22 Time: 00:27					Test Equation: Dependent Variable: RESID^2 Method: Least Squares Date: 06/05/22 Time: 00:41					Test Equation: Dependent Variable: RESID^2 Method: Least Squares Date: 06/05/22 Time: 00:47					Test Equation: Dependent Variable: RESID^2 Method: Least Squares Date: 06/05/22 Time: 00:56				

Sample: 3 2374 Included observations: 2372					Sample: 4 2558 Included observations: 2555					Sample: 4 2558 Included observations: 2555					Sample: 3 2558 Included observations: 2556				
Variable	Coeff	Std.Err	z-Stat	Prob.	Variable	Coefft	Std.Err	z-Stat	Prob	Variable	Coeff	Std.Err	z-Stat	Prob	Variable	Coeff	Std.Err	z-Stat	Prob.
C	-	1.737634	-14.58	0	C	-19.01577	2.201314	-8.63837	0	C	-29.82144	3.050533	-	0	C	-12.321	1.75080	-	0
USDINR_FT	25.33464				EURINR_FT(-	0.549403	0.072298	7.599126	0	GPINR_FT(-	0.562107	0.073094	7.69020	0	JPYINR_FT(-1)	0.391171	0.06327	6.18245	0
(-1)	0.487602	0.048229	10.11023	0	1)					1)			5		1)			3	
USDINR_SP					EURINR_SP(-	0.4594	0.174221	2.636883	0.0084	GBPINR_SP(-	0.399572	0.134526	2.97022	0.003	JPYINR_SP(-1)	0.131277	0.11590	1.13264	0.2575
(-1)	0.3405	0.123686	2.752937	0.006	1)					1)			7		2)			7	
USDINR_FT					EURINR_FT(-	-0.012238	0.097359	-0.1257	0.9	GPINR_FT(-	-0.040037	0.097493	-	0.6814	JPYINR_FT(-2)	-0.178262	0.06330	-	0.0049
(-2)	-0.11066	0.048182	-2.29673	0.0217	2)					2)			0.41067		5)			2.81594	
USDINR_SP					EURINR_FT(-	-0.191718	0.072257	-2.65327	0.008	GPINR_FT(-	-0.166314	0.072986	-	0.0228	JPYINR_SP(-2)	-0.16456	0.11579	-	0.1554
(-2)	-	0.123703	-3.11063	0.0019	3)					3)			2.27871		5)			1.42113	
	0.384795				EURINR_SP(-	-0.537468	0.252103	-2.13194	0.0331	GBPINR_SP(-	-0.485142	0.195025	-	0.0129					
					2)					2)			2.48758						
					EURINR_SP(-	-0.047402	0.174274	-0.272	0.7856	GBPINR_SP(-	0.048924	0.134748	0.36308	0.7166					
					2)					2)									
R-squared	0.109637	Mean dependent var		0.51461	R-squared	0.069247	Mean dependent var		1.12936	R-squared	0.069984	Mean dependent var			R-squared	0.035458	Mean dependent var		0.703786
Adjusted R-squared	0.108132	S.D. dependent var		1.78612	Adjusted R-squared	0.067055	S.D. dependent var		4.02024	Adjusted R-squared	0.067794	S.D. dependent var	1.0544		Adjusted R-squared	0.033945	S.D. dependent var		2.729783
S.E. of regression	1.686791	Akaike info criterion		3.88563	S.E. of regression	3.883115	Akaike info criterion		5.55389	S.E. of regression	3.793683	Akaike info criterion	3.9292		S.E. of regression	2.683052	Akaike info criterion		4.813741
Sum squared resid	6734.738	Schwarz criterion		3.89780	Sum squared resid	38420.22	Schwarz criterion		5.5699	Sum squared resid	36670.89	Schwarz criterion	5.5072		Sum squared resid	18364.05	Schwarz criterion		4.825177
Log likelihood	-	Hannan-Quinn criter.		3.89006	Log likelihood	-7088.092	Hannan-Quinn criter.		5.5597	Log likelihood	-7028.56	Hannan-Quinn criter.	5.5233		Log likelihood	-6146.961	Hannan-Quinn criter.		4.817888
F-statistic	72.86648	Durbin-Watson stat		1.79098	F-statistic	31.59484	Durbin-Watson stat		1.92477	F-statistic	31.95636	Durbin-Watson stat	5.5131		F-statistic	23.4445	Durbin-Watson stat		1.901159
Prob(F-statistic)	0				Prob(F-statistic)	0				Prob(F-statistic)	0		1.8809		Prob(F-statistic)	0			
													4						

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

Effect of Good News or Bad News on Both the series i.e. USDINR_Spot exchange and USDINR_Futures NSE 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 NSE data:

TABLE 6.10: ARIMA 1,1 spot exchange rate and UDINR Futures NSE data

Dependent Variable: RETURNS_USINR_FT	Dependent Variable: RETURNS_EUINR_FT	Dependent Variable: RETURNS_GBPINR_FT	Dependent Variable: RETURNS_JPYINR_FT
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)	Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)	Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)	Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 06/05/22 Time: 02:39	Date: 06/05/22 Time: 10:20	Date: 06/05/22 Time: 10:36	Date: 06/05/22 Time: 10:48
Sample (adjusted): 3 28654	Sample (adjusted): 3 28654	Sample (adjusted): 3 28654	Sample (adjusted): 3 28654
Included observations: 28652 after adjustments	Included observations: 28652 after adjustments	Included observations: 28652 after adjustments	Included observations: 28652 after adjustments
Convergence achieved after 97 iterations	Failure to improve likelihood (non-zero gradients) after 126 iterations	Failure to improve likelihood (non-zero gradients) after 60 iterations	Convergence achieved after 97 iterations
Coefficient covariance computed using outer product of gradients	Coefficient covariance computed using outer product of gradients	Coefficient covariance computed using outer product of gradients	Coefficient covariance computed using outer product of gradients
MA Backcast: 2	MA Backcast: 2	MA Backcast: 2	MA Backcast: 2

Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-2)^2					Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-2)^2					Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-2)^2					Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-2)^2				
Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.
C	-6.30E-06	1.20E-05	-0.52532	0.5994	C	3.31E-06	1.73E-05	0.191621	0.848	C	-5.28E-06	0.000226	-0.02329	0.9814	C	9.01E-06	2.15E-05	0.419734	0.6747
AR(1)	0.643825	0.00786	81.91497	0	AR(1)	0.663002	0.007939	83.51214	0	AR(1)	-0.029265	0.017945	-1.63081	0.1029	AR(1)	0.669111	0.00815	82.09715	0
MA(1)	-0.973239	0.001627	-598.336	0	MA(1)	-0.970895	0.001495	-649.225	0	MA(1)	-0.041331	0.000637	-64.8965	0	MA(1)	-0.966247	0.002154	-448.677	0
Variance Equation					Variance Equation					Variance Equation					Variance Equation				
C	0.000199	1.70E-06	116.9996	0	C	0.000278	2.71E-06	102.5547	0	C	0.000198	1.79E-06	110.9503	0	C	0.00028	2.77E-06	101.0433	0
RESID(-1)^2	-0.019741	0.000508	-38.8294	0	RESID(-1)^2	-0.02734	0.000434	-62.9658	0	RESID(-1)^2	-0.017621	0.000635	-27.754	0	RESID(-1)^2	-0.024927	0.000524	-47.5886	0
RESID(-2)^2	-0.02254	0.000335	-67.3273	0	RESID(-2)^2	-0.028499	0.000385	-74.0183	0	RESID(-2)^2	-0.017527	0.000279	-62.7401	0	RESID(-2)^2	-0.025507	0.000413	-61.7938	0
R-squared	0.178352	Mean dependent var	-1.57E-05		R-squared	0.171238	Mean dependent var	-1.18E-05		R-squared	0.006806	Mean dependent var	-9.66E-06		R-squared	0.163238	Mean dependent var	-6.20E-06	
Adjusted R-squared	0.178295	S.D. dependent var	0.015307		Adjusted R-squared	0.17118	S.D. dependent var	0.017948		Adjusted R-squared	0.006736	S.D. dependent var	0.015963		Adjusted R-squared	0.16318	S.D. dependent var	0.017965	
S.E. of regression	0.013875	Akaike info criterion	-5.72939		S.E. of regression	0.01634	Akaike info criterion	-5.41238		S.E. of regression	0.015909	Akaike info criterion	-5.44909		S.E. of regression	0.016434	Akaike info criterion	-5.40053	
Sum squared resid	5.515541	Schwarz criterion	-5.72766		Sum squared resid	7.649137	Schwarz criterion	-5.41065		Sum squared resid	7.25069	Schwarz criterion	-5.44736		Sum squared resid	7.73756	Schwarz criterion	-5.3988	
Log likelihood	82085.18	Hannan-Quinn criter.	-5.72883		Log likelihood	77543.72	Hannan-Quinn criter.	-5.41182		Log likelihood	78069.62	Hannan-Quinn criter.	-5.44853		Log likelihood	77373.93	Hannan-Quinn criter.	-5.39997	
Durbin-Watson stat	1.90827				Durbin-Watson stat	1.919077				Durbin-Watson stat	2.0324				Durbin-Watson stat	1.920877			
Inverted AR Roots	.64				Inverted AR Roots	.66				Inverted AR Roots	-.03				Inverted AR Roots	.67			
Inverted MA Roots	.97				Inverted MA Roots	.97				Inverted MA Roots	.04				Inverted MA Roots	.97			
Dependent Variable: RETURNS_USDINR_SP					Dependent Variable: RETURNS_EUIRN_SP					Dependent Variable: RETURNS_GBPINR_SP					Dependent Variable: RETURNS_JPYINR_SP				

Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)					Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)					Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)					Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)				
Date: 06/05/22 Time: 02:44					Date: 06/05/22 Time: 10:30					Date: 06/05/22 Time: 10:42					Date: 06/05/22 Time: 10:52				
Sample (adjusted): 3 2373					Sample (adjusted): 3 2557					Sample (adjusted): 3 2557					Sample (adjusted): 3 2557				
Included observations: 2371 after adjustments					Included observations: 2555 after adjustments					Included observations: 2555 after adjustments					Included observations: 2555 after adjustments				
Convergence achieved after 40 iterations					Convergence achieved after 29 iterations					Convergence achieved after 37 iterations					Convergence achieved after 31 iterations				
Coefficient covariance computed using outer product of gradients					Coefficient covariance computed using outer product of gradients					Coefficient covariance computed using outer product of gradients					Coefficient covariance computed using outer product of gradients				
MA Backcast: 2					MA Backcast: 2					MA Backcast: 2					MA Backcast: 2				
Presample variance: backcast (parameter = 0.7)					Presample variance: backcast (parameter = 0.7)					Presample variance: backcast (parameter = 0.7)					Presample variance: backcast (parameter = 0.7)				
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)					GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-2)^2					GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-2)^2					GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-2)^2				
Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.
C	-5.58E-05	7.06E-05	-0.79125	0.4288	C	-0.000117	0.000113	-1.03747	0.2995	C	-9.67E-05	0.000115	-0.84066	0.4005	C	7.59E-05	0.000123	0.61605	0.5379
AR(1)	-0.543481	0.614767	-0.88404	0.3767	AR(1)	-0.355191	0.257461	-1.37959	0.1677	AR(1)	-0.415209	0.381121	-1.08944	0.276	AR(1)	-0.537997	0.38755	-1.3882	0.1651
MA(1)	0.555119	0.60882	0.911796	0.3619	MA(1)	0.404761	0.251405	1.609996	0.1074	MA(1)	0.438936	0.373581	1.174941	0.24	MA(1)	0.53281	0.389663	1.367359	0.1715
Variance Equation					Variance Equation					Variance Equation					Variance Equation				
C	3.75E-07	6.75E-08	5.552939	0	C	2.48E-05	8.45E-07	29.31506	0	C	2.81E-05	8.44E-07	33.33698	0	C	3.39E-05	1.14E-06	29.80591	0
RESID(-1)^2	0.108892	0.011592	9.393461	0	RESID(-1)^2	0.242217	0.025218	9.604971	0	RESID(-1)^2	0.173321	0.012463	13.90703	0	RESID(-1)^2	0.265394	0.024298	10.92224	0
GARCH(-1)	0.874278	0.010759	81.25937	0	RESID(-2)^2	0.079441	0.01776	4.472987	0	RESID(-2)^2	0.103782	0.016995	6.106454	0	RESID(-2)^2	0.16374	0.022809	7.178671	0
R-squared	0.000588	Mean dependent var		-0.00021	R-squared	0.003511	Mean dependent var		-0.00012	R-squared	0.001699	Mean dependent var		-0.00011	R-squared	0.000455	Mean dependent var		-0.00012
Adjusted R-squared	-0.000257	S.D. dependent var		0.004597	Adjusted R-squared	0.00273	S.D. dependent var		0.006014	Adjusted R-squared	0.000916	S.D. dependent var		0.006264	Adjusted R-squared	-0.000328	S.D. dependent var		0.007566
S.E. of regression	0.004598	Akaike info criterion		-8.23994	S.E. of regression	0.006006	Akaike info criterion		-7.45455	S.E. of regression	0.006261	Akaike info criterion		-7.36884	S.E. of regression	0.007567	Akaike info criterion		-7.02756
Sum squared resid	0.050055	Schwarz criterion		-8.22533	Sum squared resid	0.092062	Schwarz criterion		-7.44082	Sum squared resid	0.100042	Schwarz criterion		-7.35511	Sum squared resid	0.146125	Schwarz criterion		-7.01383
Log likelihood	9774.445	Hannan-Quinn criter.		-8.23462	Log likelihood	9529.185	Hannan-Quinn criter.		-7.44957	Log likelihood	9419.692	Hannan-Quinn criter.		-7.36386	Log likelihood	8983.705	Hannan-Quinn criter.		-7.02258

Durbin-Watson stat	2.004531	Durbin-Watson stat	1.985613	Durbin-Watson stat	1.947159	Durbin-Watson stat	2.00295
Inverted AR Roots	-.54	Inverted AR Roots	-.36	Inverted AR Roots	-.42	Inverted AR Roots	-.54
Inverted MA Roots	-.56	Inverted MA Roots	-.40	Inverted MA Roots	-.44	Inverted MA Roots	-.53

TABLE 6.11:
GARCH 1,1 on UDINR Futures NSE

Dependent Variable: D(RETURNS_USDINR_FT) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 11:46 Sample (adjusted): 4 28654 Included observations: 28651 after adjustments Failure to improve likelihood (singular hessian) after 99 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)					Dependent Variable: D(EURINR_FT) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:08 Sample (adjusted): 3 28654 Included observations: 28652 after adjustments Convergence achieved after 77 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 + C(6)*GARCH(-1)					Dependent Variable: D(RETURNS_GBPINR_FT) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:30 Sample (adjusted): 4 28654 Included observations: 28651 after adjustments Failure to improve likelihood (non-zero gradients) after 70 iterations Coefficient covariance computed using outer product of gradients WARNING: Singular covariance - coefficients are not unique MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 +					Dependent Variable: D(RETURNS_JPYINR_FT) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:46 Sample (adjusted): 4 28654 Included observations: 28651 after adjustments Failure to improve likelihood (singular hessian) after 136 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 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.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.
C	1.35E-07	1.24E-07	1.088901	0.2762	C	0.002044	0.001311	1.559874	0.1188	C	-4.85E-08	NA	NA	NA	C	3.41E-07	3.09E-07	1.103491	0.2698
AR(1)	-0.067692	0.014008	-4.832501	0	AR(1)	0.648417	0.008183	79.24292	0	AR(1)	-0.074298	NA	NA	NA	AR(1)	-0.05594	0.014837	-3.770347	0.0002
MA(1)	-0.999807	0.000249	-4013.058	0	MA(1)	-0.970126	0.001914	-506.7573	0	MA(1)	-0.999867	NA	NA	NA	MA(1)	-0.999606	0.000365	-2737.84	0
Variance Equation					Variance Equation					Variance Equation					Variance Equation				
C	4.18E-05	2.79E-06	14.98509	0	C	0.329127	0.029326	11.2232	0	C	0.000288	NA	NA	NA	C	4.63E-05	2.53E-06	18.31329	0
RESID(-1)^2	-0.018579	0.000157	-118.4687	0	RESID(-1)^2	-0.018008	0.000266	-67.61726	0	RESID(-1)^2	-0.027865	NA	NA	NA	RESID(-1)^2	-0.022581	0.000218	-103.8192	0
GARCH(-1)	0.831231	0.013176	63.08725	0	GARCH(-1)	0.814988	0.018631	43.74408	0	GARCH(-1)	0.075703	NA	NA	NA	GARCH(-1)	0.868986	0.00868	100.1082	0

R-squared	0.54254	Mean dependent var	8.04E-08	R-squared	0.172845	Mean dependent var	0.000877	R-squared	0.539392	Mean dependent var	5.29E-08	R-squared	0.538296	Mean dependent var	8.77E-08
Adjusted R-squared	0.542508	S.D. dependent var	0.022569	Adjusted R-squared	0.172788	S.D. dependent var	1.416491	Adjusted R-squared	0.53936	S.D. dependent var	0.023452	Adjusted R-squared	0.538264	S.D. dependent var	0.026397
S.E. of regression	0.015266	Akaike info criterion	-	S.E. of regression	1.288316	Akaike info criterion	3.315208	S.E. of regression	0.015917	Akaike info criterion	-	S.E. of regression	0.017937	Akaike info criterion	-5.28715
Sum squared resid	6.676073	Schwarz criterion	-	Sum squared resid	47550.4	Schwarz criterion	3.316938	Sum squared resid	7.257846	Schwarz criterion	-	Sum squared resid	9.217098	Schwarz criterion	-5.28542
Log likelihood	79966.25	Hannan-Quinn criter.	-	Log likelihood	-47487.67	Hannan-Quinn criter.	3.315764	Log likelihood	78048.85	Hannan-Quinn criter.	-	Log likelihood	75747.07	Hannan-Quinn criter.	-
Durbin-Watson stat	2.047952		5.581116	Durbin-Watson stat	1.896863			Durbin-Watson stat	2.02444			Durbin-Watson stat	2.054515		5.286594
Inverted AR Roots	-.07			Inverted AR Roots	.65			Inverted AR Roots	-.07			Inverted AR Roots	-.06		
Inverted MA Roots	1.00			Inverted MA Roots	.97			Inverted MA Roots	1.00			Inverted MA Roots	1.00		

TABLE 6.12:

GARCH 1,1 on USDINR Spot exchange rate data

Dependent Variable: D(RETURNS_USINR_SP) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 11:59 Sample (adjusted): 4 2373 Included observations: 2370 after adjustments Failure to improve likelihood (non-zero gradients) after 49 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)					Dependent Variable: D(RETURNS_EUIRN_SP) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:12 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Convergence achieved after 56 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)					Dependent Variable: D(RETURNS_GBPINR_SP) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:41 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Failure to improve likelihood (non-zero gradients) after 41 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)					Dependent Variable: D(RETURNS_JPYINR_SP) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:53 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Convergence achieved after 45 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 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.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.
C	-1.16E-07	5.71E-08	-	0.0428	C	3.97E-08	1.94E-07	0.205233	0.8374	C	2.47E-09	1.96E-07	0.012613	0.9899	C	2.54E-07	2.33E-07	1.088621	0.2763

AR(1)	0.005651	0.02298 2	0.24588 8	0.8058	AR(1)	0.044396	0.01873 5	2.36966 3	0.0178	AR(1)	0.028379	0.02179 2	1.30224 9	0.1928	AR(1)	-0.021361	0.01939 3	1.10150 6	0.2707
MA(1)	-0.999985	2.99E- 06	334266. 2	0	MA(1)	-0.999031	0.00077 9	1282.99 5	0	MA(1)	-0.99905	0.00044 1	2265.10 5	0	MA(1)	-0.998702	0.00037 5	2661.44 3	0
Variance Equation					Variance Equation					Variance Equation					Variance Equation				
C	6.71E-07	1.09E- 07	6.13626 6	0	C	1.24E-06	2.50E- 07	4.95991 4	0	C	5.33E-06	1.00E- 06	5.31080 3	0	C	1.85E-06	3.36E- 07	5.51580 4	0
RESID(-1)^2	0.160905	0.01720 4	9.35271	0	RESID(-1)^2	0.072852	0.00758 5	9.60433 6	0	RESID(-1)^2	0.104436	0.00893 8	11.6839 1	0	RESID(-1)^2	0.107816	0.00948 2	11.3703 2	0
GARCH(-1)	0.813405	0.01534 2	53.0197 4	0	GARCH(-1)	0.893735	0.01182 6	75.5753 6	0	GARCH(-1)	0.755598	0.03376 7	22.3880 6	0	GARCH(-1)	0.863047	0.01186 1	72.7625 1	0
R-squared	0.49739	Mean dependent var	-5.66E- 06		R-squared	0.471775	Mean dependent var	-4.22E- 06		R-squared	0.47422	Mean dependent var	-2.75E- 06		R-squared	0.503388	Mean dependent var	-2.83E- 06	
Adjusted R-squared	0.496965	S.D. dependent var	0.00647 4		Adjusted R-squared	0.471361	S.D. dependent var	0.00826 4		Adjusted R-squared	0.473808	S.D. dependent var	0.00863 2		Adjusted R-squared	0.502999	S.D. dependent var	0.01073 9	
S.E. of regression	0.004592	Akaike info criterion	8.24054 9		S.E. of regression	0.006008	Akaike info criterion	-7.4758		S.E. of regression	0.006262	Akaike info criterion	7.38530 5		S.E. of regression	0.007571	Akaike info criterion	7.07458 8	
Sum squared resid	0.04991	Schwarz criterion	8.22594		Sum squared resid	0.092092	Schwarz criterion	7.46206 7		Sum squared resid	0.100021	Schwarz criterion	7.37157 3		Sum squared resid	0.146214	Schwarz criterion	7.06085 6	
Log likelihood	9771.051	Hannan-Quinn criter.	8.23523 1		Log likelihood	9552.596	Hannan-Quinn criter.	7.47082		Log likelihood	9437.035	Hannan-Quinn criter.	7.38032 5		Log likelihood	9040.249	Hannan-Quinn criter.	7.06960 8	
Durbin-Watson stat	1.997044				Durbin-Watson stat	1.975303				Durbin-Watson stat	1.955596				Durbin-Watson stat	1.97232			
Inverted AR Roots	.01				Inverted AR Roots	.04				Inverted AR Roots	.03				Inverted AR Roots	-.02			
Inverted MA Roots	1.00				Inverted MA Roots	1.00				Inverted MA Roots	1.00				Inverted MA Roots	1.00			

TABLE 6.13:

T-GARCH Spot 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 $SID(-1)^2 \cdot (RESID(-1) < 0)$ 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(RETURNS_USDINR_FT) Method: ML ARCH – Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 11:51 Sample (adjusted): 4 28654 Included observations: 28651 after adjustments Failure to improve likelihood (non-zero gradients) after 164 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)					Dependent Variable: D(EURINR_FT) Method: ML ARCH – Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:09 Sample (adjusted): 3 28654 Included observations: 28652 after adjustments Failure to improve likelihood (non-zero gradients) after 34 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 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)					Dependent Variable: D(RETURNS_GBPINR_FT) Method: ML ARCH – Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:31 Sample (adjusted): 4 28654 Included observations: 28651 after adjustments Failure to improve likelihood (non-zero gradients) after 82 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)					Dependent Variable: D(RETURNS_JPYINR_FT) Method: ML ARCH – Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:51 Sample (adjusted): 4 28654 Included observations: 28651 after adjustments Failure to improve likelihood (singular hessian) after 201 iterations Coefficient covariance computed using outer product of gradients WARNING: Singular covariance – coefficients are not unique MA Backcast: 3 Presample variance: backcast (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.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.
C	-2.50E-07	1.26E-08	19.73499	0	C	-0.00065	0.034218	-0.01899	0.9848	C	1.15E-08	1.58E-08	0.729306	0.4658	C	5.85E-08	NA	NA	NA
AR(1)	-0.119478	0.014292	-8.36	0	AR(1)	-0.060076	0.27314	-0.219947	0.8259	AR(1)	-0.064033	0.022027	-2.906949	0.0036	AR(1)	-0.092612	NA	NA	NA
MA(1)	-0.999586	2.20E-05	45381.42	0	MA(1)	0.001764	0.272869	0.006465	0.9948	MA(1)	-0.99996	9.34E-05	10705.09	0	MA(1)	-0.999896	NA	NA	NA
Variance Equation					Variance Equation					Variance Equation					Variance Equation				
C	-1.97E-06	9.36E-08	21.07614	0	C	1.11252	0.281746	3.948664	0.0001	C	0.000131	1.10E-05	11.8989	0	C	5.82E-06	NA	NA	NA
RESID(-1)^2	1.704082	0.064153	26.56264	0	RESID(-1)^2	0.036705	0.005995	6.122421	0	RESID(-1)^2	-0.034073	0.001963	-17.35709	0	RESID(-1)^2	0.412952	NA	NA	NA
RESID(-1)^2*(RESID(-1)<0)	-1.709873	0.064004	26.71509	0	RESID(-1)^2*(RESID(-1)<0)	-0.059674	0.007992	-7.466737	0	RESID(-1)^2*(RESID(-1)<0)	0.010621	0.00163	6.51607	0	RESID(-1)^2*(RESID(-1)<0)	0.440959	NA	NA	NA
GARCH(-1)	0.793493	0.005491	144.5162	0	GARCH(-1)	0.569966	0.1078	5.287272	0	GARCH(-1)	0.508032	0.036409	13.95331	0	GARCH(-1)	0.966514	NA	NA	NA
R-squared	0.542096	Mean dependent var		8.04E-08	R-squared	0.005789	Mean dependent var		-0.000877	R-squared	0.53908	Mean dependent var		5.29E-08	R-squared	0.539374	Mean dependent var		8.77E-08
Adjusted R-squared	0.542064	S.D. dependent var		0.022569	Adjusted R-squared	0.00572	S.D. dependent var		1.416491	Adjusted R-squared	0.539048	S.D. dependent var		0.023452	Adjusted R-squared	0.539342	S.D. dependent var		0.026397
S.E. of regression	0.015273	Akaike info criterion		-5.765444	S.E. of regression	1.412434	Akaike info criterion		3.523094	S.E. of regression	0.015922	Akaike info criterion		-5.48185	S.E. of regression	0.017916	Akaike info criterion		-5.385299

Sum squared resid	6.682554	Schwarz criterion	5.763425	Sum squared resid	57153.91	Schwarz criterion	3.525113	Sum squared resid	7.26277	Schwarz criterion	5.479831	Sum squared resid	9.195579	Schwarz criterion	-5.38328
Log likelihood	82599.86	Hannan-Quinn criter.	5.764794	Log likelihood	-50464.84	Hannan-Quinn criter.	3.523743	Log likelihood	78537.25	Hannan-Quinn criter.	5.481201	Log likelihood	77154.1	Hannan-Quinn criter.	-5.38465
Durbin-Watson stat	1.954092			Durbin-Watson stat	2.053715			Durbin-Watson stat	2.041733			Durbin-Watson stat	1.992376		
Inverted AR Roots	-0.12			Inverted AR Roots	-0.06			Inverted AR Roots	-0.06			Inverted AR Roots	-0.09		
Inverted MA Roots	1.00			Inverted MA Roots	-0.00			Inverted MA Roots	1.00			Inverted MA Roots	1.00		

Dependent Variable: D(RETURNS_USINR_SP) Method: ML ARCH – Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:04 Sample (adjusted): 4 2373 Included observations: 2370 after adjustments Failure to improve likelihood (non-zero gradients) after 53 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)					Dependent Variable: D(RETURNS_EUIRN_SP) Method: ML ARCH – Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:13 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Failure to improve likelihood (non-zero gradients) after 62 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)					Dependent Variable: D(RETURNS_GBPINR_SP) Method: ML ARCH – Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:42 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Failure to improve likelihood (non-zero gradients) after 45 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)					Dependent Variable: D(RETURNS_JPYINR_SP) Method: ML ARCH – Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:54 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Convergence achieved after 46 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)				
Variable	Coeff	Std.E rr	z-Stat	Prob.	Variable	Coeff	Std.E rr	z-Stat	Prob.	Variable	Coeff	Std.E rr	z-Stat	Prob.	Variable	Coeff	Std.E rr	z-Stat	Prob.
C	1.55E-07	5.59E-08	2.771466	0.0056	C	3.15E-08	2.09E-07	0.150801	0.8801	C	2.13E-08	1.90E-07	0.11224	0.9106	C	2.57E-07	2.26E-07	1.136958	0.2556
AR(1)	0.003572	0.020389	0.175187	0.8609	AR(1)	0.047451	0.018657	2.543317	0.011	AR(1)	0.029328	0.021765	1.347468	0.1778	AR(1)	0.017367	0.019132	0.907727	0.364

MA(1)	-	2.57E	-		MA(1)	-	0.001	-		MA(1)	-	0.000	-		MA(1)	-	0.000	-	
	0.999	-06	38963	0		0.998	413	706.8	0		0.999	376	2659.6	0		0.998	207	4824.5	0
	987		3.9			843		497			121		07			9		23	
Variance Equation					Variance Equation					Variance Equation					Variance Equation				
C	2.59E	4.87E	5.320	0	C	1.00E	2.14E	4.682	0	C	5.68E	1.07E	5.3328	0	C	1.72E	3.26E	5.2907	0
	-07	-08	511			-06	-07	729			-06	-06	9			-06	-07	36	
RESID(-1)^2	0.132	0.015	8.297	0	RESID(-1)^2	0.095	0.011	8.401	0	RESID(-1)^2	0.127	0.010	12.073	0	RESID(-1)^2	0.136	0.014	9.1295	0
	208	934	09			114	321	33			003	519	7			61	964	12	
RESID(-1)^2*(RESID(-1)<0)	-	0.015	-	0	RESID(-1)^2*(RESID(-1)<0)	-	0.013	-	0	RESID(-1)^2*(RESID(-1)<0)	-	0.013	-	0.005	RESID(-1)^2*(RESID(-1)<0)	-	0.015	-	0.0001
	0.087	632	5.597			0.063	355	4.765			0.038	86	2.8056			0.058	342	3.8295	
	505		755			639		235			885		52			751		58	
GARCH(-1)	0.902	0.008	102.3	0	GARCH(-1)	0.909	0.011	81.87	0	GARCH(-1)	0.743	0.036	20.458	0	GARCH(-1)	0.867	0.011	75.059	0
	013	814	346			712	112	124			662	35	33			725	56	55	
R-squared	0.496	Mean dependent var	-		R-squared	0.471	Mean dependent var	-		R-squared	0.474	Mean dependent var	-2.75E-06		R-squared	0.503	Mean dependent var	-2.83E-06	
	925		5.66E-06			712		4.22E-06			214					208			
Adjusted R-squared	0.496	S.D. dependent var	0.006		Adjusted R-squared	0.471	S.D. dependent var	0.0082		Adjusted R-squared	0.473	S.D. dependent var	0.0086		Adjusted R-squared	0.502	S.D. dependent var	0.0107	
	5		474			298		64			802		32			818		39	
S.E. of regression	0.004	Akaike info criterion	-		S.E. of regression	0.006	Akaike info criterion	-		S.E. of regression	0.006	Akaike info criterion	-		S.E. of regression	0.007	Akaike info criterion	-	
	594		8.257709			009		7.480521			262		7.385603			572		7.07745	
Sum squared resid	0.049	Schwarz criterion	-		Sum squared resid	0.092	Schwarz criterion	-		Sum squared resid	0.100	Schwarz criterion	-		Sum squared resid	0.146	Schwarz criterion	-	
	956		8.240664			103		7.4645			023		7.369582			267		7.061429	
Log likelihood	9792.385	Hannan-Quinn criter.	-		Log likelihood	9559.626	Hannan-Quinn criter.	-		Log likelihood	9438.415	Hannan-Quinn criter.	-		Log likelihood	9044.904	Hannan-Quinn criter.	-	
			8.251504					7.474711					7.379793					7.07164	
Durbin-Watson stat	1.977835				Durbin-Watson stat	1.981319				Durbin-Watson stat	1.957276				Durbin-Watson stat	1.978887			
Inverted AR Roots	-0.00				Inverted AR Roots	.05				Inverted AR Roots	.03				Inverted AR Roots	-0.02			
Inverted MA Roots	1.00				Inverted MA Roots	1.00				Inverted MA Roots	1.00				Inverted MA Roots	1.00			

TABLE 6.14:
E-GARCH Spot Exchange data USDINR

Dependent Variable: D(RETURNS_USDINR_FT) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 11:55 Sample (adjusted): 4 28654 Included observations: 28651 after adjustments Failure to improve likelihood (non-zero gradients) after 108 iterations Coefficient covariance computed using outer product of gradients WARNING: Singular covariance - coefficients are not unique MA Backcast: 3 Presample variance: backcast (parameter = 0.7) LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)*LOG(GARCH(-1))					Dependent Variable: D(EURINR_FT) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:10 Sample (adjusted): 3 28654 Included observations: 28652 after adjustments Failure to improve likelihood (non-zero gradients) after 105 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 2 Presample variance: backcast (parameter = 0.7) LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)*LOG(GARCH(-1))					Dependent Variable: D(RETURNS_GBPINR_FT) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:39 Sample (adjusted): 4 28654 Included observations: 28651 after adjustments Failure to improve likelihood (non-zero gradients) after 60 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)*LOG(GARCH(-1))					Dependent Variable: D(RETURNS_JPYINR_FT) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:51 Sample (adjusted): 4 28654 Included observations: 28651 after adjustments Failure to improve likelihood (non-zero gradients) after 47 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)*LOG(GARCH(-1))				
Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.
C	7.72E-07	NA	NA	NA	C	0.527832	0.002743	192.4509	0	C	2.50E-06	3.41E-08	73.28297	0	C	3.41E-07	5.57E-08	6.118351	0
AR(1)	0.032786	NA	NA	NA	AR(1)	-0.106311	0.071694	1.482834	0.1381	AR(1)	-0.01749	0.000992	17.62181	0	AR(1)	-0.089265	0.002601	34.3142	0
MA(1)	-0.999847	NA	NA	NA	MA(1)	0.112249	0.071573	1.568322	0.1168	MA(1)	-0.999322	6.56E-06	152345.2	0	MA(1)	-0.999786	7.15E-06	139753.2	0
Variance Equation					Variance Equation					Variance Equation					Variance Equation				
C(4)	-2.191978	NA	NA	NA	C(4)	0.209001	0.000887	235.5075	0	C(4)	-17.36283	0.006628	2619.67	0	C(4)	-9.108549	0.127835	71.25251	0
C(5)	-0.368568	NA	NA	NA	C(5)	-0.332727	0.001172	283.9203	0	C(5)	-0.236127	0.001026	230.1142	0	C(5)	-0.582918	0.006601	88.30544	0
C(6)	0.72552	NA	NA	NA	C(6)	0.830347	0.000767	1083.003	0	C(6)	-0.983947	0.000252	3901.398	0	C(6)	-0.153199	0.016041	9.550586	0

R-squared	0.510807	Mean dependent var	8.04E-08	R-squared	-0.138694	Mean dependent var	-0.000877	R-squared	0.514612	Mean dependent var	5.29E-08	R-squared	0.53667	Mean dependent var	8.77E-08
Adjusted R-squared	0.510773	S.D. dependent var	0.022569	Adjusted R-squared	-0.138773	S.D. dependent var	1.416491	Adjusted R-squared	0.514579	S.D. dependent var	0.023452	Adjusted R-squared	0.536637	S.D. dependent var	0.026397
S.E. of regression	0.015786	Akaike info criterion	-5.73674	S.E. of regression	1.511585	Akaike info criterion	3.295162	S.E. of regression	0.016339	Akaike info criterion	5.960125	S.E. of regression	0.017969	Akaike info criterion	-5.310849
Sum squared resid	7.139171	Schwarz criterion	-5.73501	Sum squared resid	65459.76	Schwarz criterion	3.296893	Sum squared resid	7.648307	Schwarz criterion	5.958395	Sum squared resid	9.249568	Schwarz criterion	5.309119
Log likelihood	82187.67	Hannan-Quinn criter.	-5.736184	Log likelihood	-47200.5	Hannan-Quinn criter.	3.295719	Log likelihood	85387.78	Hannan-Quinn criter.	5.959569	Log likelihood	76086.57	Hannan-Quinn criter.	-5.310293
Durbin-Watson stat	2.113938			Durbin-Watson stat	1.906199			Durbin-Watson stat	2.026728			Durbin-Watson stat	1.986745		
Inverted AR Roots	.03			Inverted AR Roots	-.11			Inverted AR Roots	-.02			Inverted AR Roots	-.09		
Inverted MA Roots	1.00			Inverted MA Roots	-.11			Inverted MA Roots	1.00			Inverted MA Roots	1.00		

Dependent Variable: D(RETURNS_USINR_SP) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:05 Sample (adjusted): 4 2373 Included observations: 2370 after adjustments Failure to improve likelihood (non-zero gradients) after 24 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) +					Dependent Variable: D(RETURNS_EUIRN_SP) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:13 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Convergence achieved after 71 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) +					Dependent Variable: D(RETURNS_GBPINR_SP) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:42 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Failure to improve likelihood (non-zero gradients) after 63 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) +					Dependent Variable: D(RETURNS_JPYINR_SP) Method: ML ARCH - Normal distribution (BFGS / Marquardt steps) Date: 06/05/22 Time: 12:55 Sample (adjusted): 4 2557 Included observations: 2554 after adjustments Convergence achieved after 63 iterations Coefficient covariance computed using outer product of gradients MA Backcast: 3 Presample variance: backcast (parameter = 0.7) LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) +				
C(6)*LOG(GARCH(-1))					C(6)*LOG(GARCH(-1))					C(6)*LOG(GARCH(-1))					C(6)*LOG(GARCH(-1))				
Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.	Variable	Coefficient	Std.Err	z-Stat	Prob.

C	-6.23E-08	7.83E-08	-0.795043	0.4266	C	9.71E-08	1.95E-07	0.497248	0.619	C	1.68E-08	1.94E-07	0.086651	0.9309	C	1.97E-07	2.22E-07	0.88898	0.374
AR(1)	-0.021836	0.015963	-1.367946	0.1713	AR(1)	0.047052	0.018803	2.502362	0.0123	AR(1)	0.03532	0.020414	1.730163	0.0836	AR(1)	-0.013201	0.018765	-0.703505	0.4817
MA(1)	-0.999989	1.26E-06	-793635.1	0	MA(1)	-0.998971	0.000769	-1299.71	0	MA(1)	-0.99904	0.000451	-2214.417	0	MA(1)	-0.998697	0.000327	-3058.588	0
Variance Equation					Variance Equation					Variance Equation					Variance Equation				
C(4)	-10.49767	0.237065	-44.28188	0	C(4)	-0.476701	0.079544	-5.992922	0	C(4)	-0.755797	0.150655	-5.016753	0	C(4)	-0.478842	0.064253	-7.452482	0
C(5)	0.474331	0.034273	13.83981	0	C(5)	0.167187	0.014369	11.63493	0	C(5)	0.169507	0.015072	11.2468	0	C(5)	0.20671	0.015209	13.59088	0
C(6)	0.066269	0.023544	2.814695	0.0049	C(6)	0.966287	0.007181	134.5683	0	C(6)	0.938678	0.013879	67.63294	0	C(6)	0.967481	0.005957	162.4174	0
R-squared	0.496965	Mean dependent var	-5.66E-06		R-squared	0.47178	Mean dependent var	-4.22E-06		R-squared	0.474352	Mean dependent var	-2.75E-06		R-squared	0.503527	Mean dependent var	-2.83E-06	
Adjusted R-squared	0.49654	S.D. dependent var	0.006474		Adjusted R-squared	0.471366	S.D. dependent var	0.008264		Adjusted R-squared	0.47394	S.D. dependent var	0.008632		Adjusted R-squared	0.503137	S.D. dependent var	0.010739	
S.E. of regression	0.004594	Akaike info criterion	-8.023612		S.E. of regression	0.006008	Akaike info criterion	-7.484198		S.E. of regression	0.006261	Akaike info criterion	-7.38157		S.E. of regression	0.00757	Akaike info criterion	-7.081498	
Sum squared resid	0.049952	Schwarz criterion	-8.009003		Sum squared resid	0.092091	Schwarz criterion	-7.470466		Sum squared resid	0.099996	Schwarz criterion	-7.367837		Sum squared resid	0.146173	Schwarz criterion	-7.067765	
Log likelihood	9513.98	Hannan-Quinn criter.	-8.018294		Log likelihood	9563.321	Hannan-Quinn criter.	-7.479218		Log likelihood	9432.264	Hannan-Quinn criter.	-7.376589		Log likelihood	9049.072	Hannan-Quinn criter.	-7.076517	
Durbin-Watson stat	1.944603				Durbin-Watson stat	1.980552				Durbin-Watson stat	1.969657				Durbin-Watson stat	1.988638			
Inverted AR Roots	-.02				Inverted AR Roots	.05				Inverted AR Roots	.04				Inverted AR Roots	-.01			
Inverted MA Roots	1.00				Inverted MA Roots	1.00				Inverted MA Roots	1.00				Inverted MA Roots	1.00			

As coefficient of Lambda 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.

6.7. **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 Stationary 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 NSE. 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 NSE are gets influenced by only good news their reacts positively to positive news of the markets.

CHAPTER- VII

TO EXAMINE THE DYNAMIC RELATIONSHIP BETWEEN PRICE VOLATILITY, TRADING MAGNITUDE AND MARKET DEEPNESS FOR CURRENCY FUTURES CONTRACTS IN INDIA

The price and volume of trade in the financial market are impacted by the constant and unexpected entry of new information into the market. Morse (1981)⁸⁷, Copeland (1976)⁸⁸, Jennings, and Barry (1983)⁸⁹. The positive and synchronous link between price volatility and trading volume has received significant attention in a number of empirical investigations, including those by Karpov (1987)⁹⁰, Jones et al. (1994)⁹¹, and Bessembinder and Seguin (1993)⁹². According to research by Schwert (1990)⁹³ and Gallant et al. (1992)⁹⁴, previous volatilities have an excellent predictive potential for predicting the volume of trade in stocks. Nonetheless, we found from reviewing the prior research in this field that the price-volume relationship is more nuanced than the straightforward causation wherein more volume leads to higher prices. Understanding the underlying mechanism that underpins the correlation between volume and price might provide insight into the informational architecture of the financial market. Numerous studies in this area have hinted that fluctuations in stock prices and trading volumes may both be affected. In actuality, there has not been a great deal of investigation into the dynamical features of interactions, especially in the literature on the foreign currency market, such as the feedback effects between price volatility and volume. Most prior research has focused on the correlation between trading volume and asset prices; however, few studies have incorporated market depth to explain asset volatility; this is despite the fact that market depth plays a substantial role in the correlation between

⁸⁷ Dale Morse (1981), 'Price and Trading Volume Reaction Surrounding Earnings Announcements: A Closer Examination', *Journal of Accounting Research*, Vol. 19, pp. 374-383.

⁸⁸ Thomas E. Copeland, (1976), 'A Model of Asset Trading Under the Assumption of Sequential Information Arrival', *The Journal of Finance*, Vol. 31, pp. 1149-1168.

⁸⁹ Jennings, R. and C. Barry, (1983). 'Information dissemination and portfolio choice', *Journal of Financial and Quantitative Analysis*, Vol. 18, pp. 1-19.

⁹⁰ Jonathan M. Karpoff, (1987). 'The Relation Between Price Changes and Trading Volume: A Survey', *The Journal of Financial and Quantitative Analysis*, Vol. 22, pp. 109-126.

⁹¹ Jones Charles M., Kaul Gautam and Lipson Marc L., (1994), 'Information, trading, and volatility', *Journal of Financial Economics*, Vol. 36, Issue 1, pp. 127-154.

⁹² Bessembinder Hendrik and Seguin J. Paul, (1993), 'Price Volatility, Trading Volume, and Market Depth: Evidence from Futures Markets', *The Journal of Financial and Quantitative Analysis*, Vol. 28, No. 1, pp. 21-39.

⁹³ Schwert, G W (1990) 'Stock Volatility and the Crash of '87' *Review of Financial Studies*, Vol. 3, pp. 77-102.

⁹⁴ Gallant, A R, P E Rossi and G Tauchen, (1992), 'Stock Prices and Volume', *Review of Financial Studies*, 5, pp. 199-242.

trading activity and asset prices. Seguin and Bessembinder (1992)⁹⁵ and other researchers (1993)⁹⁶ Tauchen and Pitts (1983)⁹⁷ and Kyle (1985)⁹⁸ have also talked about and argued that these three prices (assets price, trading volume, and market depth) are closely related, but it hasn't been sufficiently targeted for in-depth study because the literature hasn't agreed upon a consistent and limited definition of market depth that is to be used in empirical research. Market depth, according to Kyle (1985)⁹⁹, is the amount of orders needed to shift prices by one unit. According to his approach, market depth is influenced by both non-informational trading activity and trade volume. Open interest was employed by Bessembinder and Seguin (1993)¹⁰⁰ as a stand-in for market depth, and they found that depth greatly reduces simultaneous volatility for several futures contracts. Accordingly, it was discovered via the two lines of inquiry that volume and market depth are two critical characteristics that influence returns and seem to have a diametrically opposite effect on the movement of stock returns.

The return volatility, trading volume, and market depth for the currency futures markets under consideration have been attempted to relate dynamically using all three of the stated factors in this section of the research. Given the positive association between volumes and return volatility, further investigation is focused on determining whether information flows in these two directions are bidirectional or unidirectional. Further, the speed of information adjustment among various market parameters has been investigated, along with the nature of the connection between return volatility, volume, and market depth. In light of the literature discussed above, it will be interesting to observe the dynamic relationship between price return volatility, open interest, and trading volume, or the number of contracts (NOC).

⁹⁵ Bessembinder, H., and Seguin P.J.(1992), 'Futures Trading Activity and Stock Price Volatility', — *Journal of Finance*||, Vol. 47 No. 5, pp. 2015-2034

⁹⁶ Bessembinder, H., and Seguin P.J.(1993), 'Price Volatility, Trading Volume, and Market Depth: Evidence from Futures Markets', —*Journal of Financial & Quantitative Analysis*||, Vol. 28, No. (1), pp. 21-39.

⁹⁷ Tauchen E. George and Pitts Mark, (1983), 'The Price Variability-Volume Relationship on Speculative Markets', —*Econometrica*||, Vol. 51, No. 2, pp. 485-505.

⁹⁸ Kyle, Albert S., (1985), 'Continuous Auctions and Insider Trading', —*Econometrica*||, Vol. 53, pp. 1315- 1335.

⁹⁹ Ibid, 133.

¹⁰⁰ Ibid, 134, pp. 21-39.

7.1. Data and Methodology

From 29 October 2009 to 31 December 2020, daily currency futures closing prices, open interest, and contract volume (number of contracts) for USDINR futures were collected. The NSE currency derivative section is where these data were obtained. A number of time series econometric tools have been used for the precise investigation, including the unit root test to determine whether or not the series is fixed, the Granger Causality test to determine the significance of the educational impact, the Johansson Co-mix test to determine the duration of the relationship between the factors, and the Vector Error Correction Model (VECM) and Impulse Response Ratio test to determine whether or not the three factors are related in the short and long term. With the use of the Wald test, the VECM model's reliability was examined.

7.1.1. Stationary Test: The modified Dickey-Fuller (DF) exam known as the Augmented The Advanced Dickey-Fuller test (ADF) has been performed. Parametrically adjusting the standard DF test for higher-order correlation, ADF operates on the hypothesis that the series follows an AR (p) process. While the closing price, open interest, and volume (number of contracts) of an asset are not stationary at the level, the findings demonstrate that they are stationary at the first difference (table 6.1).

Table 7.1:
Unit Root Test Close Price, Open Interest and No of Contracts

	ADF Test			
	At Level		1 st Diff	
	t-stat	Prob.	t-stat	Prob.
Close Price	-0.705894	0.8435	-36.64458	0.0000
Open Interest	-7.177715	0.0000	-33.97187	0.0000
No of Contracts	-11.87902	0.0000	-47.20137	0.0000

At 5% Significance level.

7.1.2. Granger Causality test

Granger causality test was used to examine data flow direction, and the results are shown in table 6.2. In Table 6.2, we see how Granger causality tests for the USDINR cash rates exchange reveal a gradual increase in the correlation between the volatility of exchange rates, the volume of trades, and the open interest. The results demonstrate the existence of two-way causality between trading volume and closing costs, as the alternative hypothesis that volume influences the final cost as well as the other way around is acknowledged, while the incorrect theory that volume, or NOC, does not affect the final cost is rejected.

Additionally, the data demonstrate that there is no route of causation, from open interest to closing prices, and that no causality was discovered from closing price to open interest. In the trading of currency futures as indicated by volume, there is absolutely no correlation between the open interest and the number of contracts.

Table 7.2:
Granger Causality test

Pairwise Granger Causality Tests			
Date: 06/05/22 Time: 14:34			
Sample: 1 31694			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
D(OPEN_INTEREST) does not Granger Cause D(CLOSE_PRICE)	31627	643.370	1E-274
D(CLOSE_PRICE) does not Granger Cause D(OPEN_INTEREST)		904.123	0.0000
D(NO__OF_CONTRACTS) does not Granger Cause D(CLOSE_PRICE)	31627	362.318	3E-156
D(CLOSE_PRICE) does not Granger Cause D(NO__OF_CONTRACTS)		516.690	2E-221
D(NO__OF_CONTRACTS) does not Granger Cause D(OPEN_INTEREST)	31627	24.3653	3.E-11
D(OPEN_INTEREST) does not Granger Cause D(NO__OF_CONTRACTS)		23.6276	6.E-11

At 5% Significance level.

7.1.3. Test of long run relationship through Johansen co-integration test

The purpose of the co-integration test is to determine whether a group of non-stationary series are in fact co-integrated. Existence of a co-integrating relation is the cornerstone of the Vector Error Correction (VEC) model concept. Assessment of

Co-integration happens when there is a non-stationary relationship between all of the variables and the integration takes place in the same order for all of the variables. Even if each individual time series is not stationary, co-integration between them may make their linear combination stationary, suggesting a long-run equilibrium link. Here, we use Johansen's method to achieve our goals (1991).

TABLE 7.3:**VAR LAG ORDER SELECTION CRITERIA**

VAR Lag Order Selection Criteria						
Endogenous variables: CLOSE_PRICE OPEN_INTEREST NO__OF_CONTRACTS						
Exogenous variables: C						
Date: 06/05/22 Time: 14:36						
Sample: 1 31694						
Included observations: 31542						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1016574.	NA	1.98e+24	64.45862	64.45942	64.45887
1	-947669.1	137792.1	2.51e+22	60.09011	60.09329	60.09113
2	-943657.8	8020.788	1.95e+22	59.83633	59.84190	59.83812
3	-940882.9	5548.166	1.63e+22	59.66095	59.66890	59.66350
4	-939795.0	2174.809	1.53e+22	59.59254	59.60288	59.59585
5	-938802.8	1983.419	1.43e+22	59.53020	59.54292	59.53427
6	-937771.5	2061.372	1.34e+22	59.46538	59.48048	59.47021
7	-937261.9	1018.502	1.30e+22	59.43364	59.45113	59.43924
8	-936764.2	994.4853	1.26e+22	59.40265	59.42253	59.40902
		*	*	*	*	*
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Table-7.4:**(Result of Johansen's Co-integration test)**

Co-Integration Between	Lag Length Selected	Co Integration test Using	No of Co-Integrating equation (CEs)	Eigne Value	Trace Statistics	Critical Value at 5%	Probability
CP, NOC and OI		Trace Test	None *	0.23730 1	13007.77	29.79707	1.0000
			At most 1 *	0.13207 0	4467.895	15.49471	1.0000
		Max-Eigen Value Test	None *	0.23730 1	8539.877	21.13162	1.0000
			At most 1 *	0.13207 0	4465.345	14.26460	1.0000

* Significant at 5% level,

The results of the Johansen co-integration test are presented in Table-7.4, which also summarises the co-integration between the volume, the number of contracts (NOC), and the open interest in the trading of currency futures. The USDINR contract is the sample used in this analysis to determine the dynamic correlation between price volatility, trading volume, and market depth for currency futures contracts. Because the USDINR currency controls a significant portion of the

currency futures market and because it was the first currency against which futures were established in India, the USDINR was chosen for the study because there were enough samples and time periods available for it. It was decided that 8 lags would be the appropriate number based on the lag determination criteria. This was dependent on the Sequential Modified LR TEST Statistic LR, the Final Prediction Error FPE, and the Hannan-Quinn Information Criterion HQ. The findings indicate that there is at least one co-mix condition present among the components of closing costs, volumes (NOC), and open interest. The co-mix test uses two no cost tests, the Trace Max test and the Max Eigen Value test, to determine where the coefficient grid should be placed inside the factors. The findings may be seen in table 6.3. P-Values greater than 5% indicate that there is no co-ordinating equation between the final price, volume (NOC), and Open interest at the 5% significance level, despite the fact that the null hypothesis ($H_0: r=0$ (None)) was accepted by both tests (Trace test and Max Eigen Value test with p-values of 1.0000 and 1.0000, respectively). This suggests that the variables, CP, NOC, and OI, do not have a long-term connection. In other words, there is no shared long-term information between closing price, volume (NOC), and open interest. Null hypothesis will thus be accepted.

Vector Error Correction Models are a suitable way to capture short run dynamics if variables are non-stationary and not co-integrated (VECMs). It examines how a variable responds to modifications and enhancements in other variables as well as the corrections necessary to account for any departures from the long-run equilibrium connection. In light of the lack of evidence for co-integration, we next ran the vector error correction model (VECM), which is well suited to identifying the lead-lag relationship and chain of causes among the CP, NOC, and OI. Table 7.5 displays the outcomes of the VECM.

TABLE 7.5:
ANALYSIS OF LONG RUN AND SHORT RUN RELATIONSHIP THROUGH VECM TEST

Vector Error Correction Estimates			
Date: 06/05/22 Time: 14:42			
Sample (adjusted): 10 31694			
Included observations: 31525 after adjustments			
Standard errors in () & t-statistics in []			
Cointegrating Eq:	CointEq1		
CLOSE_PRICE(-1)	1.000000		
NO__OF_CONTRACTS(-1)	0.002209		
	(3.4E-05)		
	[65.7519]		
OPEN_INTEREST(-1)	0.001178		

	(3.9E-05)		
	[30.4085]		
C	-655.1877		
Error Correction: CointEq1	D(CLOSE_PRICE)	D(NO__OF_CONTRACTS)	D(OPEN_INTEREST)
	0.000523	-785.3788	-537.1582
	(1.5E-05)	(8.13017)	(6.56459)
	[34.4429]	[-96.6006]	[-81.8266]
D(CLOSE_PRICE(-1))	-0.986176	99256.33	105526.4
	(0.00678)	(3628.24)	(2929.57)
	[-145.469]	[27.3566]	[36.0212]
D(CLOSE_PRICE(-2))	-0.912167	52348.38	60503.76
	(0.00891)	(4767.42)	(3849.39)
	[-102.401]	[10.9804]	[15.7178]
D(CLOSE_PRICE(-3))	-0.763836	60848.82	60738.36
	(0.01041)	(5570.28)	(4497.64)
	[-73.3896]	[10.9238]	[13.5045]
D(CLOSE_PRICE(-4))	-0.675962	63170.61	69188.84
	(0.01097)	(5871.43)	(4740.80)
	[-61.6155]	[10.7590]	[14.5943]
D(CLOSE_PRICE(-5))	-0.516057	37771.20	34921.79
	(0.01098)	(5878.81)	(4746.76)
	[-46.9807]	[6.42497]	[7.35697]
D(CLOSE_PRICE(-6))	-0.316690	9156.089	14136.47
	(0.01038)	(5556.37)	(4486.41)
	[-30.5039]	[1.64786]	[3.15095]
D(CLOSE_PRICE(-7))	-0.184264	-18928.18	-7515.965
	(0.00887)	(4747.77)	(3833.52)
	[-20.7712]	[-3.98675]	[-1.96059]
D(CLOSE_PRICE(-8))	-0.083289	-20353.15	-11787.77
	(0.00679)	(3634.72)	(2934.81)
	[-12.2639]	[-5.59964]	[-4.01654]
D(NO__OF_CONTRACTS(-1))	-1.04E-06	0.681719	1.089846
	(3.3E-08)	(0.01774)	(0.01432)
	[-31.2670]	[38.4376]	[76.1041]
D(NO__OF_CONTRACTS(-2))	-8.87E-07	0.600003	0.959372
	(3.3E-08)	(0.01746)	(0.01410)
	[-27.1973]	[34.3610]	[68.0442]
D(NO__OF_CONTRACTS(-3))	-7.41E-07	0.506807	0.809996
	(3.2E-08)	(0.01696)	(0.01369)
	[-23.3798]	[29.8857]	[59.1556]
D(NO__OF_CONTRACTS(-4))	-6.01E-07	0.414008	0.673049
	(3.0E-08)	(0.01614)	(0.01303)
	[-19.9407]	[25.6506]	[51.6449]
D(NO__OF_CONTRACTS(-5))	-4.96E-07	0.333424	0.530935
	(2.8E-08)	(0.01501)	(0.01212)
	[-17.6881]	[22.2131]	[43.8073]
D(NO__OF_CONTRACTS(-6))	-4.13E-07	0.248826	0.402084
	(2.5E-08)	(0.01346)	(0.01087)
	[-16.4130]	[18.4808]	[36.9858]
D(NO__OF_CONTRACTS(-7))	-2.58E-07	0.161266	0.256179
	(2.1E-08)	(0.01134)	(0.00916)
	[-12.1774]	[14.2167]	[27.9700]

D(NO_OF_CONTRACTS(-8))	-1.46E-07	0.059894	0.113133
	(1.5E-08)	(0.00823)	(0.00664)
	[-9.50267]	[7.27947]	[17.0294]
D(OPEN_INTEREST(-1))	-9.92E-07	0.899686	-0.236573
	(2.6E-08)	(0.01402)	(0.01132)
	[-37.8627]	[64.1821]	[-20.9016]
D(OPEN_INTEREST(-2))	-9.83E-07	0.759990	-0.248486
	(3.1E-08)	(0.01658)	(0.01339)
	[-31.7297]	[45.8333]	[-18.5595]
D(OPEN_INTEREST(-3))	-7.89E-07	0.663023	-0.219904
	(3.4E-08)	(0.01822)	(0.01471)
	[-23.1780]	[36.3900]	[-14.9478]
D(OPEN_INTEREST(-4))	-7.09E-07	0.598479	-0.137526
	(3.5E-08)	(0.01893)	(0.01528)
	[-20.0537]	[31.6218]	[-8.99943]
D(OPEN_INTEREST(-5))	-5.54E-07	0.461296	-0.123120
	(3.5E-08)	(0.01869)	(0.01509)
	[-15.8817]	[24.6875]	[-8.16050]
D(OPEN_INTEREST(-6))	-3.19E-07	0.331428	-0.109947
	(3.3E-08)	(0.01743)	(0.01407)
	[-9.79731]	[19.0174]	[-7.81337]
D(OPEN_INTEREST(-7))	-2.51E-07	0.186651	-0.086647
	(2.8E-08)	(0.01504)	(0.01214)
	[-8.92430]	[12.4142]	[-7.13730]
D(OPEN_INTEREST(-8))	-9.86E-08	0.113498	-0.021815
	(2.1E-08)	(0.01114)	(0.00900)
	[-4.73820]	[10.1880]	[-2.42514]
C	0.004497	260.0910	-112.2848
	(0.00545)	(2919.33)	(2357.17)
	[0.82440]	[0.08909]	[-0.04764]
R-squared	0.479815	0.590042	0.577601
Adj. R-squared	0.479402	0.589717	0.577266
Sum sq. resids	29543.09	8.46E+15	5.52E+15
S.E. equation	0.968455	518311.8	418503.4
F-statistic	1162.178	1813.429	1722.910
Log likelihood	-43708.56	-459535.5	-452792.5
Akaike AIC	2.774595	29.15537	28.72758
Schwarz SC	2.781489	29.16226	28.73448
Mean dependent	0.000726	484.1682	38.24003
S.D. dependent	1.342234	809187.5	643673.4
Determinant resid covariance (dof adj.)		1.40E+22	
Determinant resid covariance		1.39E+22	
Log likelihood		-937891.9	
Akaike information criterion		59.50661	
Schwarz criterion		59.52809	
Number of coefficients		81	

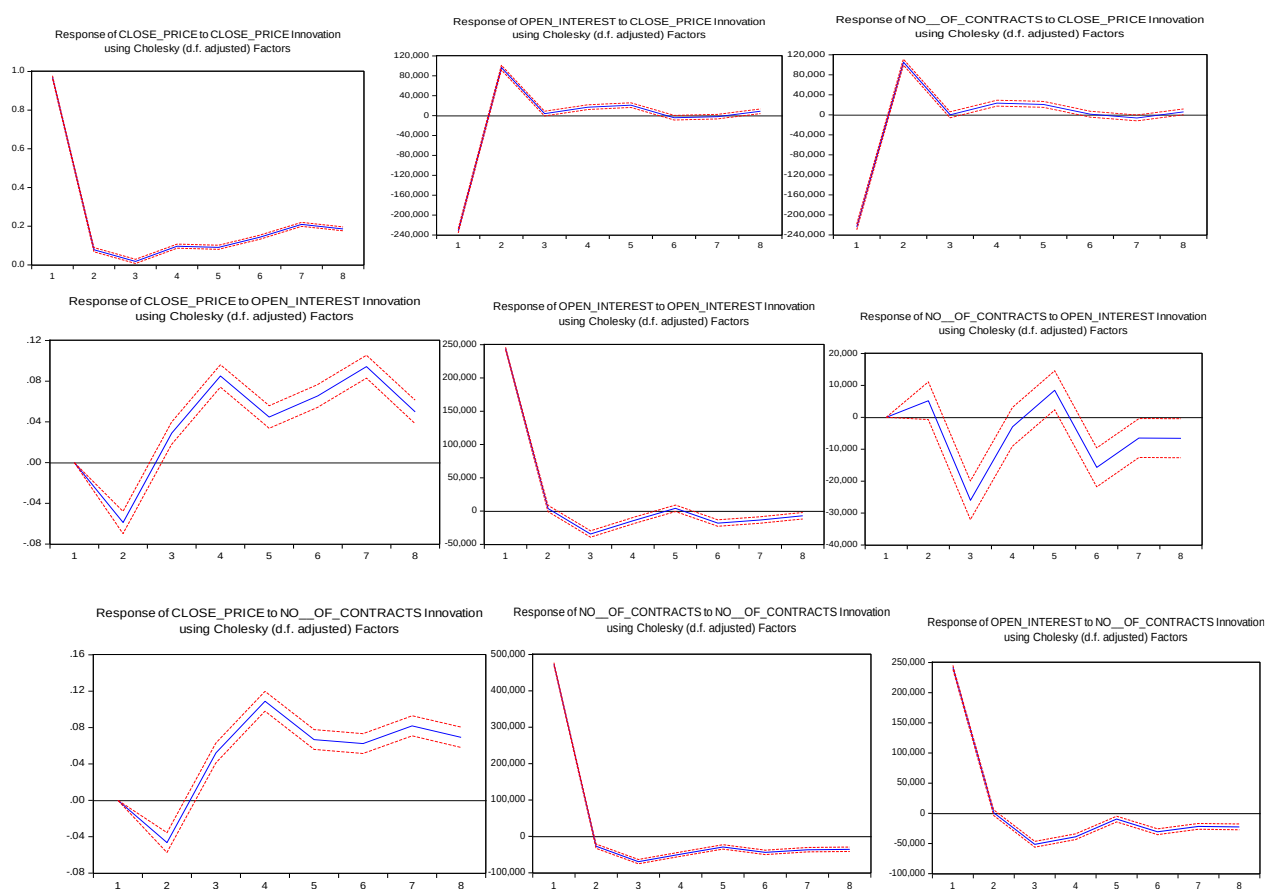
Dependent Variable: D(CLOSE_PRICE) Method: Least Squares (Gauss-Newton / Marquardt steps) Date: 06/05/22 Time: 14:50 Sample (adjusted): 10 31694 Included observations: 31525 after adjustments D(CLOSE_PRICE) = C(1)*(CLOSE_PRICE(-1) + 0.00220910003341 *NO__OF_CONTRACTS(-1) + 0.00117826663735 *OPEN_INTEREST(-1) - 655.187710243) + C(2) *D(CLOSE_PRICE(-1)) + C(3)*D(CLOSE_PRICE(-2)) + C(4) *D(CLOSE_PRICE(-3)) + C(5)*D(CLOSE_PRICE(-4)) + C(6) *D(CLOSE_PRICE(-5)) + C(7)*D(CLOSE_PRICE(-6)) + C(8) *D(CLOSE_PRICE(-7)) + C(9)*D(CLOSE_PRICE(-8)) + C(10) *D(NO__OF_CONTRACTS(-1)) + C(11)*D(NO__OF_CONTRACT S(-2)) + C(12)*D(NO__OF_CONTRACTS(-3)) + C(13) *D(NO__OF_CONTRACTS(-4)) + C(14)*D(NO__OF_CONTRACT S(-5)) + C(15)*D(NO__OF_CONTRACTS(-6)) + C(16) *D(NO__OF_CONTRACTS(-7)) + C(17)*D(NO__OF_CONTRACT S(-8)) + C(18)*D(OPEN_INTEREST(-1)) + C(19) *D(OPEN_INTEREST(-2)) + C(20)*D(OPEN_INTEREST(-3)) + C(21)*D(OPEN_INTEREST(-4)) + C(22)*D(OPEN_INTEREST(- 5)) + C(23)*D(OPEN_INTEREST(-6)) + C(24)*D(OPEN_INTEREST(-7)) + C(25)*D(OPEN_INTEREST(-8)) + C(26)					Dependent Variable: D(NO__OF_CONTRACTS) Method: Least Squares (Gauss-Newton / Marquardt steps) Date: 06/05/22 Time: 14:51 Sample (adjusted): 10 31694 Included observations: 31525 after adjustments D(NO__OF_CONTRACTS) = C(27)*(CLOSE_PRICE(-1) + 0.00220910003341*NO__OF_CONTRACTS(-1) + 0.001178266637 35*OPEN_INTEREST(-1) - 655.187710243) + C(28) *D(CLOSE_PRICE(-1)) + C(29)*D(CLOSE_PRICE(-2)) + C(30) *D(CLOSE_PRICE(-3)) + C(31)*D(CLOSE_PRICE(-4)) + C(32) *D(CLOSE_PRICE(-5)) + C(33)*D(CLOSE_PRICE(-6)) + C(34) *D(CLOSE_PRICE(-7)) + C(35)*D(CLOSE_PRICE(-8)) + C(36) *D(NO__OF_CONTRACTS(-1)) + C(37)*D(NO__OF_CONTRACT S(-2)) + C(38)*D(NO__OF_CONTRACTS(-3)) + C(39) *D(NO__OF_CONTRACTS(-4)) + C(40)*D(NO__OF_CONTRACT S(-5)) + C(41)*D(NO__OF_CONTRACTS(-6)) + C(42) *D(NO__OF_CONTRACTS(-7)) + C(43)*D(NO__OF_CONTRACT S(-8)) + C(44)*D(OPEN_INTEREST(-1)) + C(45) *D(OPEN_INTEREST(-2)) + C(46)*D(OPEN_INTEREST(-3)) + C(47)*D(OPEN_INTEREST(-4)) + C(48)*D(OPEN_INTEREST(- 5)) + C(49)*D(OPEN_INTEREST(-6)) + C(50)*D(OPEN_INTEREST(-7)) + C(51)*D(OPEN_INTEREST(-8)) + C(52)					Dependent Variable: D(OPEN_INTEREST) Method: Least Squares (Gauss-Newton / Marquardt steps) Date: 06/05/22 Time: 14:52 Sample (adjusted): 10 31694 Included observations: 31525 after adjustments D(OPEN_INTEREST) = C(53)*(CLOSE_PRICE(-1) + 0.002209100033 41*NO__OF_CONTRACTS(-1) + 0.00117826663735 *OPEN_INTEREST(-1) - 655.187710243) + C(54) *D(CLOSE_PRICE(-1)) + C(55)*D(CLOSE_PRICE(-2)) + C(56) *D(CLOSE_PRICE(-3)) + C(57)*D(CLOSE_PRICE(-4)) + C(58) *D(CLOSE_PRICE(-5)) + C(59)*D(CLOSE_PRICE(-6)) + C(60) *D(CLOSE_PRICE(-7)) + C(61)*D(CLOSE_PRICE(-8)) + C(62) *D(NO__OF_CONTRACTS(-1)) + C(63)*D(NO__OF_CONTRACT S(-2)) + C(64)*D(NO__OF_CONTRACTS(-3)) + C(65) *D(NO__OF_CONTRACTS(-4)) + C(66)*D(NO__OF_CONTRACT S(-5)) + C(67)*D(NO__OF_CONTRACTS(-6)) + C(68) *D(NO__OF_CONTRACTS(-7)) + C(69)*D(NO__OF_CONTRACT S(-8)) + C(70)*D(OPEN_INTEREST(-1)) + C(71) *D(OPEN_INTEREST(-2)) + C(72)*D(OPEN_INTEREST(-3)) + C(73)*D(OPEN_INTEREST(-4)) + C(74)*D(OPEN_INTEREST(-5)) + C(75)*D(OPEN_INTEREST(-6)) + C(76)*D(OPEN_INTEREST(-7)) + C(77)*D(OPEN_INTEREST(-8)) + C(78)				
CoefficientStd. Error t-Statistic Prob.					CoefficientStd. Error t-Statistic Prob.					CoefficientStd. Error t-Statistic Prob.				
C(1)	0.000523	1.52E-05	34.4429	0	C(27)	-785.3788	8.130168	-96.60056	0	C(53)	-537.1582	6.564588	-81.82665	0
C(2)	-0.986176	0.006779	-145.4689	0	C(28)	99256.33	3628.236	27.35664	0	C(54)	105526.4	2929.567	36.02116	0
C(3)	-0.912167	0.008908	-102.4005	0	C(29)	52348.38	4767.422	10.98044	0	C(55)	60503.76	3849.387	15.71776	0
C(4)	-0.763836	0.010408	-73.3896	0	C(30)	60848.82	5570.28	10.92383	0	C(56)	60738.36	4497.643	13.50449	0
C(5)	-0.675962	0.010971	-61.6155	0	C(31)	63170.61	5871.431	10.75898	0	C(57)	69188.84	4740.803	14.59433	0
C(6)	-0.516057	0.010984	-46.9807	0	C(32)	37771.2	5878.81	6.424973	0	C(58)	34921.79	4746.761	7.356973	0
C(7)	-0.31669	0.010382	-30.50391	0	C(33)	9156.089	5556.368	1.647855	0.0994	C(59)	14136.47	4486.41	3.150954	0.0016

C(8)	-0.184264	0.008871	-20.7712	0	C(34)	-18928.18	4747.768	-3.986754	0.0001	C(60)	-7515.965	3833.518	-1.960592	0.0499
C(9)	-0.083289	0.006791	-12.26394	0	C(35)	-20353.15	3634.724	-5.599642	0	C(61)	-11787.77	2934.806	-4.016543	0.0001
C(10)	-1.04E-06	3.31E-08	-31.26695	0	C(36)	0.681719	0.017736	38.43757	0	C(62)	1.089846	0.01432	76.10408	0
C(11)	-8.87E-07	3.26E-08	-27.19732	0	C(37)	0.600003	0.017462	34.36098	0	C(63)	0.959372	0.014099	68.04419	0
C(12)	-7.41E-07	3.17E-08	-23.37982	0	C(38)	0.506807	0.016958	29.88566	0	C(64)	0.809996	0.013693	59.15557	0
C(13)	-6.01E-07	3.02E-08	-19.94066	0	C(39)	0.414008	0.01614	25.65061	0	C(65)	0.673049	0.013032	51.64494	0
C(14)	-4.96E-07	2.80E-08	-17.68811	0	C(40)	0.333424	0.01501	22.21311	0	C(66)	0.530935	0.01212	43.80729	0
C(15)	-4.13E-07	2.52E-08	-16.41303	0	C(41)	0.248826	0.013464	18.48085	0	C(67)	0.402084	0.010871	36.98578	0
C(16)	-2.58E-07	2.12E-08	-12.17743	0	C(42)	0.161266	0.011343	14.21673	0	C(68)	0.256179	0.009159	27.97003	0
C(17)	-1.46E-07	1.54E-08	-9.50267	0	C(43)	0.059894	0.008228	7.279473	0	C(69)	0.113133	0.006643	17.02939	0
C(18)	-9.92E-07	2.62E-08	-37.86268	0	C(44)	0.899686	0.014018	64.18205	0	C(70)	-0.236573	0.011318	-20.9016	0
C(19)	-9.83E-07	3.10E-08	-31.72969	0	C(45)	0.75999	0.016582	45.83325	0	C(71)	-0.248486	0.013389	-18.55953	0
C(20)	-7.89E-07	3.40E-08	-23.178	0	C(46)	0.663023	0.01822	36.38997	0	C(72)	-0.219904	0.014711	-14.94782	0
C(21)	-7.09E-07	3.54E-08	-20.05371	0	C(47)	0.598479	0.018926	31.62177	0	C(73)	-0.137526	0.015282	-8.999434	0
C(22)	-5.54E-07	3.49E-08	-15.88167	0	C(48)	0.461296	0.018685	24.68747	0	C(74)	-0.12312	0.015087	-8.160497	0
C(23)	-3.19E-07	3.26E-08	-9.797307	0	C(49)	0.331428	0.017428	19.01745	0	C(75)	-0.109947	0.014072	-7.813367	0
C(24)	-2.51E-07	2.81E-08	-8.924295	0	C(50)	0.186651	0.015035	12.41419	0	C(76)	-0.086647	0.01214	-7.137303	0
C(25)	-9.86E-08	2.08E-08	-4.738199	0	C(51)	0.113498	0.01114	10.18797	0	C(77)	-0.021815	0.008995	-2.425137	0.0153
C(26)	0.004497	0.005455	0.824399	0.4097	C(52)	260.091	2919.329	0.089093	0.929	C(78)	-112.2848	2357.171	-0.047635	0.962
R-squared	0.479815	Mean dependent var	0.000726		R-squared	0.590042	Mean dependent var	484.1682		R-squared	0.577601	Mean dependent var	38.24003	
Adjusted R-squared	0.479402	S.D. dependent var	1.342234		Adjusted R-squared	0.589717	S.D. dependent var	809187.5		Adjusted R-squared	0.577266	S.D. dependent var	643673.4	
S.E. of regression	0.968455	Akaike info criterion	2.774595		S.E. of regression	518311.8	Akaike info criterion	29.15537		S.E. of regression	418503.4	Akaike info criterion	28.72758	
Sum squared resid	29543.09	Schwarz criterion	2.781489		Sum squared resid	8.46E+15	Schwarz criterion	29.16226		Sum squared resid	5.52E+15	Schwarz criterion	28.73448	
Log likelihood	-43708.56	Hannan-Quinn criter.	2.776802		Log likelihood	-459535.5	Hannan-Quinn criter.	29.15757		Log likelihood	-452792.5	Hannan-Quinn criter.	28.72979	
F-statistic	1162.178	Durbin-Watson stat	2.003328		F-statistic	1813.429	Durbin-Watson stat	2.05529		F-statistic	1722.91	Durbin-Watson stat	2.04558	
Prob(F-statistic)	0				Prob(F-statistic)	0				Prob(F-statistic)	0			

7.2. Impulse Response Function:- Granger causality merely supports the direction of the link between the variables; it may not be helpful in revealing the full context of the interaction between the variables in the system. At this point, it is crucial to understand how one variable will react to a positive impulse or shock in terms of one standard deviation from the remaining effects of other variables in the system. If one variable reacts to an impulsive shock in another, it can be assumed that the latter is the source of the former. One can determine the association in terms of positive and negative effects using impulse response analysis. Analysis of this kind is sometimes referred to as multiplier analysis or impulse response function analysis. The impulse behaviour can also be comprehended through a graphical representation. Consequently, a graphical presentation is shown to help the reader comprehend the impulsive behaviour of the three variables provided for this study.

Graph:7.1:

(Impulse Response Function Graph)



The Impulse response in the dependent variable on the dependent variable is seen in Graph 6.1. The preceding graph shows that when the residuals of volume (NOC) are shocked by one unit standard deviation (SD), the closing price of currency futures has a negative reaction over the next eight days

(Indicated by CP to NOC figure in the above diagram). When market depth (Open Interest) is shocked, the futures closing price volatility up to the next eight days demonstrates a favorable reaction (as the third figure in above diagram indicates). However, when one SD shock was applied to volume and pricing, a favorable reaction was seen. When the one unit of SD shock was applied, the remaining data likewise showed positive responses, such as those for the relationships between open interest and volume, open interest and price, and open interest and volume.

7.3. Conclusion

This chapter examined the dynamics of the relationships between three currency futures variables: trading volume, represented by the number of contracts (NOC), price return volatility, represented by futures closing prices, and market depth, represented by open interest. Data for all three variables were stationary at the initial difference, according to the unit root test. The Granger Causality test revealed a bidirectional causal link between the number of contracts (NOC), also known as volume, and closing price of currency futures. Futures closing prices and market depth, or open interest, have a one-way causal connection, meaning that open interest caused closing price. The association between OI and NOC (volume) is not causal.

Results from Johansen co-integration indicated that no co-integration equation exist among the variable which further offer the evidence to the existence of no long run relationship between the variables. Vector error correction model indicated that apart from long run relationship among the three variable there are also existence of short run relationship among the variable (Market depth, Closing prices and the volume of trades). Impulse response function shows that giving one unit shock to standard deviation of one variable can affect upto more than 8 upcoming days on the other variable. Hence from the Co-integration and VECM test, it has been ascertained that null hypothesis of no relationship among Open interest, volume traded and closing prices is rejected and it is concluded that these variables function inter-dependently in currency future market in India. From the test results of vector error correction model (VECM) presented in Table 6.4, it could be identified that there exist short run dynamics among variables in addition to the long run relationship. From Granger causality test, Co-integration test and VECM result, it is clearly understandable that all test give the clue of having interdependent relationship within and among the variables. A long run relationship is found apart from short run relationship and the variable showing negative but not significant are interpreted to have short run dynamic relationship only. Such short run dynamics are evidenced by the variables $D(CP(-1))$ with p-value 0.0001, $D(CP(-2))$ with p-value 0.0102, $D(NOC(-1))$

with p- value 0.0644 (significant at 10% level) and $D(OI(-1))$ with p-value 0.0058, when the dependent variable is assumed to be the closing price. When the NOC (Volume) is assumed as dependent variable, the long run error correction term -11572.91 with significant p-value=0.0000 indicated long run relationship among the dependent and independent variables. Short run relationship are also evident among and within the variables through the respective coefficients $D(CP(-1))$ with p-value 0.0452, $D(NOC(-1))$ with p-value 0.0000, $D(NOC(-2))$ with p-value 0.0000 and $DOI(-1)$ with p-value 0.0000.). And finally when the open interest was taken as dependent variable, in addition to long run association, there were indication of the existence of short run relationship within and among the variables and this relationship was indicated by $D(NOC(-1))$ with p-value 0.0000 and $DOI(-2)$ with p-value 0.0000.

CHAPTER- VIII

TO FORECAST THE CURRENCY SPOT PRICE IN INDIAN FOREIGN EXCHANGE MARKET

Given that it affects the flow of money for a variety of business players, including exporters, importers, investors, high frequency traders, bankers, tourists, business concerns, foreign employees, financial institutions, and policymakers, exchange rate fluctuation is regarded as a very important issue in terms of a nation's economy (Santhos kumar et al., 2011)¹⁰¹. As a result, it is crucial to predict the fluctuation.s. Many nations switched from fixed exchange rates to floating exchange rate systems as a result of the Bretton Woods Conference, which led to the rejection of the full conversion of gold into dollars Garber (1993)¹⁰² and Mohnot (2011)¹⁰³. The transition from a fixed to a floating exchange rate prompted discussion among many actors concerning the degree of volatility in the foreign exchange system, necessitating an assessment of exchange rate volatility. Volatility measurement is one of the most in-demand areas of financial research that has given academic researchers, practitioners, market participants, investors, and policy makers valuable inputs to portfolio selection, asset allocation, asset pricing, portfolio diversification, and risk management. There are several models available to predict the volatility of asset values, and it is widely known that stylized facts like the fat-tails distribution, volatility clustering, seasonality impact, leverage effect, asymmetry effect, etc. serve as examples of how asset prices behave.

Numerous experimental research projects have been conducted to thoroughly examine volatility in various nations. In order to analyse volatility, Engle (1982)¹⁰⁴ created the Auto Regressive Conditional Heteroscedastic (ARCH) model. His student Bollerslev (1986) made a significant contribution by developing the Genaralized Auto Regressive Conditional Heteroscedastic (GARCH) model. Improved models including Exponential GARCH (EGARCH) and Threshold GARCH (TGARCH) were created concurrently with the original ARCH and GARCH models. In this chapter, fundamental ARCH, GARCH, as well as sophisticated and advanced E-GARCH and T-GARCH, are

¹⁰¹ Santosh Kumar et.al. (2011) -Empirical testing of exchange rate volatility and introduction of currency futures in India||, -International Conference on Economics and Finance Research, IPEDR||, Vol. 4, pp.366-368.

¹⁰² Garber P. M., (1993) _The Collapse of the Bretton Woods Fixed Exchange Rate System, —A Retrospective on the Bretton Woods System: Lessons for International Monetary Reform, University of Chicago Press||, pp. 461-494.

¹⁰³ Mohnot, R. (2011), _Forecasting Forex Volatility in Turbulent Times||, -Global Journal of Business Research||, Vol. 5(1), pp. 27-38.

¹⁰⁴ Robert Engle 1982. Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation, -Econometrica|| ,Vol. 50, issue 4,pp. 987-1007.

used to estimate and predict exchange rate volatility. Finding the most appropriate model to quantify exchange rate volatility for the four specified currencies is the goal of the volatility analysis in this chapter. Evidence of several empirical research modelling volatility using a variety of symmetric and asymmetric models, including ARCH, GARCH, EGARCH, GJR-GARCH, PARCH, and TARCH, is available. Engle (1982), Bollerslev (1986), Nelson (1991), Glosten et al. (1993), Sentana (1995), Fidrmuc and Horvath (2008), Schnabl (2008), Neely (2009), Li and Hong (2011), Maradiaga et al. (2012); Koutmos (2012), Marshall et al. (2012); Zhang and Hu (2013); Nikolai (2013); and Kumar (2013) are some notable studies in this field. The US dollar (USD), the euro (EUR), the Japanese yen (JY), and the British pound sterling (GBP) were the four major currencies under study against which futures contracts are available in India. The present research work also examined the phenomenon of volatility clustering and leverage effect in exchange rates in relation to the Indian rupee (INR).

8.1. Data and Methodology

From 2008 to 2020, daily exchange rates—also referred to as spot prices for currency futures—were obtained from the RBI. Several time series econometric tools were used in this analysis, such as the unit root test to determine if time series data were fixed, the Auto Regressive Conditional Heteroscedastic (ARCH) model, the Generalized Auto Regressive Conditional Heteroscedastic (GARCH(1,1)) model, the Exponential Generalized Auto Regressive Conditional Heteroscedastic (EGARCH) model, and the Threshold Generalized Auto Re Stationary testing for the return from the spot swapping scale was able to be determined by using the unit root test through the ADF and PP tests.

Table 8.1:
(Unit Root Test Result)

	ADF Test				PP Test			
	Level		1 st Diff.		Level		1 st Diff.	
	t-stat	Prob.	t-stat	Prob.	t-stat	Prob.	t-stat	Prob.
USDINR_SP	-1.227825	0.6646	-55.51742	0.0001	-1.246340	0.6563	-55.59169	0.0001
EUROINR_SP	-1.684597	0.4391	-53.29954	0.0001	-1.755894	0.4029	-53.31598	0.0001
GBPINR_SP	-1.590196	0.4875	-53.28956	0.0001	-1.659312	0.4520	-53.28255	0.0001
JPYINR_SP	-2.766489	0.0633	-56.30605	0.0001	-2.729838	0.0691	-56.37023	0.0001

* Significant at 5% level,

The unit root test findings are shown in Table 7.1 with the aim of determining if Stationary exists in the time series data under investigation. Since all of the series were discovered to be stationary at first difference, the tests ADF and PP rejected the null hypothesis of having unit root in the currencies spot prices return and further acknowledged the absence of having unit root. All of the variables chosen were assumed to be stationary based on the findings presented in the aforementioned table 7.1.

Figure 8-A:
(Volatility clustering–USDINR_Exchange Rate Return)

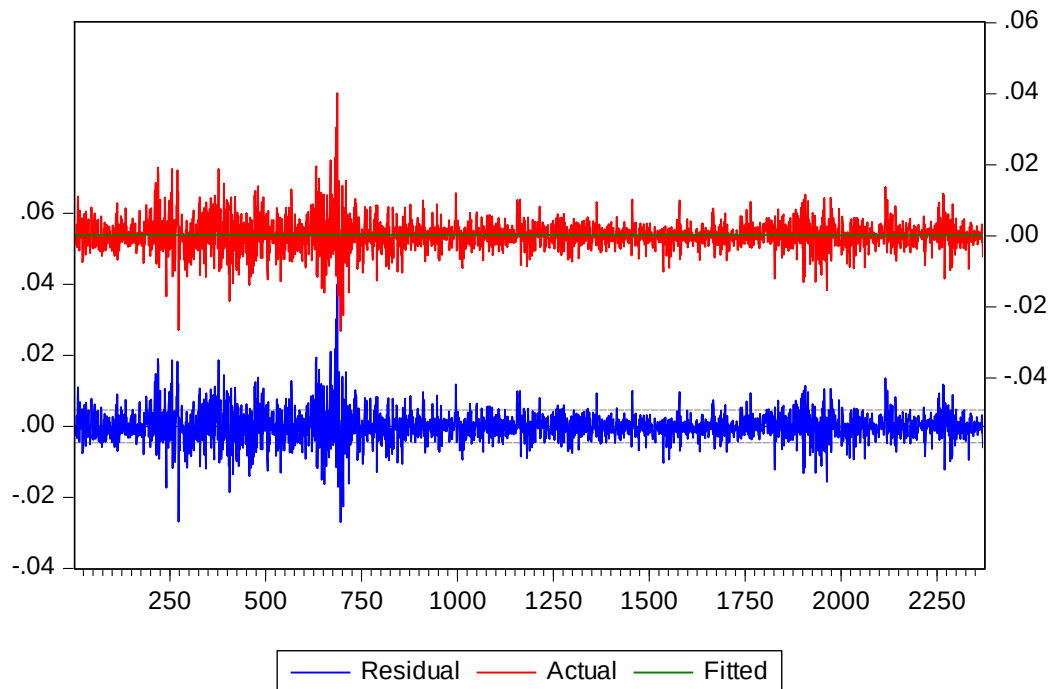


Figure 7-A shows a time series of returns and residuals distribution for the USD/INR spot rate. The return series is shown by red colour spikes, while the residuals pattern is shown by blue colour. A quick glance at the residual spikes indicates that the volatility is lower from day 750 to day 2250, or about, than it was from day 250 to day 750. It is evident that low volatility is followed by high volatility in the days 250 to 750, low volatility in the days 750 to 1750, and moderate volatility in the days 1750 to 2250. The Volatility Clustering property of a time series (Sing Y.P et al., 2006) is a prerequisite for using the nonlinear volatility models, namely the ARCH and GARCH models. It was discovered that there is autocorrelation and the ARCH effect in the data when attempting to determine whether serial correlation and the ARCH effect are present in the series. To put it another way, analysing the spikes reveals that certain periods are riskier than others, meaning that the predicted magnitude of error at some points is higher than at other times, supporting the heteroskedastic character of the data series. The distribution of these dangerous returns throughout the data is not random. In contrast, there is some autocorrelation in how risky financial returns are. The outcome of applying the GARCH model to the USDINR spot rate has been summarised in table 7.2.

Table-8.2:
GARCH Analysis (USDINR_ER)

USDINR_ER		Variable	Coefficient	Std. Error	z-Statistic	Prob.	AIC	SIC
GARCH (1,1)	GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)							
	Mean EQ.	C	5.08E-07	7.14E-08	7.121835	0.0000*	-8.240688	-8.226089
		RESID(-1)^2	0.116372	0.010959	10.61859	0.0000*		
		GARCH(-1)	0.858801	0.011649	73.72110	0.0000*		
E-GARCH	LOG(GARCH) = C(1) + C(2)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(3)*RESID(-1)/@SQRT(GARCH(-1)) + C(4)*LOG(GARCH(-1))							
	Mean EQ.	C	-0.524415	0.050921	-10.29860	0.0000	-8.238338	-8.228609
	VarianceEQ	C(2)	0.207252	0.017738	11.68377	0.0000		
		C(3)	0.054464	0.009432	5.774405	0.0000		
		C(4)	0.967146	0.003950	244.8503	0.0000		
T-GARCH	GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)							
	Mean EQ.	C	4.74E-07	6.38E-08	7.432574	0.0000*	-8.250690	-8.233658
		RESID(-1)^2	0.141948	0.014421	9.843012	0.0000*		
		RESID(-1)^2*(RESID(-1)<0)	-0.083385	0.014504	-5.748944	0.0000*		
			GARCH(-1)	0.873913	0.011116	78.61859		

* Significant at 5% level,

To determine which of these three is the best model to predict the volatility for a defined currency spot rate, the different GARCH family models—more particularly, GARCH (1,1), E-GARCH, and T-GARCH—were employed. For the USDINR spot rate, Table 7.2 displays the outcomes of the GARCH (1,1), E-GARCH, and T-GARCH tests for instability. Both the ARCH expression (RESID(-1)²), or squared residuals obtained from the mean condition, and the GARCH expression (GARCH(-1)), or earlier day's leftover change or instability, are shown in GARCH (1,1), indicating that both ARCH and GARCH (1,1) affect the ongoing instability of the spot rate. Instability was dissected and shown using not only GARCH (1,1) but also E-GARCH and T-GARCH. In addition to the finding, sure coefficients for C (2), C (3), and C (4) with p-upside of 0.0000 further corroborate that the influence effect was not discovered during the E-GARCH test. Assuming the coefficient value is negative and the p-value is large, it is probable that there will be a substantial impact on the instability. In this particular case, the influence effect refers to the observed tendency

for the unpredictability of a resource to be correlated negatively with the profits associated with that resource. Therefore, we promise that unfavorable data will have a more pronounced impact on instability than positive data. The T-GARCH outcome was interpreted to mean that the ARCH expression was large, and there was also evidence of an influence on the volatility of cash prices. This was demonstrated by the positive coefficient value of T-GARCH (Threshold value), which is represented by $\text{RESID}(-1)^2 * (\text{RESID}(-1)0)$, with a significant P-value of 0.0000.

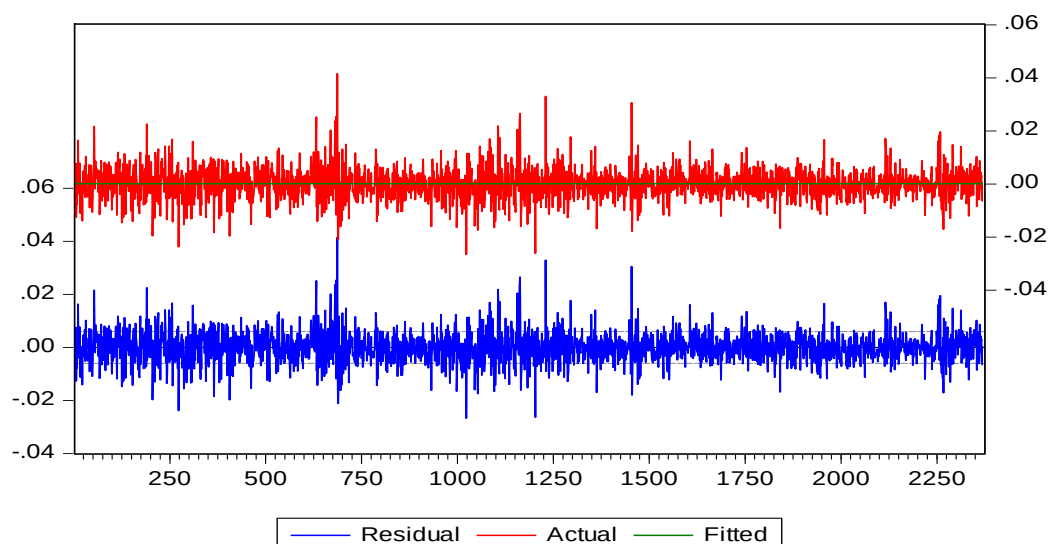
All three models were found to be significant, therefore a new question props up that out of these three models used for modeling the volatility, which one is appropriate and best suitable model. The criterion –The better is the model, low is the AIC, SIC value was applied to find the best among the three models applied. Thus, the lowest AIC and SIC value identifies best suitable model to model the volatility of the currency price. In the present analysis E-GARCH was found to be having the lowest AIC and SIC values thus identifying E-GARCH to be the best suitable model.

All three models were shown to be significant, raising the new question of which of the three models was most suited and adequate for predicting volatility. To determine which of the three models was best, the criterion "The better the model, low is the AIC, SIC value" was used. The model that best captures the volatility of the currency price has the lowest AIC and SIC value. E-GARCH was determined to be the best suited model in the current investigation since it had the lowest AIC and SIC values.

EURO vs. INR Exchange Rate

Figure 8-B: depicts volatility clustering of EUROINR_ER through graphical presentation.

Figure-: 8.B: (Volatility clustering –EUROINR_ER)



Time series of EUROINR spot rate returns and residuals distribution are shown in Figure 7B. The behaviour of the EUROINR exchange rate exhibits volatility clustering, which suggests that the volatility of the USDINR exchange rate may be modelled using non-linear volatility models. Figure 7-B shows the return series' red spikes and the residuals pattern's blue representation. Looking at the residual spikes, it can be seen that the volatility is lower between days 1550 and 2250, or about, than it is between days 100 and 1500. It is evident that strong volatility occurs between days 100 and days-1500 and is followed by moderate volatility from days 1550 to days 2250. This graph shows that periods of low volatility are followed by periods of high volatility. The serial correlation and ARCH effect in the EUROINR spot rate series were analyzed, and they were shown to be present in the data, just as they were in the USDINR spot rate series.

The volatility of the spot rate for the EUR/INR currency was examined using the same technique, i.e., the ARCH and GARCH family models. The findings are presented in Table 7.3.

Table-8.3:
GARCH Analysis (EUROINR_ER)

EUROINR_ER		Variable	Coefficient	Std. Error	z-Statistic	Prob.	AIC	SIC
GARCH(1 ,1)	GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)							
	Mean EQ.	C	8.36E-07	1.40E-07	5.956678	0.0000*	-7.491000	-7.476401
		RESID(-1)^2	0.054949	0.005252	10.46327	0.0000*		
		GARCH(-1)	0.921541	0.006366	144.7546	0.0000*		
E-GARCH	LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)*RESID(-1)/@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))							
	Mean EQ.	C	-0.421021	0.054148	-7.775313	0.0000*	-7.489689	-7.472657
	Variance EQ	C(2)	0.125268	0.011171	11.21316	0.0000*		
		C(3)	0.029183	0.007181	4.063783	0.0000*		
		C(4)	0.968552	0.004961	195.2225	0.0000*		
		C(5)						
T GARCH	GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)							
	Mean EQ.	C	9.01E-07	1.48E-07	6.080132	0.0000*	-7.492420	-7.475388
		RESID(-1)^2	0.066244	0.006719	9.858555	0.0000*		
		RESID(-1)^2*(RESID(-1)<0)	-0.027225	0.008989	-3.028749	0.0025		
		GARCH(-1)**	0.921517	0.007397	124.5846	0.0000*		

* Significant at 5% level,

Results of volatility modelling for EUROINR currency spot rates using GARCH (1,1), E-GARCH, and T-GARCH are shown in the above table. Each test's result is presented in two parts, the first of which is a mean equation and the second of which is a variance equation. The ARCH term "RESID (-1) 2" (prior period's squared residuals is generated from mean equation) provides information regarding volatility and historical returns for exchange rates. With a p-value of 0.0000, the GARCH term "GARCH (-1)" (prior day's residual variance or volatility) was found to be significant, indicating that both ARCH and GARCH (1,1) have an impact on the present volatility of the spot rate. As evidenced by the three positive coefficient values of 8.36E-07, 0.054949, and 0.921541 with significant P-values of 0.0000, 0.0000, and 0.0000 for both ARCH (RESID(-1)²) and GARCH (GARCH(-1)) terms, respectively, the results show that GARCH(1,1) does have a significant effect over the current day's volatility. The positive values of coefficients C(2), 3, and 4 and significant P-value *RESID(-1)/@SQRT(GARCH(-1)) show that the results from E-GARCH show that there is no asymmetric effect over the current days volatility, which means that there is not much effect of positive and negative information flows over the current exchange rate fluctuation. The T-GARCH result shows that the threshold effect has not been seen since the threshold.

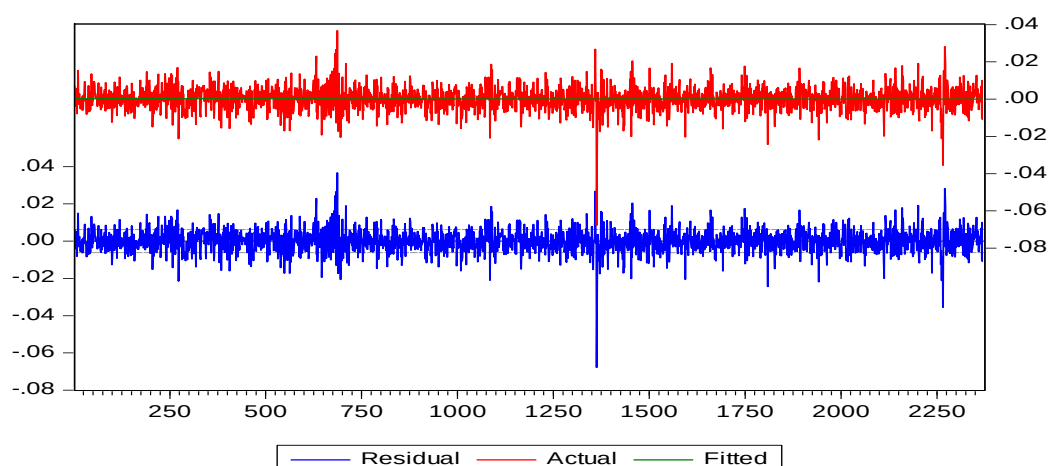
Since all three models were shown to be relevant in this case, it is crucial to understand which model is most acceptable and suitable for use in simulating volatility. E-GARCH was shown to be the most effective at simulating the volatility of the EUROINR with the aid of the lowest AIC and SIC values.

GARCH Analysis (USDINR_ER)

GBP vs. INR Exchange Rate

Figure 8-C demonstrates volatility clustering of GBPINR_ER through graphical presentation.

Figure-8-C:(Volatility clustering T –GBPINR_ER)



GBPINR spot rate returns and residuals distribution behavior is shown in Figure-7-C. This picture also depicts the clustering of volatility, which suggests that non-linear volatility models may be used, as they were for the first two research currencies. Volatility spikes in figure 7-C show red spikes (upper) of the return series and blue ones (lower) illustrate residuals pattern of the series, same as the previous two images in figure 7-A and figure 7-B. It was noted that there was considerable volatility from day one to about day 750, moderate volatility from day 800 to day 1200, and then increasing volatility from day 1 250 to day 2 200. Small volatility is followed by small volatility, and high volatility is followed by high volatility, which is a certain indicator of volatility clustering. It shows that nonlinear volatility models like the ARCH and GARCH models may be utilised to model the volatility using this series. The GBPINR spot rate series was examined for serial correlation and the ARCH effect prior to the application of the models, and it was discovered that the data had both of these effects. Further analysis was done based on these features discovered in the series, and the results are shown in table 7.4 as follows:

Table-8.4: GARCH Analysis (GBPINR_ER)

GBPINR_ER		Variable	Coefficient	Std. Error	z-Statistic	Prob.	AIC	SIC
GARCH(1, 1)	“GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)”							
	Mean EQ.	C	3.88E-06	7.98E-07	4.867810	0.0000	-7.405115	-7.390516
		RESID(-1)^2	0.096082	0.012942	7.424211	0.0000		
		GARCH(-1)	0.801751	0.031567	25.39809	0.0000		
E-GARCH	“LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)*RESID(-1)/@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))”							
	Mean EQ.	C	0.000149	0.000131	1.144037	0.2526	-7.404092	-7.387060
	Variance EQ	C(4)	-1.051829	0.198932	-5.287373	0.0000		
		C(5)	0.193012	0.021083	9.154946	0.0000		
		C(6)	0.070606	0.009794	7.208887	0.0000		
		C(7)	0.911673	0.018238	49.98756	0.0000		
T GARCH	“GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)”							
	Mean EQ.	C	3.97E-06	7.96E-07	4.983860	0.0000	-7.413008	-7.395976
		RESID(-1)^2	0.137112	0.017366	7.895501	0.0000		

	RESID(-1)^2*(RESID(-1)<0)	-0.092554	0.014741	-6.278535	0.0000	
	GARCH(-1)	0.804260	0.031070	25.88546	0.0000	

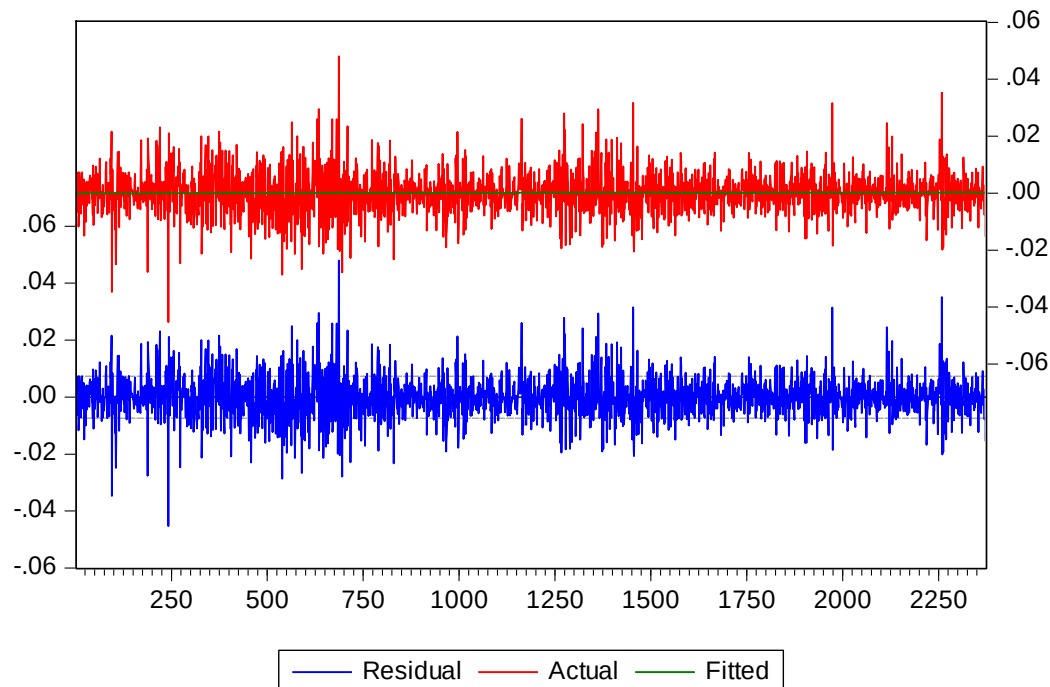
* Significant at 5% level, ** Significant at 10% level

Results of volatility modelling for GBPINR currency spot rates using all three models applied to the prior analysis—GARCH (1,1), E-GARCH, and T-GARCH—are shown in Table 7.4. These data were provided for each test in the same two sections that the earlier research did: first, the mean equation, and then, the variance equation. The mean equation yields the ARCH term, also known as the squared residuals from the preceding period, which may be interpreted as a measure of the historical volatility of the return on the exchange rate. As the p-value for the previous day's residual variance or volatility was found to be 0.0000, it is clear that the current volatility of the GBPINR spot rate is affected by both ARCH and GARCH (1,1). With positive coefficient values of 0.096082 and 0.801751 for the ARCH (RESID(-1)²) and GARCH (GARCH(-1)) terms, respectively, and significant P-values of 0.0000 and 0.0000 for each, the results show that GARCH (1,1) strongly effects the volatility seen today. The negative value of the coefficient (-1.051829) of C(4) with a significant P-value indicates that there is an asymmetric effect over the current days volatility, which means that there is a significant impact of both positive and negative information flows over the current exchange rate fluctuation.

The T-GARCH result shows that the threshold effect is not present since the threshold coefficient, (RESID(-1)²*(RESID(-1)<0)), has a negative value but a significant p-value whereas the GARCH value is positive and substantial P. All three models were shown to be important in this case as well. The conclusion obtained is that, although though all three models may be used to simulate volatility, the model with the lowest AIC and SIC value is the most appropriate and optimal. T-GARCH was determined to be the best model to estimate the volatility in the instance of GBPINR currency spot rates based on the lowest AIC, SIC value.

JPY vs. INR Exchange Rate: Figure 8-D demonstrates volatility clustering of JPYINR_ER through graphical presentation.

Figure-8-D: (Volatility clustering –JPYINR_ER)



The return series' and its residuals' volatility behaviour is shown in Figure 7-D. The top one has to do with series return variability, whereas the lower one has to do with series residuals. This graph demonstrates that there is significant volatility from day 100 to day 750, low volatility from day 800 to day 1500, and then moderate volatility from day 1600 to day 2250. All of the prerequisites, including the absence of serial correlation and the ARCH effect, have already been verified and proven to be satisfied. These characteristics suggest that the JPYINR spot rate time series can have its volatilities modelled using ARCH and GARCH.

Figure 7-D exhibits the volatility behavior of both the return series and its residuals. The upper one is related to series return variability whereas the lower one is related to residuals of the series. This figure shows that from the day 100 to 750, there are high volatility and thereafter from the 800 day to 1500 days there were low volatility observed and then after 1600 to 2250 moderate volatility can be seen. All the preconditions such as non-existence of serial correlation and ARCH effect have already been checked and found that preconditions were fulfilled. These properties indicate that JPYINR spot rate time series is amenable to model its volatilities through ARCH and GARCH. The models ARCH, GARCH (1,1) T-GARCH, and E-GARCH were used to estimate the volatility, and

the optimum model for JPYINR spot rates was determined using the AIC and SIC criteria. The results of this exam are shown in table 7.5 as follows.

Table:8.5: GARCH Analysis (JPYINR_ER)

JPYINR_ER		Variable	Coefficient	Std. Error	z-Statistic	Prob.	AIC	SIC
GARCH(1, 1)	"GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)							
	Mean EQ.	C	-1.97E-05	0.000130	-0.152130	0.8791	-7.107817	-7.093217
	Variance EQ	C2	2.44E-06	3.42E-07	7.141804	0.0000*		
		RESID(-1)^2	0.103563	0.009128	11.34532	0.0000*		
		GARCH(-1)	0.853544	0.012894	66.19734	0.0000*		
E-GARCH	LOG(GARCH) = C(4) + C(5)*ABS(RESID(-1)/@SQRT(GARCH(-1))) + C(6)*RESID(-1)/@SQRT(GARCH(-1)) + C(7)*LOG(GARCH(-1))							
	Mean EQ.	C	0.000130	0.000133	0.977191	0.3285	-7.111842	-7.094810
	Variance EQ	C(4)	-0.645903	0.071524	-9.030514	0.0000*		
		C(5)	0.192177	0.015640	12.28749	0.0000*		
		C(6)	0.064078	0.010436	6.140363	0.0000*		
		C(7)	0.949543	0.006504	146.0041	0.0000*		
T- GARCH	GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*RESID(-1)^2*(RESID(-1)<0) + C(7)*GARCH(-1)							
	Mean EQ.	C	0.000117	0.000135	0.860002	0.3898	-7.114044	-7.097012
	Variance EQ	C2	2.39E-06	3.36E-07	7.106327	0.0000*		
		RESID(-1)^2	0.135838	0.014118	9.621883	0.0000*		
		RESID(-1)^2*(RESID(-1)<0)	-0.078298	0.016476	-4.752260	0.0000*		
		GARCH(-1)	0.859999	0.013133	65.48339	0.0000*		

* Significant at 5% level,

We have examined the JPYINR spot rate for the volatility modelling, just as the other three currency spot rates. The results of the GARCH study for the JPYINR spot rate are discussed in Table 7.5. The outcome is broken down into three sections, the first of which explains the GARCH (1,1) model of volatility, the second of which illustrates the EGARCH implication, and the third and final one of which is T-GARCH. The ARCH ((RESID(-1)²)) and GARCH (GARCH(-1)) coefficient values are 0.103563 and 0.853544, respectively, with p-values of 0.0000 and 0.0000, according to the findings

of the GARCH (1,1) study. It shows that the mean equation-derived squared residuals from the prior period and the previous day's residual variance or volatility both include information about volatility and have an effect on the spot rate's volatility today. As indicated by the negative coefficient for $C(4)$, (-0.645903) with the p-value 0.0000, the E-GARCH result demonstrates that the leverage effect is not seen. If the coefficient value is negative and the p-value is big, it is likely that leverage is having an effect on volatility. As used above, "leverage effect" refers to the empirically observable tendency for asset volatility to be inversely related to return volatility. What this means is that it is reasonable to expect that bad news will have a larger effect on volatility than positive news. According to the findings of the T-GARCH analysis, the $RESID(-1)^2 * (RESID(-1)0)$ coefficient value (0.135838) is negative but significant with a p-value of 0.0000, while the GARCH($GARCH(-1)$) value (0.859999) was found positive and significant (P-values 0.0000). Since the E-GARCH model had the lowest AIC and SIC values, it was selected as the best fitting model.

8.2. Conclusion

Exchange rates have always been a crucial economic indicator with a significant impact on the international monetary system (Frankel and Saravelos, 2012), and their volatility has also been a key contributor to the instability in the global financial system that has an impact on business decisions (Bofinger and Wollmershäuser, 2003 and 2014). (Schnabl, 2008). In light of the rising volatility in the foreign currency market, attempts have been undertaken to forecast exchange rate fluctuations. This chapter looked into the presence of leverage impact in Indian currency spot rates as well as volatility clustering characteristics in the series. The study used daily data in order to provide the most relevant models for properly explaining the volatility in the series. The GARCH family models were used in an effort to quantify the volatility. The GARCH, EGARCH, and T-GARCH model findings support the exchange rate's asymmetry and volatility. Based on the lowest AIC and SIC criterion, the best predictable model was chosen. The exchange rates for USDINR and EUROINR showed that the volatility, which is best described and assessed by T-GARCH, may be caused by the extreme volatility of these two currency rates. The T-GARCH was determined to be better appropriate to simulate the volatility for these two currencies because they are the two most popular and widely used currencies in the world. Similarly to the findings in the works of Hsieh (1989), Longmore and Robinson (2004), Mapa (2004), and Alberg et al., the JPYINR exchange rate series suggested that EGARCH is the best model to explain its volatility behavior. Given its modest use, the GBPINR exchange rate was better described by the GARCH (1,1) model (2006).

CHAPTER – IX

SUMMARY, FINDINGS AND CONCLUSION

The expansion of financial services and markets throughout the world has created both tremendous possibilities and significant hazards. The majority of the world's economies are now increasingly interconnected and dependent on one another because to financial globalisation. It has expanded beyond only the industrialised economies and now includes the rest of the financial world as well. Developing nations profit from financial globalisation when their domestic financial markets are excellent, deep, stable, strong, and regulated and their financial systems are sturdy and established. The opening of the Indian financial market to globalization and monetary progress in the years 1990-1991 resulted in a number of significant monetary and monetary changes in the country, including the establishment of the Securities and Exchange Board of India (SEBI), the National Stock Exchange of India (NSEIL), the National Securities Depository Limited, and the National Securities Clearing Corporation (NSCCL). These institutions, which had cutting-edge technology on hand, increased transaction system transparency and, as a result, provided robust protection for all present and future investors. These organisations have positioned themselves as role models for other established financial organisations, forcing them to modify the way they now operate and replace it with operations that are more focused on contemporary technology in-order to stay competitive. The growth of the financial market also required the creation of the derivatives market and the introduction of derivative instruments to increase the level of complexity in the various financial market segments.

On November 18, 1996, the Securities Exchange Board of India (SEBI) established a committee, chaired by Dr. L. C. Gupta, to provide pertinent reports and make recommendations about the regulatory framework for the derivative market in the Indian financial sector. The March 17, 1998, report from this committee included important suggestions that needed to be taken into account before derivatives goods could be introduced in India. So that derivatives trading may be subject to the same regulations as securities trading, this committee has advocated that derivatives be formally recognized as securities. In June 1998, SEBI formed a second committee, headed by Prof. J. R. Verma, to provide suggestions on how best to manage risk in India's derivatives market. In a study published in October 1998, Professor Verma detailed the margining system, criteria for charging initial margins, broker's net worth, deposit requirements, and real-time monitoring of the derivative market, among other things, to ensure its smooth functioning. Taking into account the major recommendations made by Dr. L. C. Gupta and Prof. J. R. Verma in their conclusions, SEBI gave the go-ahead for the derivatives market to launch in India's two largest exchanges, NSE and

BSE, in the year 2000. It legalized Sensex and S&P CNX Nifty index futures trading on the Bombay Stock Exchange (BSE) and the National Stock Exchange of India (NSE). Between 2001 and 2003, a slew of new derivative contracts emerged, including index options trading in June 2001, stock options trading in July 2001, futures contracts based on individual equities trading in November 2001, and interest rate futures trading in March 2003. When the derivative market was first introduced to India's financial industry, it revolutionized how risk and returns were managed. This market has sparked extensive changes in investment structure and market integration in line with industrialised nations. Regarding foreign exchange derivatives, the market is mostly transaction-based and based on the foreign exchange exposure of the underlying currency in accordance with the needs of market participants. The Indian foreign exchange derivative market is similarly regulated to other derivatives products and requires the surrender of foreign exchange assets in the Indian foreign exchange market. This market includes designated intermediaries with restricted permission, authorised dealers (ADs), often banks, and end users including corporations, individuals, and institutional investors. The four main kinds of foreign exchange derivatives products that are now offered in India are forwards, futures, options, and currency swaps. Foreign exchange derivatives, also referred to as currency derivatives, are primarily employed by corporations for risk management purposes, including the hedging of asset prices against price risk on global markets as well as the hedging of exchange rate risks by FIIs, NRIs, and other foreign investors.

Since the goal of this research project is to examine the currency derivative market in India, namely currency futures, Many individuals find it extremely challenging to predict their upcoming future payments since the precise inflow (amount of the receivables value) that they anticipate receiving in the future in foreign currency is unpredictable due to the increased volatility in currency value. This has significant consequences for the negotiation of contracts, particularly international contracts, and these implications are crucial for participants in the export, import, delivery, or acceptance of cross-border remunerative goods or the entry into long-term international contracts. On April 20, 2007, the Reserve Bank of India (RBI) issued detailed guidelines for the over-the-counter (OTC) usage of foreign currency futures, options, and swaps to assist these businesses in mitigating their exposure to currency market volatility. Concurrently, the RBI formed an internal working group to examine the potential advantages of implementing currency futures. In its April 2008 report, the internal working group suggested the establishment of exchange traded currency futures. Because of this, the Reserve Bank of India (RBI) and the Securities and Exchange Board of India (SEBI) established a Standing Technical Committee to investigate the international

currency forward and future market and make suggestions for the incorporation of currency futures into the Indian financial market. The Committee presented its findings to the RBI on May 29, 2008, and on August 6, 2008, SEBI also issued circulars in this respect. And eventually, the Indian financial sector was allowed to trade exchange-traded currency futures. On August 20, 2008, trading in currency futures for the US dollar against the Indian rupee began on the currency derivatives market of the National Stock Exchange. Later in February 2010, futures contracts for the euro, pound, and yen against the Indian rupee were created, with the NSE serving as their first launch platform. Exchange Traded Currency Futures were designed with the use of electronic trading platforms and effective risk management systems to increase price discovery efficiency and transparency, reduce counter-party credit risk, and give access to all prospective market players. Additionally, banks were given the ability to join this section of the Exchange, giving them a new opportunity.

Derivatives are primarily financial instruments that are linked to and valued according to the value of their underlying assets, such as certain financial stocks, indices, commodities, currencies, or interest rates, and are traded independently with the aim of managing the financial risk brought on by changes in the underlying asset's price over the course of its life. Forwards, futures, options, and swaps are all forms of derivatives that are exchanged. The majority of derivative trading involves hedging, or holding opposing positions in the futures market, to reduce financial risk. Using derivative markets, the following economic utilities are achieved:

1. At the time of the derivative contract's expiration, the prices of the derivatives products converge with the prices of the underlying assets. As a result, the price discovery mechanism from future to spot, or vice versa, is made easier by the derivatives market.
2. By shifting the risk from one contract party to another, the risks associated with price swings are hedged in this market. In other words, it may be claimed that the derivatives market makes it easier for players who don't want to take risks to shift those risks to those who are eager to do so in exchange for payment.
3. Due to the nature of derivatives, they are always connected to the underlying cash markets. Due to increased engagement by additional parties who would not have otherwise engaged due to a lack of a risk transfer agreement or risk management options, the underlying market now experiences larger trading volumes.

4. A more regulated environment for speculative trading is facilitated by the derivatives market. Due to the lack of a regulated and organised derivatives market, traders first engaged in transactions in the underlying cash markets. Due to a standardised system of margining, monitoring, and activity surveillance, it became very difficult for players to manipulate such types of mixed markets.
5. The derivatives market encourages and assists many people in increasing their long-term investments and savings. The capability offered by the derivative market expands the scope of operations by allowing players to shift risk, which encourages participants to think outside the box.

One of the world's most active markets for exchange-traded derivatives is the currency derivative market in India. This is now achievable because to recent advancements in India's financial markets, which are accessible to all citizens thanks to fast and transparent electronic trading and a large retail market. The National Stock Exchange (NSE), which controls a significant portion of the Indian market's overall turnover, has played a significant role as the market leader in currency derivative trading. The derivatives market is playing a crucial role in terms of enhancing the quality and speed of information flow, increasing market depth overall, as well as market liquidity, which helps to reduce market volatility due to informational asymmetries.

Since the launch of the Indian currency futures and derivative market, the currency derivative market at NSE has experienced significant development in a very short period of time. Better-performing currency futures contracts have the potential to have an influence on the economy via leveraging changes in the country's exchange rate. After nearly 39 years following the invention of currency futures at the Chicago Mercantile Exchange, this market has just just been implemented in India (CME). With the launch of next generation exchanges, the NSE-CD market has seen significant growth in just 5 to 6 years and is soon likely to exceed the equity cash segment.

The number of contracts traded on the currency futures market increased from 3,26,72,768 in the market's first year to 74,14,84,767 in the following year, representing an increase of about 95.59 percent through 2021. The volume of contracts (volume) traded on the NSE under the currency derivative sector for futures contracts reached an all-time high in the year 2010–11. Since the inception of trading at CD, the turnover of currency futures has expanded from Rs. 1,62,272.43 Cr. (Year 2008-09) to Rs. 59,83,242.32Cr. (In the year 2020-21), with a growth of 97.28 percent. This underlines the market's significance and potential reach for exchange-traded currency futures contracts.

The second chapter goes into great length about the growth of the derivative market and currency derivative both globally and in India. The derivative market has developed a wide range of products that make it easier to transfer risk as a tool for risk management in the financial sector. This chapter has provided a thorough overview of the slow evolution of derivatives, from their initial debut at the Chicago Mercantile Exchange (CME) through their more recent trading at the NSE and BSE. This market is growing in many different ways. This chapter also covers in depth the development of derivatives in India. In India, the index and stock derivative market received the first official legal status in 2000–2001, followed by the currency derivative market in 2008. Today, derivative trading, which is recognised as one of the fastest growing risk management systems, is completely integrated into the Indian financial markets. Exchange traded derivatives are extensively standardised in India and provide the investor group clear & easy transaction methods. The regulatory bodies in charge of policing this area of the financial market, including currency derivatives, are SEBI and RBI.

The third chapter addresses several studies that have previously been conducted in the derivatives market and stock market that were considered to be helpful in defining methodology and analytical tools, as well as in offering research-related input suggestions with regard to the research gap. This chapter detailed the many empirical investigations that have already been done on this topic and served as the basis for this study. The examined literature revealed that there have been a sufficient number of research on currency futures, their relationship to the spot market, and global volatility. However, when research on the currency derivative market in India was examined, no noteworthy papers were discovered. Additionally, it was found that many studies had been conducted to evaluate the impact of derivatives trading on the underlying market, though these studies tended to concentrate on developed markets and originated primarily in Europe and the United States, with only a handful of studies pertaining to countries like Japan and Korea. There is a dearth of research on the effects of the advent of currency derivatives trading in developing nations like India, especially as it relates to the entrance of derivatives in the currency market. There were no notable research released about the Indian currency future market. It was therefore sought to track the development of currency derivatives in India and their interactions with the underlying cash market using this as the research gap for the current study. The Indian Currency Futures Market and its relationship to the spot exchange market needed to be studied in light of the aforementioned. Appropriate procedures were developed for the analytical framework of the research in issue based on the existing literature. Bollerslev's (1986) Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model's conditional variance was discovered to be the best instrument

for studying the volatility of exchange rate series. The ARCH & GARCH models were determined to be appropriate models by Andersen (1996), Chatrath, Ramchander & Song (1996) to measure the spot rate volatility. For the spot rate volatility, (GARCH) was also utilised by Ioannis Asimakopoulou, David Ayling, and Wan Mansor Mahmood in 2000, M. T. Raju and Kiran Karande in 2003, Jussi, Petri, and Sami in 2006, Douglas K. Pearce, M. Nihat Solakoglu, Vivek Bhargava A. and D.K. Malhotra in 2007, Somnath Sharma (2011) Therefore, the same econometrics approaches were applied in the current study. Johansson co-integration and the VECM model were also discovered to be appropriate tools for price discovery study, as recommended by Kenneth D. Garbade and William L. Silber in 1983, Banamber Mishra, Matiur Rahman, Steve Caples in 1992, Ahmet Can Inci, Biao Lu in 2005, Leo Chan and Donald Lien in 2006, Kailash Chandra Pradhan and Sham Bhat.K in 2006, Kapil Gupta and Balwinder.

The following four particular objectives for analysis are included in this study based on the aforementioned research scope.

- Examining the spot exchange rate's trend of change after currency futures were introduced to India's FX market.
- Objective: Investigate how prices in Indian currency futures markets are set.
- The purpose of this study is to analyze the interplay between price volatility, volume of trades, and liquidity in the Indian currency futures market.
- In order to predict the current rate of the Indian rupee on the foreign exchange market

9.1.Data and Methodology used for the Study

The National Stock Exchange (NSE) and Reserve Bank of India (RBI) in India provided the secondary data used in this study. The sample size is justified in light of the study's goal. The sample data covered the periods from January 1, 2004 to August 2020 for the USDINR exchange rate and from August 29, 2008 to August 2020 for USDINR futures prices for the first and second objectives, respectively. These objectives centered on the price transparency system in Indian monetary prospects and the study of the evolution of spot exchange rates after the introduction of cash destinations in India's unfamiliar commerce market. For the remaining three currencies (EUROINR, JPYINR, and GBPINR), test data for trade rates and futures costs spans from January 1, 2004 through August 31, 2020 (for spot rates) and October 29, 2010 through August 31, 2020 (for prospective closing rates), respectively. Third, we used open revenue and trading volume to investigate the special relationship between cash futures contract cost predictability, trading volume, and market depth in India. Dates between October 29, 2010 and August 31, 2020 are used as an example time span in

which fortunes may be swapped. The cash spot price in India's foreign trade market was estimated using data from the period between October 2010 and August 31, 2020. There are typically three types of contracts traded in tandem on the prospects markets: those with expirations in the near future, the intermediate future, and the far future. The majority of trading activity occurs in near month contracts, rather than the next two types of agreements, hence only those contracts are taken into account in this analysis. Microsoft Excel and the statistical and econometric software programme E-views are used to examine the data that have been gathered.

The fourth chapter discusses numerous approaches and resources used for this study's analysis. This study aims to investigate how derivatives affect the underlying spot market, or exchange rate, in particular how currency futures affect it. This chapter covered every general and essential methodology component as well as the tools needed to analyse data appropriately and interpret it in accordance with the stated study objectives. This research made use of visual representations where appropriate, descriptive statistics to help with understanding baseline data, and other helpful pointers on technique gleaned from the reviewed literatures. For long-term relationships, one can use the Johansen co-integration (1988, 1991) test; for short-term relationships, one can use the Johansen Vector error correction model (VECM) test; for unidirectional and bidirectional relationships among the variables under study, one can use the Granger Causality test (1969); for autoregressive conditional heteroscedasticity (ARCH) by Engel (1982); for GARCH family models by Bollerslev (1986); and (Mandelbrot, 1963). Augmented Dickey Fuller (ADF) (1979) and Phillips and Perron (1988) tests are the most used methods for finding a unit root in a series. An explanation of the data's structure is provided by descriptive statistics, and the existence of an Arch effect in the disturbance term was checked using the Arch LM test, volatility clustering, and the ARCH model so that the GARCH model could be used.

Chapter five consists of two parts relating to first two objectives. The first part was about the —To explore the movement-pattern of spot exchange rate after introduction of currency futures in foreign exchange market in India.‖ and the second part was about the —To study the price discovery mechanism in Indian currency future markets.‖.

Since time series data were employed for analysis, the first section of chapter five in this research deals with the preliminary and diagnostic analysis of data. It was necessary to comprehend the nature of the data in order to determine the applicability of the analysis tool and, afterwards, to apply the advanced econometric tool for further analytical purposes. Before moving on to further research, it is customary to study time series data to determine if a unit root exists in the series.

Since time series data were employed for the analysis, the first section of chapter five in this

study deals with the preliminary and diagnostic data analysis. Understanding the nature of the data was necessary in order to determine the applicability of the analysis tool and, subsequently, the application of advanced econometric tools for further research. Before moving on to further analysis, time series data must often be studied to see if a unit root exists in the series. Therefore, the Stationary was checked using the ADF and PP tests. Chapter 5's initial section of study revealed that daily foreign exchange spot prices are stationary at the first difference. The results of the ADF and PP tests showed that the series had significant p-values at first difference for both tests of Stationary, which allowed the use of more sophisticated econometric techniques on these series to analyse the various research objectives. It was observed that, with the exception of USDINR, the pre-introduction standard deviation in the series for each currency was consistently low when compared to the post-introduction era. In the case of the USDINR, the standard deviation used to measure the change in volatility after the introduction of futures contracts for the currency in India was 10.07268, which was more than twice as high as the standard deviation used to measure volatility prior to the introduction of derivatives (Pre USDINR derivative was 2.011328). This rise in standard deviation shows that volatility has increased after currency futures for this exchange, i.e. USDINR, were introduced. The spot rate volatility for other exchange rates, on the other hand, showed a tendency to decline with the introduction of currency futures contracts. After the launch of futures contracts in the EUR, GBP, and JPY, the standard deviation has decreased. The spot rate may provide as evidence of increased volatility following the introduction of futures for a variety of reasons. Heightened speculative activity, policy divergence from fundamentals like monetary policy, macroeconomic shocks, or other news may be the main causes of the increased volatility. Based on the dollar's widespread adoption, there may have been additional causes for the heightened volatility of USDINR. The four monetary forms under study — USDINR, EURINR, JPYINR, and GBPINR — have been the subjects of an examination in the last part of this section into cost disclosure and the connection among spot and fates costs. The essential contribution of sign on the connection between the two costs is given by the perception from the charts and the clear insights, which were again examined through the Johansson co-mix test to search for the presence of a long-run connection between the spot and fates costs. The presence of a transient connection between the spot and fates was explored utilizing the Johansen Vector Error Correction Model (VECM). The unit root in the factors being talked about was checked utilizing the ADF and PP tests, and the outcomes uncovered that both the spot and fates costs were fixed at the underlying contrast. The aftereffects of the Co-mix and VECM tests uncovered that there was no less than one co-coordinated condition between the spot and fates costs, which upheld the possibility that these two costs are connected in the long-and present moment and return to harmony at whatever point one of them strays from the

other over the long haul. It was shown that for each of the four monetary standards, the fates cost drives the spot value and might be used to gauge the spot cost from now on. The ends might be drawn with certainty that the spot and fates might play a huge impact in cost revelation. Thus, there is a worldly causal connection between them. The Co-mix and VECM test uncovered that the invalid speculation that there is no relationship between's the future cost and spot cost is dismissed, which prompted the end that the cost disclosure process works in the Indian cash fates market. Part six was connected with the investigation of dynamic of relationship among market profundity, cost instability, exchanging volume for cash fates exchanging. There is a positive and coordinated connect between exchanging volume and cost instability, as per scholastics like Karpov (1987), Bessembinder and Seguin (1993), and Jones et al. (1994). In their examinations, Schwert (1990) and Gallant et al. (1992) found that verifiable volatilities had a huge prescient limit with regards to foreseeing exchanging volume stocks. However, the link between price and volume is more nuanced than the straightforward and simple causation that volume moves prices. In the financial literature, particularly in the literature pertaining to the foreign currency market, the feedback effects between price volatility and volume have yet to be a subject of significant examination. Few research have used market depth to explain asset volatility, despite the fact that it plays a significant role in connection to trading activity and assets price drive, since most prior studies focused primarily on the link between the assets price and trading volume. Lee et al. (1992, 1993), Seguin & Bessembinder (1992, 1993), and (1993). These three variables—assets price, trading volume, and market depth—have also been discussed and argued by Tauchen & Pitts (1983) and Kyle (1985), but they are still not being given much attention because the literature has not come to an agreement on a clear-cut definition of market depth that can be applied to empirical studies. Chapter six of this study have taken this into consideration and analyzed the relationship among market depth, price volatility, trading volume for currency futures trading. From 29 October 2009 to 31 December 2020, daily closing prices for currency futures, open interest, and the number of contracts traded as the volume of trading (number of contracts) for USDINR futures were collected. The NSE currency derivative section is where these data were obtained. To conduct the empirical analysis, we employed a number of time series econometric tools, including the unit root test to ensure the series was stationary, the Granger Causality test to determine the direction of the informational effect, the Johansson Co-integration test to examine the long-term relationship between the variables, and the Vector Error Correction Model (VECM) and Impulse Response Ratio test to examine the long-term and short-term associations between the three variables. The viability of the VECM model was assessed using the Wald test. According to the results of the Augmented Dickey-Fuller (ADF), the asset's closing price, open interest, and volume (number of contracts) are non-stationary at the level

but stationary at the first differential. The Granger Causality test was performed to establish the direction of causality among the interconnected variables. Results showed that trading volume and futures closing price had a bidirectional causal relationship, which means that both variables influence one another. Results also demonstrated a one-way causal link between market depth (open Interest) and futures closing prices, with Open Interest driving closing price rather than the other way around. VECM (Vector error correction model) results showed that the three variables were related across the short, medium, and long terms in addition to the long run (Market depth, Closing prices and the volume of trades). One unit of shock to the standard deviation can have an impact on the responding variables for up to 8 days in the future, according to the results of the impulse response function.

The modelling of spot rate volatility using the most complex volatility models, such as ARCH, GARCH, GARCH (1,1), E-GARCH, and T-GARCH, was covered in Chapter 7. The volatility in exchange rates has also been a key factor in the instability in the global financial market that affects corporate decision-making (Bofinger and Wollmershäuser (2003) Daly), making it one of the important economic indicators that can have a significant impact on the international monetary market (2011). Taking this into account, attempts are being made to develop methods for anticipating exchange rate changes in line with rising currency market volatility (Schnabl, 2008). This chapter applied historical data on a daily basis to examine the presence of leverage effect in Indian currency spot rates and the existence of volatility clustering characteristics in the series in order to recommend the most appropriate models for properly explaining the volatility in the series. The GARCH family models were used in an effort to quantify the volatility. The lowest AIC and SIC criteria were used to choose the optimal predictability model. The USDINR and EUROINR exchange rates were found to be the most volatile currency futures, which showed that T-GARCH was the best method for describing and measuring their volatility. However, the GARCH provided a superior explanation for the GBPINR exchange rate (1,1). Fourth exchange rate, or JPYINR, is a moderately used currency, therefore the E-GARCH model was the best fit to characterize its volatility behaviour. Results were in line with those found in the works of Hsieh (1989), Longmore and Robinson (2004), Mapa (2004), and Alberg et al (2006).

Important Results of the Study

This study examines recent developments in the currency derivative market and their effects on the underlying cash market in terms of volatility after their introduction, the existence of price discovery, and the dynamics of the relationship between market depth, open interest, and price volatility in the currency futures market. It also models the spot market rate using the ARCH and GARCH family models in an effort to identify an appropriate model that can adequately explain volatility. The

following is a list of the main conclusions reached in this study:

1. Four spot currency rates (INR-USD, INR-EUR, INR-GBP, and INR-JPY) were used in the analysis, and their Stationary was tested using the ADF and PP procedures. Despite finding that the spot rates for the four currencies were stationary at the first difference, the results suggested that the series were not stationary at the level.
2. The four currency spot rates for the duration of the study were all observed with kurtosis values exceeding the higher limit, i.e. 3, and with a significant probability value of 0.000 of the Jarque-Bera statistics. This is shown by descriptive statistics of currency return series supplemented with the corresponding graph. The results of the kurtosis and Jarque-Bera tests revealed that all of the variables taken into consideration for the study had excess kurtosis and were non-normal, which suggests that there is heteroskedasticity in the currency return series.
3. The descriptive statistics showed that since the launch of USDINR currency futures trading, there has been an increase in volatility as measured by standard deviation. The standard deviation of exchange rate return has, nevertheless, somewhat increased for the EUROINR spot rate with the introduction of the futures. Regarding the JPYINR return, it was noted that the pre-introduction period's standard deviation was higher than the post-introduction period's, indicating a reduction in volatility. Similar behaviour, i.e. a spike in volatility following the introduction of currency futures, was seen with GBPINR as well. Thus, other from USDINR, the volatility has generally decreased with the introduction of derivatives.
4. The futures and spot prices of all four currencies considered for the price discovery function were found to be non-stationary at first difference (ADF) but stationary at level (ADF).
5. The Co-integration test result indicated that at least one co-integrated equation exists between the spot and futures prices, showing that there is at least one integrating equation demonstrating long term relationship between the two prices, i.e. spot and futures. The VECM research also revealed how the error correction vector influences the long and short term equilibrium in the two

prices. In the case of USDINR and EUROINR, both futures and spot prices have a long term connection and both re-correct and bring equilibrium position to one another if disequilibrium occurs. In the case of GBPINR and JPYINR, a long run link was discovered, however it was only from spot to futures price, implying that spot price corrects the equilibrium position in the long run if disequilibrium occurs. In other words, in the case of the USDINR and the EUROINR, price discovery works from both prices. Specifically, futures price to spot price and spot price to futures price. However, in the case of GBPINR and JPYINR, price discovery operates solely from spot price to futures price.

6. The Granger Causality test revealed a bidirectional causal link between the number of contracts (NOC), i.e. volume, and the closing price of currency futures. The unidirectional causal association between market depth, i.e. Open Interest, and futures closing price was observed. There is no causal link between OI and NOC (volume). The results of Johansen co-integration showed that at least one co-integration equation exists among the three variables (market depth, closing prices, and trading volume), indicating the presence of a long run dynamic relationship between the variables.
7. The ADF and PP tests were run to guarantee Stationary before the exchange rate estimate was made. According to the findings, after accounting for the initial dissimilarity, all four currencies remained stable during the whole experiment. All four currencies shown evidence of volatility clustering in the aforementioned data set. T-GARCH is the best model for explaining and assessing volatility, as seen by the USDINR and EURINR exchange rates. Similar to the findings of Hsieh (1989), Longmore and Robinson (2004), Mapa (2004), and Alberg et al. (2005), we find that E-GARCH is the best model to explain the volatility behavior of the JPYINR exchange rate series, whereas GARCH (1,1) is the best model to explain the volatility behavior of the GBPINR exchange rate (2006).

9.2. Recommendations based on the research

1. According to the results of this research, the introduction of currency futures contracts for the EUROINR, GBPINR, and JPYINR lowered volatility in the underlying spot market. With the advent of currency futures, the USDINR spot rate became far more volatile than usual. This might be attributed to increasing speculative activity in the USDINR futures market. Market regulators must make

risk management techniques more stringent and supervised. More particularly, for the highly sought-after currencies.

2. Policymakers can increase the margin amount required for entrance into derivatives contracts to curb rising market speculation. This may also aid in avoiding ignorant trading in the currency derivatives market.
3. The financial crisis may also have contributed to increased volatility in the USDINR, given the introduction of CF occurred at that time and had a greater impact on USDINR pricing. The findings imply that the Indian derivative market should be more strictly controlled in order to mitigate the impact of the global financial crisis on the Indian market.
4. Investors may prefer to invest in the less volatile currency rather than USDINR futures.
5. The introduction of currency derivatives has resulted in decreased reliance on the global derivative market for both Indian and international investors. Because currency derivatives were introduced considerably later in the currency market than in the stock market. The market's efficiency must be continuously monitored.
6. Investors must have an adequate awareness programme in place to comprehend the numerous complexity in the currency derivative market as well as the volatility risk associated. This study suggests that investors participate in a training programme on a regular basis. If they are risk averse, they can identify the less volatile investment.

9.3. Prospects for Future Research & Limitation of the Study

Even though India has a century-old stock market, currency futures and options trading are relatively new. Although the currency derivatives market in India has been active for more than a decade, there have been few attempts to assess how the advent of currency futures trading has affected price discovery and currency volatility on the spot market. Further research may be conducted to investigate the influence of derivatives on underlyings at intraday announcement. With a longer research period, there is still plenty of room for additional in-depth investigation of the dynamic interaction between the spot and derivatives markets. Some suggested research areas include:

1. The performance of currency derivatives during the financial crisis may be studied in depth throughout the crisis era.

2. An investigation on the hedging efficacy of currency derivatives products in relation to Indian currency derivatives can be conducted.
3. A study of investors' perceptions of the usefulness of currency derivatives can also be conducted.
4. An intercontinental comparison or global currency volatility analysis can also be done.

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