An Empirical Study on Dynamics of Foreign Exchange Market in India

A Report submitted to the UGC under Major Research Project

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Preface

The foreign exchange market is the largest highly and liquid financial market in the world with worldwide average daily turnover around $5.3 trillion, which makes foreign exchange highly global trading asset. Foreign exchange forms the basis of dealings for trade and other monetary transactions between economies of the world. Foreign exchange market operates with heterogeneous participants comprises of central banks, commercial banks, companies, brokers, fund managers, speculators and individuals. Central banks regulate the market for smooth and orderly operations with a broader objective of economic and financial development. On the other hand, other participants try to minimise the potential risk with the best possible way and try to maximise the profit. Presences of high volatility make the exposure management challenge since the global capital is highly volatile and purely depends on the performances in the economic fundamentals. Moreover, country-specific and market-specific investors sentiments also influence the same. This volatile pattern in the foreign exchange market is extremely crucial for a country like India which has unfavourable trade balance and facing stiff competition in the global market.

Foreign exchange market is one of the enormous financial markets having trading centres across the globe on which the sun never sets and operate in a virtual platform. It operates like other financial markets where the price of the currency is measured as the value of a foreign currency relative to domestic currency or vice-versa. A foreign exchange contract typically states the currency pair, the amount of the contract, the agreed rate of exchange. Highly dynamic nature of exchange rate necessitates and predict the behaviour for minimising the potential exposure. Understanding the foreign exchange rate movements is not only crucial for exporters and,

importers but also other active market participants such as commercial banks, brokers, central banks, traders, speculators, tourists and investors.

For understanding the movements in the foreign exchange market, much emphasis is given on fundamental, behavioural, technical analysis along with central bank's actions for currency management. Fundamental analysis involves the study of economic fundamentals of a country such as Gross Domestic Product (GDP), Balance of Payment (BOP) Position, Political Stability, Inflation, Interest Rates and Rating by major Global Credit Rating Agencies etc. Non-fundamental factors play an inevitable role as the market not always consensus with fundamental, but it has strong relations with sensitive factors. Behavioural factor like bandwagon effects, peers/social and rumours influence the participant's decision. Similarly, technical analysis uses exchange rate forecasting techniques based on historical movements in the market.

Impact of fundamental and non-fundamental factors on the foreign exchange market has become a widely studied topic in academic literature. One side of this literature focuses on the impact of fundamental and non-fundamental factors, while the other on the role, efficiency and use of technical analysis by foreign exchange traders in generating trading signals. Some studies have reported from their survey of foreign exchange traders that non-fundamental factors such as bandwagon effects, over-reaction to news, technical trading, and excessive speculation determines short-run exchange rate and the role of fundamental factors in relevant in the long run. Previous literature on technical analysis provides that technical analysis is an important and widely used method of analysis in the foreign exchange market and that applying certain technical trading rules over a sustained period may lead to significant positive excess returns. Most of these studies have however been limited to major developed countries and some

developing countries excluding India. These results might differ between the countries as it depends on the specific country's market regulations, 'maturity' and the economy itself.

Motives for central bank interventions in the foreign exchange market are clearly available and supported by the academic literature. But the impact of central bank interventions on foreign exchange volatility and its relationship with technical rules profitability is still unclear. Some studies on a survey of foreign exchange dealers have reported that central bank intervenes with the objective to bring stability in the market have an intervention which reduces volatility; whereas other studies have reported from their survey evidence that central bank interventions increase volatility in the market. This contradiction needs to be addressed and has aroused the necessity to identify the existent impact of central bank interventions on foreign exchange volatility so that behaviour of the market to intervention practices can be understood clearly. Studies on central bank interventions and technical trading rules profitability provides that trading rules are unusually profitable on days on which interventions take place, so the same needs to be investigated in the Indian context.

This study primarily investigates the dynamic characteristics of Indian foreign exchange market including perception and attitude of the market participants to forecasting the exchange rate with an artificial neural network technique. It specifically examines the relative importance of fundamental as well non-fundamental that influence foreign exchange rate predictions and their time-varying behaviour in the market. Similarly, it explores the significance of fundamental and non-fundamental factors in the trading decision of foreign exchange traders. Study tries to discover an appropriate model to forecast the exchange rate movements of INR-USD; INR-GBP, INR-JPY and INR-EUR. Further study assesses the impact of central bank interventions by measuring the extent of the volatility of the Indian foreign exchange market due to Central Bank

interventions. Finally, study recommend measures for policy makers, investors and corporate on the basis of the findings from the present study.

Following the sanctioning of the project by the project by the University Grants Commission, the study was carried out in multiple directions. The study used both primary and time series data for analysing the dynamics of the Indian foreign exchange market. Samples or the primary analysis were collected from major north Indian cities like Delhi, Chandigarh, Amritsar, Jalandhar and Ludhiana based on the highest number of registered foreign exchange brokers. Using a purposive sampling technique, a non-disguised structured questionnaire was administered to collect data from 250 respondents across five cities. content validity of questionnaire items were ensured after a detailed discussion with two experts' having more than 20 years of experience in the foreign exchange market and two professors from the academic field. After four revisions consensus was formed among the suggestions of experts from two fields and questionnaires were administered on 60 brokers from Ludhiana. After a gap of 20 days' questionnaire was again administered to same 60 brokers.

Heterogeneous respondents include 58 dealers registered with Reserve Bank of India, 94 brokers/sub-brokers registered with Securities and Exchange Board of India and 96 investors from different cities. From each city, major trading locations were identified, and respondents were targeted accordingly. One investor from each broker office was selected based on highest trading experience. Time series data on exchange rate, central bank intervention, and other economic variables at different frequencies were collected from RBI, Federal reserve, and international monetary fund. For analysing, modelling and interpreting the primary and secondary data consistent with stated objectives, various statistical, econometric and artificial

intelligence tools and techniques have been employed with the help of software like SPSS, GPower, E-views (Student Version), Statistica (Courtesy NIT, Jalandhar) and Microsoft Excel.

Study discovered some interesting points on the determination of foreign exchange rate in Indian market. Exchange rate determination through fundamental factors was significantly higher than technical and behavioural factors. Similarly, fundamental factors have greater ability to determine foreign exchange rate than speculation. However, the usefulness of a factor may vary for prediction of trends and turning points. The trend prediction results revealed that fundamental factors were considered somewhat more useful in predicting trends than predicting turning points in the foreign exchange market. Study discovered that broker/sub-broker views regarding the effect of speculation on increase in exchange rate volatility were significantly higher than dealer group and investor group. Investor views regarding the effect of speculation on increase in exchange rate volatility were significantly higher than dealer group. However, no significant difference was found in the views of broker/sub-broker group and investor group

Central bank intervenes in the foreign exchange market to achieve multiple objectives such as controlling inflation, boost growth, maintaining international competitiveness, preventing disorderly market condition, reserve accumulation and upholding internal and external balance There are several techniques to intervene in the foreign exchange market such as Concerted, Sterilized, Scheduled, Spot Market and Forward Market interventions depending on the objective, country and time of intervention. Survey result found that foreign exchange traders profoundly believe that central bank interventions affect the foreign exchange rate. But traders disagree with the statement that central bank interventions have an influence on profits for chartists in short term, dealer and investor group disagreed, and broker/sub-broker disagreed to the statement. Time series data reveal the presence of leaning against wind policy of RBI to

manage the exchange rate uncertainties. However, RBI intervention is capable of minimizing the exchange rate volatility though it failed to influence exchange rate.

I, author of the report, owe gratitude to individuals and functionaries of the university who played an important role right from the writing of the project proposal till the completion and submission of the project report otherwise it would not be possible (and we would be failing in our duties if we do not acknowledge their help and support). To begin with, we owe a deep sense of gratitude to Professor Furqan Qamar, the founder Vice-Chancellor of the central university of Himachal Pradesh, Dharamshala who encouraged principal investigator to develop and submit the project proposal to the University Grants Commission (UGC) for funding, while he was in the university he took particular interest to ensure adequate facility for the systematic and smooth execution of the project. I express my heartful thanks to our present Vice-Chancellor prof Kuldeep Chand Agnihotri who promptly addressed all our problems whenever these were brought to his notice. I also grateful to Prof H. R. Sharma, pro-vice chancellor for his help at every stage of the implementation of the project. I am also grateful to Prof. Y.S.Verma, former pro-vice chancellor and Dean, School of Business and Management Studies for his immeasurable patronage and inspiration. My collegues in the Department of Accounting and Finance namely Dr Mohinder Singh, Dr Manpreet Arora, and Dr Ashis Nag have always been very supportive and helpful and deserve my profound appreciations and sincere thanks. I also appreciate Dr Jagdish Raj Saini, Dr Sachin Kashyap, Mr Abdul Rishad, and Mr Akhil Sharma, Research Scholars, who accomplished various tasks like designing, collecting and analysing data, and preparing the report with great commitment and devotion in their meticulous work.

I am incredibly grateful to Mr Munish Sharma, research assistant, unconditionally helped in various phases of this project. We also remain indebted to our respondents from Delhi,

Chandigarh, Amritsar, Jalandhar and Ludhiana for their complete and sincere involvement in the study, otherwise, it would not have been possible to complete within the time frame and thankful to National Institute of Technology (Jalandhar) for their technical support. I further wish to put on record my appreciation to the Registrar and Finance officer of the university for facilitating smooth implementation of the project. The secretarial assistance rendered by Mr Sandeep Singh, LDC and Mr. Munish, finance department for their support and assistance from the beginning till the completion and submission of the project report is highly appreciated and gratefully acknowledged. In the end, I also wish to acknowledge the financial support provided by the University Grants Commission for undertaking the study.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

Introduction

The foreign exchange market is the generic term for the worldwide institutions that exist to exchange or trade currencies. Foreign exchange is often referred to as "forex" or "FX." The foreign exchange market is an over-the-counter (OTC) market, which means that there is no central exchange and clearinghouse where orders are matched (Lien, 2009). FX dealers and market makers around the world are linked to each other around the clock via telephone, internet links, and fax, creating one cohesive market.

Undoubtedly, we are now living in a world where all the major economic functions-consumption, production, exchange and investment are highly globalized. India import sugar and sugar confectionery from Brazil, Thailand, Guatemala and Spain. American consumers, for example, routinely purchase oil imported from Saudi Arabia and Nigeria, TV sets from Korea, automobiles from Germany and Japan, garments from China, shoes from Indonesia, pasta from Italy, and wine from France. Foreigners, in turn, purchase American-made aircraft, software, movies, jeans, wheat, and other products. Continued liberalization of international trade is certain to further internationalize consumption patterns around the world (Eun & Resnick, 2012). It is thus essential for financial managers to fully understand vital international dimensions of currency risk involved in settlement of these trades and the available tools for its management.

Understanding the foreign exchange rate movements is not only important for exporters and, importers but also for those who deal in currency market regularly such as, commercial banks, brokers and central banks, traders and speculators, tourists and investors, etc. The exchange of currencies is done in the foreign exchange market, which is one of the biggest financial markets having trading centres in each part of a single world on which the sun never sets (Krugman, Obstfeld, & Melitz, 2012). The foreign exchange rate is the value of a foreign currency relative to domestic currency. A foreign exchange contract typically states the currency pair, the amount of the contract, the agreed rate of exchange etc.

For understanding the movements in the foreign exchange market much emphasis is given on fundamental, behavioural, technical analysis and central bank moves for currency management. Fundamental analysis involves the study of economic fundamentals of a country such as Gross Domestic Product (GDP), Balance of Payment (BOP) Position, Political Stability, Inflation, Interest Rates and Rating by major Global

Credit Rating Agencies etc. Non-fundamental factors such as behavioural factor and technical factors also play an important role in the foreign exchange market. Behavioural factors include Bandwagon effects, Peers/social influences and Rumours etc. Technical analysis is concerned with exchange rate prediction on the basis of historical data. Many techniques have been developed over a period such as Fibonacci retracement levels, moving averages, oscillators, candlestick charts, and Bollinger bands (Edwards, Magee & Bassetti, 2007). Central bank intervenes in the foreign exchange market to achieve many objectives such as controlling inflation, to maintain internal and external balance and prevent resource misallocation or preserve competitiveness and boost growth, to prevent or deal with disorderly markets or crises. There are several methods available to central banks for intervention such as Concerted, Sterilized, Scheduled, Spot Market and Forward Market etc**.** Application of a particular method depends upon intervention objectives.

1.1 Historical Events in the Foreign Exchange Market

In July 1944, representatives of 44 nations met in Bretton Woods, New Hampshire, to create a new institutional arrangement for governing the international economy in the years after World War II. After various negotiations, the final form of the Bretton Woods Agreement consisted of the following key points:

- The formation of key international authorities designed to promote fair trade and international economic harmony.
- The fixing of exchange rates among currencies.
- The convertibility between gold and the U.S. dollar, thus empowering the U.S. dollar as the reserve currency of choice for the world.

Of the three aforementioned parameters, only the first point is still in existence today. Since the demise of Bretton Woods, the IMF has worked closely with another progeny of Bretton Woods: The World Bank. The Bretton Woods Agreement was in operation from 1944 to 1971, when it was replaced with the Smithsonian Agreement, an international contract of sorts pioneered by U.S. President Richard Nixon out of the necessity to accommodate for Bretton Woods' shortcomings (Lien, 2009). Unfortunately, the Smithsonian Agreement possessed the same critical weakness: while it did not include gold/U.S. dollar convertibility, it did maintain fixed exchange rates a fact that did not accommodate the ongoing U.S. trade deficit and the international need for a weaker U.S.

dollar. As a result, the Smithsonian Agreement was short-lived. Ultimately, the exchange rates of the world evolved into a free market, whereby supply and demand were the sole criteria that determined the value of a currency. While this did and still does result in a number of currency crises and greater volatility between currencies, it also allowed the market to become self-regulating, and thus the market could dictate the appropriate value of a currency without any hindrances.

1.2 Foreign Exchange Market Key Attributes

Foreign exchange is the largest market in the world and has growing liquidity.

- There is 24-hour around-the-clock trading.
- Traders can earn a profit in both bull and bear markets.
- There are no trading curbs.
- Instant executable trading platform minimizes slippage and errors.
- Even though higher leverage increases risk, many traders see trading the FX market as getting more bang for the buck.

Traders can implement in the FX market the same strategies that they use in analysing the equity markets. For fundamental traders, countries can be analysed like stocks. For technical traders, the FX market is perfect for technical analysis, since it is already the most commonly used analysis tool by professional traders (Lien, 2009). It is therefore important to take a closer look at the individual attributes of the FX market to really understand why this is such an attractive market to trade.

1.3 Nature of Indian Foreign Exchange Market

Foreign exchange transactions in India can be segmented as interbank market and retail market transactions. Market participants under these segments can trade in foreign currency through different ways like futures, options, spot, swaps and forwards.

1.3.1 Players in the foreign exchange market. The Forex market is formed by different participants with varying needs and interests that trade directly with each other. These participants can be divided into two groups: the interbank market and the retail market.

1.3.1.1 Interbank market. The interbank market designates FX transactions that occur between central banks, commercial banks and financial institutions.

- ***Central bank.*** The task of actually operating in the currency markets so as to fix a country's exchange rate is usually assigned to another institution (often its central bank), which is not always strictly an arm of government. For example, while the Bank of England is an agency of Her Majesty's government, the US Federal Reserve Bank is independent of the federal government in Washington DC (Copeland, 2005). As principal monetary authority, their role consists in achieving price stability and economic growth. They regulate the entire money supply in the economy by setting interest rates and reserve requirements. They also manage the country's foreign exchange reserves that they can use in order to influence market conditions and exchange rates.
- ***Commercial banks.*** Commercial banks are at the centre of the foreign exchange market because almost every sizable international transaction involves the debiting and crediting of accounts at commercial banks in various financial centres. Thus, the vast majority of foreign exchange transactions involve the exchange of bank deposits denominated in different currencies (Krugman, 2012). Commercial banks provide liquidity to the Forex market due to the trading volume they handle every day. Some of this trading represents foreign currency conversions on behalf of customers' needs while some are carried out by the banks' proprietary trading desk for speculative purpose.
- ***Financial institutions.*** Financial institutions such as money managers, investment funds, pension funds and brokerage companies trade foreign currencies as part of their obligations to seek the best investment opportunities for their clients.

1.3.1.2 Retail market. The retail market describes transactions made by smaller speculators and investors. These transactions are executed through Forex brokers who act as a mediator between the retail market and the interbank market. The participants in the retail market are hedge funds, corporations and individuals.

- ***Hedge Funds.*** Hedge funds are private investment funds that speculate in various assets classes using leverage. Hedge funds cater to very wealthy individuals and are not bound by government regulations (Krugman, 2012). Macro Hedge Funds pursue trading opportunities in the Forex Market. They design and execute trades after conducting a macroeconomic analysis that reviews the challenges affecting a country and its currency. Due to their large amounts of liquidity and their

aggressive strategies, they are a major contributor to the dynamic of Forex Market.

- ***Corporations.*** They represent the companies that are engaged in import/export activities with foreign counterparts. Their primary business requires them to purchase and sell foreign currencies in exchange for goods, exposing them to currency risks. Through the Forex market, they convert currencies and hedge themselves against future fluctuations.
- ***Individuals***. Individual traders or investors trade Forex on their own capital in order to profit from speculation on future exchange rates. They mainly operate through Forex platforms that offer tight spreads, immediate execution and highly leveraged margin accounts.

1.3.2 Different ways to trade foreign exchange. Over the past few years, the FX market has evolved significantly. Many products have been introduced as alternative ways to invest in or trade currencies. Foreign exchange spot is the oldest of these markets and represents the underlying for many of the new derivative products. Options, futures, and forwards are the next oldest but forwards are generally Ltd to a nonretail audience (Lien, 2009).

A foreign exchange deal is always done in currency pairs, for example, US Dollar-Indian Rupee contract (USD-INR); British Pound – Indian Rupee (GBP - INR), Japanese Yen-U.S. Dollar (JPY-USD), U.S. Dollar-Swiss Franc (USD-CHF) etc. Some of the liquid currencies in the world are USD, GBP, EUR, JPY, and CHF and some of the liquid currency contracts are on USD-JPY, USD-EURO, EURO-JPY, USD-GBP, and USD-CHF.

In a currency pair, the first currency is referred to as the base currency and the second currency is referred to as the 'counter/terms/quote' currency. The exchange rate tells the worth of the base currency in terms of the quote currency, i.e. for a buyer, how much of the terms currency must be paid to obtain one unit of the base currency.

- ***Spot.*** A spot exchange rate is quoted for immediate delivery of the purchased currency, or the currency is delivered "on the spot" usually in two bank business days' time (Wang, 2009). This transaction is the core of the foreign exchange market. The FX spot market is the largest market in the world with a daily

turnover of over $3 trillion. Spot forex is quoted in pairs. Foreign exchange settlement days are called value dates.

- ***Forward*.** A forward contract is an agreement made directly between two parties to buy and to sell currency on a specific date in the future, at a fixed price that is agreed at the outset between the two parties. The forward exchange rate is the rate that is contracted today for the exchange of currencies at a specified date in the future (Levi, 2005). Forwards are bilateral over-the-counter (OTC) transactions, and at least one of the two parties concerned is normally a bank or some other financial institution. OTC transactions are used extensively by corporations, traders and investing institutions who are looking for a deal that is tailored to meet their specific requirements.
- ***Futures.*** FX future contract involve an agreement to buy/sell a certain amount of a certain currency (in exchange for another currency) for a predetermined price (known as the future price) at some point later in time known as the maturity date (Weithers, 2006). Unlike forward deals, which are negotiated directly between two parties, futures are standardized. Delivery is guaranteed by the clearinghouse associated with the exchange. A trader who contacts a broker and buys futures is said to have along position. One who sells futures has a short position. The value of a trader's position is adjusted on a daily basis.
- ***Options.*** Option does not buy or sell the underlying directly but buys or sells the right without obligation on the underlying. The right can be the right to buy (when it is called call option) and the right to sell (when it is called put option). Commercial and investment banks run the currency options market. The same money centre dealers that constitute the core of the spot and forward foreign exchange market are the most powerful market makers of currency options. Currency options are used by currency hedgers, traders, speculators, portfolio managers, and, on occasion, by central banks. To some market participants, options are viewed as an alternative to forwards or futures (Weithers, 2006).
- ***Swaps.*** Swaps are agreements between two parties to exchange cash flows in the future according to a prearranged formula. They can be regarded as portfolios of forward contracts. The two commonly used swaps are Interest rate swaps and currency swaps Interest rate swaps entail swapping only the interest related cash flows between the parties in the same currency. Currency swaps entail swapping

both principal and interest between the parties, with the cash flows in one direction being in a different currency than those in the opposite direction.

1.4 Growth of Foreign Exchange Market in India

Currency futures (Indian Rupee and US Dollar) started trading at National Stock Exchange (NSE) in 2008. Only recognized exchanges permitted by Reserve Bank of India (RBI) can offer currency future contracts in four currency pairs i.e., USDINR, EURINR, GBPINR and JPYINR. SEBI and RBI permitted introduction of USDINR options on stock exchange from July 30, 2010. Currency options were introduced at NSE and USE from October 29, 2010. Currency derivatives at BSE started from November 2013. Recognized exchanges permitted by RBI in for currency futures contracts are as follows:

- NSE Currency Derivatives
- BSE Currency Derivatives
- MCX'SX Currency Derivatives
- USE Currency Derivatives

United Stock Exchange of India Ltd. has stopped providing trading facilities to its members from 30th of December 2014. Table 1.1 shows the growth of currency derivative trading in India. A total number of currency derivative contracts increased from 6.25 crore in 2008-09 to 74.9 crore in 2014-15.

Table 1.1: ***Growth of foreign exchange trading (currency trading) in India.***

Years	Aug-08 - Mar-09	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	Apr-14 - Dec-14
NSE No. of contracts (Lakhs)	327.38	3786.00	7496.02	9733.44	9592.43	6601.92	4806.65
NSE Total Value (Crore)	162563	1782609	3449787	4674990	5274465	4012512	3023907
MCX-SX No. of contracts (Lakhs)	298.47	4081.66	9031.85	7703.25	5973.10	3985.84	849.57
MCX-SX Total Value (Crore)	148826	1944654	4194018	3732444	3303179	2422410	534329
USE No. of contracts (Lakhs)	Na	Na	1677.72	3151.97	237.66	474.79	81.61
USE Total Value (Crore)	Na	Na	762502	1491781	132862	301620	52185

BSE No. of contracts (Lakhs)	Na	Na	Na	Na	Na	391.57	1754.62
BSE Total Value (Crore)	Na	Na	Na	Na	Na	244312	1073916
Contracts Total (Lakhs)	625.86	7867.73	18205.60	20588.67	15803.21	11454.14	7492.46
Value Total (Crore)	311389	3727263	8406307	9899215	8710506	6980854	4684337
Growth Rate (%)	Na	1096.97	125.53	17.75	-12.00	-19.85	-32.89

Source. Handbook of Statistics on Indian Securities Market 2014.

It shows 12 times rise in a number of contracts since the beginning of currency derivative trading in India. The total value of currency derivative contracts traded at all stock exchanges in India was 3.1 trillion rupees which increased to 98.9 trillion in 2011-12 and starts declining thereafter to turn to 46.8 trillion in 2014-15. Total trading turnover showed a tremendous rise of 1096.97 per cent in 2009-10. However, growth rate started declining from 125.53 per cent in 2010-11 to 17.75 per cent in 2011-12 and becomes negative -12.00 per cent in 2012-13. Declining phase continued to rise and turn out to be -32.89 per cent in 2014-15 from -19.85 per cent in 2013-14.

1.5 Structure of Indian Foreign Exchange Market

The foreign exchange market in India marked its beginning towards the end of the 1970s. During the start of foreign exchange market in India banks in India were allowed to undertake intra-day trade in foreign exchange. Major changes in the Indian foreign exchange market began in the 1990s that shift in the currency regime in India from partially float to full float. Before 1992, the exchange rate was under strict regulation of Indian Government. After 1992, the exchange rate became more and more market-determined as Government of India realised the need for reducing the control. All this leads to current account convertibility which means buy or sell of foreign currency on specific activities were relaxed such as foreign travel, medical treatment, study fees, receipt/payment related to import-export, receipt/payment of interest, investment in foreign securities, business travel related expenses etc.

Prior to 1992, the exchange rate of the rupee was officially determined in terms of a weighted basket of currencies of India's major trading partners. During this period, authorized dealers use to buy and sell foreign currency at the daily rate announced by RBI. Hence the exchange rate was allowed to fluctuate but within a certain range. Prime

intention of RBI was to manage the exchange rate in a way which primarily facilitates imports to India. In order to manage exchange rate, regulations were framed and implemented from time to time. The brief of regulations is discussed in the following sub-heads:

a) **Foreign exchange regulation act (FERA), 1973.** The Foreign Exchange Regulation Act (FERA) enacted in 1973, strictly controlled all activities related to foreign exchange. FERA was introduced in 1973, to make available necessary foreign exchange required for payment of increasing import bills due to the import of capital goods, crude oil & petrol products. As per FERA, all Forex earnings by companies and residents have to reported and surrendered (immediately after receiving) to RBI (Reserve Bank of India) at a rate which was mandated by RBI. Any violation of FERA was a criminal offence liable to imprisonment. The Act also specified dealers and money changers who were authorised to deal in foreign exchange.

b) **Foreign Exchange Management Act (FEMA) 2000:** Foreign Exchange Management Act (FEMA) 2000 was introduced as the government realised the need to liberalise the foreign exchange policy. The list of activities in which a person/company can undertake forex transactions were expanded under FEMA. Through FEMA, the government liberalised the export-import policy, limits of foreign direct investment (FDI) & foreign institutional investments (FII) and repatriations, cross-border mergers and acquisitions (M&A) and fundraising activities. Under FEMA, the restrictions on withdrawal of foreign exchange for the purpose of current account transactions has been removed. However, the Central Government may, in public interest in consultation with the Reserve Bank impose such reasonable restrictions for current account transactions as may be prescribed. The presumptions of Mens Rea and abatement assumed under FERA have been excluded in FEMA. The definition of "Resident", under FERA was different from that under Income Tax Act. However, under FEMA, it is consistent with Income Tax Act. Now the criteria of 182 days to make a person resident in India has been brought under FEMA. The monetary penalty payable under FERA was nearly five times the amount involved. Under FEMA the quantum of penalty has been considerably decreased to three times the amount involved.

1.5.1 Authorised dealers in foreign exchange At present, the conversion of currency notes, coins or travellers' cheques designated in foreign currency into Indian Rupees and vice versa is possible through an authorised dealer (AD). An authorised dealer is any person specifically authorized by the Reserve Bank under Section 10(1) of FEMA, 1999, to deal in foreign exchange or foreign securities and normally includes banks Authorised dealers (ADs) Category-I banks, ADs Category-II and ADs Category-III-Full Fledged Money Changers (FFMCs). Further, AD Category-I, ADs Category-II and ADs Category-III may appoint franchisees (also known as Agents) to undertake the purchase of foreign currency.

a) **ADs Category-I:** Category I of ADs includes commercial banks, State Co-op banks and Urban Co-op banks as specified by RBI from time to time. List of ADs in category I is depicted in Table 1.2.

Table 1.2: ***List of Authorised Dealers in Category-I.***

The Royal Bank of Scotland N.V.	Standard Chartered Bank
Abu Dhabi Commercial Bank Ltd.	State Bank of Bikaner & Jaipur
Allahabad Bank,	State Bank of Hyderabad
Andhra Bank,	State Bank of India
Antwerp Diamond Bank NV	State Bank of Mauritius Ltd.
AB Bank Ltd	State Bank of Mysore
Axis Bank Ltd.	State Bank of Patiala
Bank International Indonesia	State Bank of Travancore
Bank of America NA	Syndicate Bank
Bank of Bahrain & Kuwait PSC	Tamil Nadu Mercantile Bank Ltd.
Bank of Baroda	Bank of Nova Scotia
Bank of Ceylon	The Dhana Laxmi Bank Ltd.
Bank of India	The Federal Bank Ltd.
Bank of Maharashtra	The Jammu & Kashmir Bank Ltd.
Bank of Tokyo-Mitsubishi UFJ Ltd.	The Laxmi Vilas Bank Ltd.
Barclays Bank PLC	The South Indian Bank Ltd.
BNP Paribas	UCO Bank
Bombay Mercantile Co-op Bank Ltd.	Union Bank of India
Credit Agricole Corporate & Investment Bank	United Bank of India
Canara Bank	Vijaya Bank
The Catholic Syrian Bank Ltd.	Yes Bank Ltd.
Central Bank of India	The Cosmos Co-op Bank Ltd
China trust Commercial Bank	The Kalupur Commercial Co-op Bank Ltd
Shinhan Bank	Abhyudaya Co-op Bank Ltd
Citi Bank	The Shamrao Vithal Co-op Bank Ltd
City Union Bank Ltd.	JSC VTB Bank
Corporation Bank	The Bharat Co-op Bank (Mumbai) Ltd
Dena Bank	U B S AG
Deutsche Bank A.G.	FirstRand Bank Ltd
DBS Bank Ltd.	Commonwealth Bank of Australia
Development Credit Bank Ltd.	The Thane Janata Sahakari Bank Ltd
HDFC Bank Ltd.	United Overseas Bank Ltd
The Hongkong Shanghai Banking Corporation	Credit Suisse AG
ICICI Bank Ltd.	SBERBANK

IDBI Bank Ltd.	Australia and New Zealand Banking Group Ltd
Indian Bank	The Ratnakar Bank Ltd
Indian Overseas Bank	Rabobank International (Co-op Centrale Raiffeisen-Boerenleen bank B.A.)
IndusInd Bank Ltd.	Punjab and Maharashtra Co-op Bank Ltd
ING-Vysya Bank Ltd.	National Australia Bank
JP Morgan Chase Bank	Industrial and Commercial Bank of China
The Karnataka Bank Ltd.	Woori Bank
The Karur Vysya Bank Ltd.	Westpac Banking Corporation
Kotak Mahindra Bank Ltd.	Sumitomo Mitsui Banking Corporation
Krung Thai Bank Public Company Ltd	Bharatiya Mahila Bank Ltd
The Maharashtra State Co-op Bank Ltd.	NKGSB Co-opBank Ltd
Mashreq Bank P.S.C.	Industrial Bank of Korea
Mizuho Corporate Bank Ltd	Doha Bank
Oriental Bank of Commerce	National Bank of Abu Dhabi PJSC
Punjab and Sind Bank	KEB Hana Bank
Punjab National Bank	BANDHAN BANK LIMITED
The Saraswat Co-op Bank Ltd.	Bassein Catholic Co-op Bank Ltd.
Societe Generale	SBM Bank (Mauritius) Ltd
Sonali Bank Ltd	IDFC Bank Ltd.

Source. RBI- Authorised Dealers in Foreign Exchange, 2016

b) **ADs Category-II**: Category II of ADs comprises of upgraded FFMCs, Co-op banks and Regional Rural Banks (RRB) and other institutions as specified by RBI from time to time. Table 1.3 displays list of ADs in category II.

Table 1.3: ***List of Authorised Dealers in Category-II.***

Sl. No.	Licensed By (Regional Office)	ADs Category-II
1.	Ahmedabad	a) Green Channel Travel Services (A Division of IRM Ltd.) b) Vadilal Industries Ltd., Prime Co-op Bank Ltd. c) Prime Co-op Bank Ltd d) Dahod Mercantile Co Op Bank Ltd,
2.	Bangalore	a) M/s Weizmann Forex Ltd. b) M/s Travel Tours Pvt. Ltd. c) The Bhatkal Urban Co-op Bank Ltd. d) M/s Orient Exchange & Financial Services Pvt. Ltd.
3.	Chennai	a) Essel Finance VKCForex Ltd. b) Prithvi Softech Ltd. c) India Cements Capital Ltd.
4.	Chandigarh	a) M/s Paul Merchants Ltd.
5.	Hyderabad	a) The Darussalam Co-op Urban Bank Ltd. b) The A.P. Mahesh Co-op Urban Bank Ltd. c) The Visakhapatnam Co-op Bank Ltd. d) Telangana Grameena Bank e) The Agrasen Co-op Urban Bank Ltd.
6.	Kanpur	a) Prathama Bank b) Shivalik Mercantile Co-op Bank Ltd.
7.	Kochi	a) Lulu Forex Private Ltd. b) Manappuram Finance Ltd. c) Muthoot Forex Ltd. d) Muthoot Fincorp Ltd. e) UAE Exchange & Financial Services Ltd.
8.	Kolkata	a) Mercury Travels Ltd. b) R.R. Sen & Bros. Pvt. Ltd. c) Multimoney Forex Ltd.

9.	Mumbai	a) Centrum Direct Ltd. b) Cox & Kings (I) Ltd. c) Pheroze Framroze & Co. Pvt Ltd. d) Thomas Cook (I) Ltd. e) Wall Street Finance Ltd. f) Kanji Forex Pvt Ltd. g) Supama Forex Pvt. Ltd. h) Kesari Tours Pvt Ltd. i) Citizen Credit Co-op Bank Pvt Ltd. j) Ace Co-op Bank Ltd. k) New India Co-op Bank Ltd. l) Thane Bharat Sahakari Bank Ltd. m) The Zorastrian Co-op Bank Ltd. n) The Mahanagar Co-op Bank Ltd. o) The Greater Bombay Co-op Bank Ltd. p) Shri Arihant Co-op Bank Ltd. q) Janata Sahakari Bank Ltd. r) Kallappana Awade Ichalkaranji Janata Sahakari Bank Ltd. s) Apna Sahakari Bank Ltd. t) Samarth Sahakari Bank Ltd. u) Sahebrao Deshmukh Co-op Bank Ltd. v) GP Parsik Bank w) Nkgsb Co-op Bank Ltd.
10.	New Delhi	a) Department of Posts (Ministry of Communications & IT). b) Supreme Securities Ltd. c) American Express Banking Corporation. d) D. Paul'S Travel & Tours Ltd. e) Transcorp International Ltd. f) Quick Forex Ltd.

Source. RBI- Authorised Dealers in Foreign Exchange, 2016

c) **ADs category-III:** Category III of ADs consists of selected financial and other institutions as specified by RBI from time to time. Table 1.4 shows, list of institutions that are permitted by RBI to act as FFMCs in India.

Table 1.4: ***List of Authorised Dealers in Category-III.***

S. No.	**Full Fledged Money Changers (FFMCs)**
1.	Clearing Corporation of India Ltd.
2.	Export-Import Bank of India
3.	Small Industries Development Bank of India
4.	Industrial Finance Corporation of India Ltd.
5.	IFCI Factors Ltd (formerly known as Foremost Factors Ltd.)
6.	Canbank Factors Ltd.
7.	SBI Global Factors Ltd.
8.	Bibby Financial Services (India) Private Ltd.
9.	India Factoring and Finance Solutions Private Ltd.

Source. RBI- Authorised Dealers in Foreign Exchange, 2016

1.5.2 Foreign exchange dealers association of India (FEDAI). Foreign Exchange Dealers Association of India (FEDAI) was set up in 1958 as an Association of banks dealing in foreign exchange in India (typically called Authorised Dealers) as a self-regulatory body and is incorporated under Section 25 of The Companies Act, 1956. Its

major activities include framing of rules governing the conduct of inter-bank foreign exchange business among banks vis-à-vis public and liaison with RBI for reforms and development of forex market.

Presently some of the functions are as follows:

- Guidelines and Rules for Forex Business.
- Training of Bank Personnel in the areas of Foreign Exchange Business.
- Accreditation of Forex Brokers
- Advising/Assisting member banks in settling issues/matters in their dealings.
- Represent member banks on Government/Reserve Bank of India/Other Bodies.
- The announcement of daily and periodical rates to member banks.

Due to continuing integration of the global financial markets and increased pace of de-regulation, the role of self-regulatory organizations like FEDAI has also transformed. In such an environment, FEDAI plays a catalytic role for the smooth functioning of the markets through closer co-ordination with the RBI, other organizations like Fixed Income Money Market and Derivatives Association of India (FIMMDA), the Forex Association of India and various market participants. FEDAI also maximizes the benefits derived from synergies of member banks through innovation in areas like new customized products, bench-marking against international standards on accounting, market practices, risk management systems, etc. Following institutions are member of FEDAI.

a) **Public Sector Banks:** Table 1.5 shows public sector banks who are members of FEDAI.

Table 1.5: ***Public Sector Banks***

Allahabad Bank	Punjab & Sind Bank
Andhra Bank	Punjab National Bank
Bank of Baroda	State Bank of Bikaner & Jaipur
Bank of India	State Bank of Hyderabad
Bank of Maharashtra	State Bank of India
Bharatiya Mahila Bank Ltd	State Bank of Mysore
Canara Bank	State Bank of Patiala
Central Bank of India	State Bank of Travancore
Corporation Bank	Syndicate Bank
Dena Bank	UCO Bank
IDBI Bank Ltd	Union Bank of India
Indian Bank	United Bank of India
Indian Overseas Bank	Vijaya Bank
Oriental Bank of Commerce	

Source. FEDAI- Member Banks, 2016

b) **Foreign Banks:** Foreign banks who are members of FEDAI are exhibited in table 1.6.

Table 1.6: *Foreign Banks*

AB Bank Ltd	KEB Hana Bank
Abu Dhabi Commercial Bank	Krung Thai Bank Public Company Ltd
Australia and New Zealand Banking Group Ltd	Mashreq Bank p.s.c
Bank of America N.A.	Mizuho Bank Ltd
Bank of Bahrain & Kuwait B.S.C.	National Bank of Abu Dhabi PJSC
Bank of Ceylon	National Australia Bank
PT Bank Maybank Indonesia TBK	Co-op Centrale Raiffeisen-Boerenleen Bank B.A
Barclays Bank PLC	SBERBANK
BNP Paribas	Shinhan Bank
CTBC Bank Co. Ltd.	Societe Generale
Citi Bank N.A.	Sonali Bank Ltd
Commonwealth Bank of Australia	Standard Chartered Bank
Credit Agricole Corporate and Investment Bank	SBM Bank (Mauritius) Ltd.
Credit Suisse AG	Sumitomo Mitsui Banking Corporation
DBS Bank Ltd	The Royal Bank of Scotland N.V.
Deutsche Bank AG	The Royal Bank of Scotland plc
Doha Bank QSC	The Bank of Nova Scotia
Firstrand Bank	The Bank of Tokyo Mitsubishi UFJ Ltd.
Industrial and Commercial Bank of China Ltd	The Hongkong and Shanghai Banking Corporation Ltd.
Industrial Bank of Korea	United Overseas Bank Ltd.
JP Morgan Chase Bank N.A.	Westpac Banking Corporation
JSC VTB Bank	Woori Bank

Source. FEDAI- Member Banks, 2016

c) **Private Sector Banks / Co-op Banks:** Table 1.7 depicts private sector banks and co-op banks who are members of FEDAI.

Table 1.7: *Private Sector Banks / Co-op Banks.*

Abhyudaya Co-op Bank Ltd.	The Jammu & Kashmir Bank Ltd.
The Ahmedabad Mercantile Co-op Bank Ltd.	The Kalupur Commercial Co-op Bank Ltd.
AXIS Bank Ltd.	Karnataka Bank Ltd.
The Bharat Co-op Bank (Mumbai) Ltd.	The Karur Vysya Bank Ltd.
Bandhan Bank Ltd.	Kotak Mahindra Bank Ltd.
Bassein Catholic Co-op Bank Ltd.	The Lakshmi Vilas Bank Ltd.
Bombay Mercantile Co-op Bank Ltd.	The Maharashtra State Co-op Bank Ltd.
The Catholic Syrian Bank Ltd.	NKGSB Co-op Bank Ltd.
City Union Bank Ltd.	Punjab and Maharashtra Co-op Bank Ltd.
The Cosmos Co-op Bank Ltd.	RBL Bank Ltd.
Development Credit Bank Ltd.	The Saraswat Co-op Bank Ltd.
The Dhana Lakshmi Bank Ltd.	The SVC Co-op Bank Ltd.
The Federal Bank Ltd.	The South Indian Bank Ltd.
HDFC Bank Ltd.	Tamil Nadu Mercantile Bank Ltd.
ICICI Bank Ltd.	TJSB Sahakari Bank Ltd.
IDFC Bank Ltd.	YES Bank Ltd.
IndusInd Bank Ltd.	

Source. FEDAI- Member Banks, 2016

d) **Financial Institutions / Others:** Financial institutions and other institutions who are members of FEDAI are exhibited in table 1.8.

Table 1.8: ***Financial Institutions/Others.***

Export-Import Bank of India
IFCI Ltd
Small Industries Development Bank of India
Thomas Cook (India) Ltd

Source. FEDAI- Member Banks, 2016

1.6 Fundamental Analysis

Fundamental analysis focuses on the economic, social, and political forces that drive supply and demand. Those using fundamental analysis as a trading tool look at various macroeconomic indicators such as growth rates, interest rates, inflation, and unemployment (Lien, 2009). Fundamental analysts will combine all of this information to assess current and future performance. This requires a great deal of work and thorough analysis, as there is no single set of beliefs that guides fundamental analysis. Traders employing fundamental analysis need to continually keep abreast of news and announcements that can indicate potential changes to the economic, social, and political environment. All traders should have some awareness of the broad economic conditions before placing trades. Trading currencies is not difficult for fundamental traders.

Currency prices reflect the balance of supply and demand for currencies. Two of the primary factors affecting the supply and demand of currencies are interest rates and the overall strength of the economy. Economic indicators such as GDP, foreign investment, and the trade balance reflect the general health of an economy and are therefore responsible for the underlying shifts in supply and demand for that currency. There is a tremendous amount of data released at regular intervals, some of which is more important than others. Data related to interest rates and international trade is looked at the most closely. If the market has uncertainty regarding interest rates, then any bit of news relating to interest rates can directly affect the currency market.

Determining which effect dominates can be tricky, but generally, there is a consensus beforehand as to what the interest rate move will do. Indicators that have the biggest impact on interest rates are the producer price index (PPI), consumer price index (CPI), and GDP. Generally, the timing of interest rate moves is known in advance. The trade balance shows the net difference over a period of time between a nation’s exports and

imports. When a country imports more than it exports the trade balance will show a deficit, which is generally considered unfavourable. For example, if U.S. dollars are sold for other domestic national currencies (to pay for imports), the flow of dollars outside the country will depreciate the value of the dollar. Similarly, if trade figures show an increase in exports, dollars will flow into the United States and appreciate the value of the dollar. From the standpoint of a national economy, a deficit in and of itself is not necessarily a bad thing. If the deficit is greater than market expectations, however, then it will trigger a negative price movement.

1.7 Technical Analysis

Prior to the mid-1980s, the FX market was primarily dominated by fundamental traders. However, with the rising popularity of technical analysis and the advent of new technologies, the influence of technical trading on the FX market has increased significantly. The availability of high leverage has led to an increased number of momentum or model funds, which have become important participants in the FX market with the ability to influence currency prices. Technical analysis focuses on the study of price movements. Technical analysts use historical currency data to forecast the direction of future prices (Lien, 2009). The premise of technical analysis is that all current market information is already reflected in the price of each currency; therefore, studying price action is all that is required to make informed trading decisions. In addition, technical analysis works under the assumption that history tends to repeat itself.

In technical analysis, the price and volume data are analysed to be able to predict future movements. The analysis of trends is necessary for trading in the forex because in the forex you can gain in a bull market and a bear market as you buy one currency and sell the other (Dicks, 2010). Technical analysis is a very popular tool for short-term to medium-term traders. It works especially well in the currency markets because short term currency price fluctuations are primarily driven by human emotions or market perceptions. The primary tool in technical analysis is charts. Charts are used to identify trends and patterns in order to find profit opportunities. The most basic concept of technical analysis is that markets have a tendency to trend. Being able to identify trends in their earliest stage of development is the key to technical analysis. Technical analysis integrates price action and momentum to construct a pictorial representation of past currency price action to predict future performance (Pring, 2002). Technical analysis

tools such as Fibonacci retracement levels, moving averages, oscillators, candlestick charts, and Bollinger bands provide further information on the value of emotional extremes of buyers and sellers to direct traders to levels where greed and fear are the strongest.

1.8 Behavioural Factors

Behavioural finance research has contributed significantly in the field of foreign exchange trading by exploring through different methods factors that affect trader's psychology. Behavioural factors comprise variables that affect trader's psychology such as bandwagon effects, over reaction to the news, market judgment, peers & social influences and rumours etc. Over reaction to news followed by bandwagon, effects are the most important driving factors that cause movements in the exchange rate. (Cheung, Chinn, & Marsh, 2004). Successful forex trading requires a total approach that integrates fundamentals, technical analysis, and psychology (Cofnas, 2007).

Bandwagon effects are the effect on the exchange rate to move in a particular direction continuously due to traders' perceived expectations of such change in future. Many studies have provided empirical evidence that exchange rate movements over a short term may be caused due to the bandwagon effect (Pippenger, 2004). Foreign exchange rates over short periods are influenced by trading opinions formed by traders on the basis of bandwagon expectations (Frankel and Froot, 1987).

The news is a vast concept covering events such as expert's forecasts, large transaction call from a customer, or political and economic news releases (Guillaume et al., 1997). Response to news arrival during soother periods may be different from that during high uncertain periods (Dominguez & Panthaki, 2006). Using high-frequency data, (Andersen et al. 2003) conclude that announcement surprises (difference between expectations and realizations of macroeconomic fundamentals) trigger quick jumps in exchange rates. Out of total price variation, 30% is accounted by news (Evans and Lyons, 2003). Investors respond with different to good and bad news (Prast & Vor, 2005). News announcements effects exchange rate within 5 min of the announcements, so the news events do not dominate exchange rate movements for very long (Pearce & Solakoglu, 2007).

Judging the market movement i.e. exchange rate is the process of ascertaining the exchange rate direction through the evaluation technique preferred by the trader. The traders may choose between technical and fundamental trading rules. Technical analysis

is a trading technique that applies graphical and statistical tools to recognize trends and reversals by inferring future price movements from those of the recent past. On the other hand, fundamental trading rules intend to predict exchange rate direction on the basis of fundamentals of the currency value. Fundamental traders keep a close look to gain from differences between the exchange rate and its fundamental value (Westerhoff, 2003).

Peer effects and social influences have been identified as major factors influencing individual opinions in psychological and sociological literature (Banerjee, 1992, Banerjee and Fudenberg, 2004). Trading decisions of investors are influenced by peers who maintained brokerage accounts at the same branch (Ng and Wu, 2010).

Rumours are concocted stories or accusations which may or may not be true. Information in an economy is disbursed through market agents which may result in the spread of a rumour. Beliefs of the agents in the market get influenced by the rumour, so the rumour has a direct impact on market outcomes (Kosfeld, 2005). In a short period one of the major sources of currency variation could be rumours. Rumours may relate to economic, political and about large transaction flows. In the present scenario, electronic screens have now taken over the role of the telephone as a medium for spreading rumours (Oberlechner & Hocking, 2004). Modern trading and information technology have exploded the market with a vast amount of data. Market participants such as brokers and investors demand fast execution and leave lesser time for careful thinking and processing and interpretation of information skilfully (Slovic, 1986). Importance of the events and amount of doubt involved in the matter also increases the occurrences of rumours (Allport & Postman, 1947).

One of the major reasons for the presence of rumours in the market is the feeling of doubt and uncertainty, which arises because the market environment is highly indeterminate. In such highly uncertain environments rumours play an important role (DiFonzo & Bordia, 1997). Incorrect news and rumours play a substantial role in the foreign exchange market (Osterberg &Wetmore Humes, 1993). More the number of sources of information more will be the listening and circulation of story and more will be the refinements in rumour, which also makes it more credible (DiFonzo et al., 1994).

1.9 Central Bank Intervention

The issue of central bank intervention in the foreign exchange market is crucial and highly relevant in order to know how intervention effects exchange rate. Central banks

intervene in foreign exchange markets in order to achieve several objectives, such as controlling inflation, to maintain internal balance, to maintain external balance, to prevent resource misallocation or preserve competitiveness and boost growth, to prevent or deal with disorderly markets and/or crises

Intervention is required to smooth out excessive fluctuations in exchange rates in order to avoid the adverse effects of these fluctuations on economic activity for example, for the Plaza Accord of September 1985, whereby the central banks of the five largest industrial countries (G5) agreed to carry out concerted intervention to limit the upsurge in the US dollar, which had been appreciating relentlessly for the previous four years or so. Intervention in the foreign exchange market may work through various channels for interventions. Whether or not official exchange rate intervention is effective in influencing exchange rates, and the means by which it does so, are issues of crucial policy importance, and they have been the subject of a vast academic and policy-related literature (Sarno & Taylor, 2001). Present day exchange markets are characterized by massive turnover stemming particularly from short-term position taking. All this leads to increased volatility and/or bandwagon effect in exchange rates. In these conditions, the role of intervention is bound to be limited. Co-ordinated interventions undertaken in recent years are modestly successful (Carew & Slatyer, 1989).

Central banks in emerging markets view intervention as an effective tool within their monetary policy framework (Filardo, Ma & Mihaljek, 2011). However, to be effective intervention needs to be aligned with macroeconomic and financial market conditions, if the exchange rate is depreciating because of weak fundamentals, the intervention will not help stabilise it for very long (Mihaljek, 2005). Unilateral interventions, in some cases, reduce volatility where as coordinated interventions were more counterproductive as the greater the number of central banks intervenes in coordination (Antonakakis, 2012). Intervention to be more effective should be more frequent rather than one large intervention (Seerattan & Spagnolo 2009). Coordinated interventions have large effects on exchange rates; the efficacy of central bank intervention depends on the characteristics of the foreign exchange market at the time the operations become known to traders (Dominguez, 2003).

Central banks earn profits with interventions and technical trading rules are unusually profitable on days on which interventions take place, moving average trading rules are highly profitable on days when central banks intervene (Saacke, 2002) and showed that

the trading rules tend to bet against central banks. Moving average trading rules are remarkably efficient at predicting exchange rate changes on days when central banks intervene technical trading rule profitability is dramatically reduced if intervention days are removed from the sample (LeBaron, 1999).

1.10 Need and Significance of the Study

Impact of fundamental and non-fundamental factors on the foreign exchange market has become a widely studied topic in the academic literature. One side of this literature focuses on the impact of fundamental and non-fundamental factors, while the other on the role, efficiency and use of technical analysis by foreign exchange traders in generating trading signals. Some studies have reported from their survey of foreign exchange traders that non-fundamental factors such as bandwagon effects, over-reaction to news, technical trading, and excessive speculation determines short-run exchange rate and the role of fundamental factors in relevant in the long run. Previous literature on technical analysis provides that technical analysis is an important and widely used method of analysis in the foreign exchange market and that applying certain technical trading rules over a sustained period may lead to significant positive excess returns. Most of these studies have however been limited to major developed countries and some developing countries excluding India. These results might differ between the countries as it depends on the specific country's market regulations, 'maturity' and the economy itself.

Motives for central bank interventions in the foreign exchange market are clearly available and supported by the academic literature. But the impact of central bank interventions on foreign exchange volatility and its relationship with technical rules profitability is still unclear. Some studies on a survey of foreign exchange dealers have reported that central bank intervenes with the objective to bring stability in the market have an intervention which reduces volatility; whereas other studies have reported from their survey evidence that central bank interventions increase volatility in the market. This contradiction needs to be addressed and has aroused the necessity to identify the existent impact of central bank interventions on foreign exchange volatility so that behaviour of the market to intervention practices can be understood clearly. Studies on central bank interventions and technical trading rules profitability provides that trading rules are unusually profitable on days on which interventions take place so the same needs to be investigated in the Indian context.

1.11 Objective of the Study

The specific objectives of the study are:

1. To examine the relative importance of fundamental as well non-fundamental that influence foreign exchange rate predictions and the role of their specific constituents over different time horizons.
2. To know the level of importance assigned by foreign exchange traders to fundamental and non-fundamental factors, while trading in the foreign exchange market.
3. To assess the impact of central bank interventions in the foreign exchange market in India.
4. To assess and quantify the extent of the volatility of the Indian foreign exchange market due to Central Bank interventions.
5. To recommend the appropriate model to forecast the exchange rate movements of INR-USD; INR-GBP, INR-JPY and INR-EUR.
6. To recommend measures for policy makers, investors and corporate on the basis of conclusions from the present study.

1.12 Structure of the Study

The work of the present study has been organised into eight chapters.

Chapter 1: Introduction provides an overview of the topic and related concepts, need and significance of the study and objective to be achieved. It also provides a thorough discussion on the first objective related to nature, growth and structure of Indian foreign exchange market.

Chapter 2: Review of literature presents the review of previous studies into five sections: survey of traders, fundamental and technical analysis, volatility, forecasting and Central Bank Interventions.

Chapter 3: Database and analytical tools details research design, survey strategy, selection of a sample from the population, pilot study, data collection process, secondary data time period &source and statistical techniques applied for data analyses.

Chapter 4: Ability of fundamental and non-fundamental factors to determine exchange rate and importance given by foreign exchange traders to these factors while trading in the foreign exchange market is dealt in this part of the study.

Chapter 5: Empirical verification of Impact of Central Bank Interventions on the basis of Primary data.

Chapter 6: Central Bank Interventions, Exchange Rate and Volatility based on secondary data

Chapter 7: Forecasts of US Dollar (USD), Great Britain Pound (GBP), Euro (EUR) and Japanese Yen (JPY) was done on the basis of Artificial Neural Networks and appropriateness of fitted models was checked**.**

Chapter 8: Summary, conclusion and implications provides overall overview of present study followed by findings, implications, conclusion and scope for future research.

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Review of Literature

During the past two decades, the Indian forex market witnessed a change in the dynamics due to the implementation of the market-determined exchange rate system and liberalisation. It has experienced intense volatility and stability simultaneously since May 2013.

So the appropriate forecasting of the exchange rate is important for policymakers, bankers, and multinationals, particularly those corporations who deal with currency transfers. A lot of research work has been conducted to investigate the different aspects of exchange rate such as Volatility and Forecasting. An effort has been made to review the different studies accomplished by various researchers.

The review is based on themes related to the study. The theme wise review is as follows:

Theme 1: **Studies Associated to Survey of Traders**

Theme 2: **Studies Related to Fundamental and Technical Analysis**

Theme 3: **Studies Related to Central Bank Interventions**

Theme 4: **Studies Related to Forecasting**

2.1 Studies Associated to Survey of Traders

Lui and Mole (1998), from a questionnaire survey, reported the results regarding the use of fundamental and technical analyses by foreign exchange dealers in Hong Kong. They revealed that more than 85% of respondents rely on both fundamental and technical analyses for predicting future rate movements at different time horizons. At shorter horizons, dependence on technical analysis was found higher than fundamental analysis, but the situation was reversed as the length of the horizon considered was extended. Technical analysis was stated slightly more useful in forecasting trends than fundamental analysis, but significantly more useful in predicting turning points. Interest rate related news was found to be a relatively important fundamental factor in exchange rate forecasting while moving average and/or other trend-following systems were the most useful technical technique.

Cheung and Wong (2000), stated some findings from a survey of practitioners in the interbank foreign exchange markets in Hong Kong, Tokyo, and Singapore. They found

that traders behaviour is influenced by the prevailing market practice, a large customer base, short-run exchange rate dynamics were believed to mainly depend on non-fundamental forces (e.g., bandwagon effects, over-reaction to news, technical trading, and excessive speculation) rather than fundamentals, the respondents also said technical trading has non-trivial impact on medium- to long-run exchange rates, both speculation and central bank intervention are perceived to increase market volatility. Their test for homogeneity shows that the response patterns depend on the market from which the respondent is selected, seniority, position limit, turnover volume, and headquarters location.

Chinn and Cheung (2001), surveyed US foreign exchange traders about the operations of the foreign exchange market at both the microstructural and macroeconomic levels. With respect to the microstructural characteristics, they found that the share of customer business, versus interbank business, has remained constant. However, channelization of these transactions has considerably shifted from traditional brokers to electronically-brokers. The importance of individual macroeconomic variables shifts over time, although interest rates appeared to be important, economic fundamentals were perceived to be more important at longer horizons, while short-run deviations from the fundamentals were attributed to excess speculation and institutional customer/hedge fund manipulation, speculation was generally viewed positively, central bank intervention does not appear to have a substantial effect.

Oberlechner (2001), surveyed the perceived importance of chartist/technical and fundamental analysis among foreign exchange traders and financial journalists in Frankfurt, London, Vienna, and Zurich. Their results confirmed that most traders use both forecasting approaches and that the shorter the forecasting horizon, the more important chartist/technical analysis was. Financial journalists placed more emphasis on fundamental analysis than do foreign exchange traders. Importance of chartism has increased over the last decade. Foreign exchange traders mention a series of psychological motives and consequences of the use of Chartism.

Marsh et al. (2004), surveyed UK based foreign exchange dealers and documented the factors that practitioners believe affect the foreign exchange market. The authors addressed topics in three main areas: the microeconomic operation of the foreign exchange market, the beliefs of dealers regarding the importance of observable macroeconomic fundamental factors in affecting exchange rates, microstructure factors in

FX. They found that non-observable fundamental factors dominate short horizon changes in exchange rates, but observable fundamentals were deemed important over much shorter horizons than the mainstream empirical literature suggest, market 'norms' and behavioural phenomena were very strong in the FX market and appear to be key determinants of the bid–ask spread, market practitioner's accord some importance to purchasing power parity as the determinant of a currency's 'fundamental value', but does not dominate in their trading calculations, traders viewed long-term movements as being determined by a much larger set of fundamental variables.

Menkhoff and Gehrig (2006), extended earlier survey studies on the use of technical analysis by considering flow analysis as a third form of information production. Their survey covered FX dealers and also the rising fund managers. They found that FX traders and international fund managers regard technical analysis important than nine years ago. Neither fundamentals nor flows were equally wide-spread in FX trading and in fund management. Chartists revealed as the largest group in FX trading and as the second largest in fund management and technical analysis was the 'workhorse' in foreign exchange. Further in-depth analyses confirmed that technical analysis is an instrument for short-term forecasting but not for very short-term horizons which were dominated by flow analysis. Fund managers use the three kinds of information distinguished in a similar pattern as FX dealers but with longer overall forecasting horizons.

Bhanumurthy (2006), examined the relevance of macroeconomic models in exchange rate determination in India. He undertook a primary survey, with the help of a structured mailed questionnaire, on the Indian foreign exchange dealers to understand the dynamics of the market. He gave two distinctive approaches in exchange rate determination i.e. macro fundamentals (goods market and asset market) and Market Microstructure (Inventory model and Information model). He found that majority of the dealers feel in the short and medium term, the changes in the exchange rate is not influenced by the changes in macro fundamentals, rather is basically influenced by the micro variables like order flow, market movement, speculation, Central Bank intervention etc. But in the long run, still, it is the macro fundamentals that determine the exchange rates. Majority of dealers felt that PPP condition couldn't help in predicting the rate change in the short run. But it can help to predict only in the long run.

Fischer et al. (2009), tested the perceptions of Kyrgyz FX dealers against the beliefs of traders from five financial centres using detailed survey data. The objective of their study

was to know whether FX dealers from Kyrgyzstan, a low-income country, have similar perceptions to FX dealers from other international financial centres. Their survey evidence founds that the FX dealers' responses from the Kyrgyz interbank market differ from those from other international financial centres. Stark differences arise in the perceptions concerning the effectiveness of central bank interventions and the influence of speculation. They attributed the low liquidity level and the strong presence of the central bank as important explanations for the differences in the survey responses between FX dealers from Kyrgyzstan and FX dealers from developed FX markets.

2.2 Studies Related to Fundamental and Technical Analysis

Lee et al. (2001), examined the random walk behaviour for nine Asian foreign exchange rates and technical trading rules and found that nine Asian foreign exchange rates mostly follow a random walk process, so the corresponding exchange rate markets were efficient. In sample, results showed that the technical analysis rules based on moving average and channel rules indicate significant positive profits. But an out-of-sample basis did not generate significant, positive profits. So they concluded that if trend-following trading rules generate a significant loss, then a trend-reversing trading rule may yield significant profits.

Martin (2001), in his paper, has investigated the profitability of moving average trading rules of developing country currencies and explores the relationship between profitability and exchange rate regime. He found that there was no relationship between profitability and the stated exchange rate regime but a significant correlation exists between the out-of-sample returns and the level of foreign currency reserves. Profitability of moving average trading rules found to be related to the potential for intervention. The trading rules were not found to outperform a simple short-selling strategy or risk-free strategy.

Menkhoff and Taylor (2007), analysed previous literature on technical analysis and then established a set of stylised facts including the facts that technical analysis is an important and widely used method of analysis in the foreign exchange market and that applying certain technical trading rules over a sustained period may lead to significant positive excess returns. Evidence explored suggested that it may be large exchange rate movements themselves that may be leading both intervention and technical analysis profitability. Their stylised fact state that higher profitability of technical analysis in flexible exchange rate markets indicates that these markets may be characterized by a

degree of volatility that cannot be explained by fundamentals alone. Technical forces were more important in the shorter-run for a full understanding of exchange rate dynamics, professionals need a combination of several tools, in particular, both technical and fundamental analysis.

Singh et al. (2008), explored the role of market microstructure in explaining the short-run movement in the exchange rate in India. They examined the interdependence of intra-day high, low and closing exchange rates within the framework of parametric technical trading strategy. They found that the interdependence of intra-day high, low and close exchange rates encompassing trading strategies, associated with the demand and supply conditions in foreign exchange market exists, the close exchange rate could have symmetric long-run response to intra-day high and low exchange rates, trading strategy models coupled with macroeconomic fundamentals were useful for ascertaining the impact of a particular macroeconomic shock on the demand or supply conditions.

Cialenco and Protopapadakis (2011), examined the in and out of sample behaviour of two popular trading systems, Alexander filters and Double MA filters, for 14 developed country currencies using daily data with bid-ask spreads, from 1986 to 2009, to assess whether technical trading still makes excess returns in the FX markets. They found substantial and statistically significant in sample returns over the whole sample, returns for both trading systems were high in the first sub-period, but declined over the second sub-period. No reliable out-of-sample trading profits were found. They showed that small variations in the parameters of the out-of-sample simulations produce substantial differences in the returns obtained and in the inferences of significance, which implies that traders operating the same trading system but with slightly different "training parameters" for their algorithms are likely to realize very different speculative returns.

Neely and Weller (2011), considered several hypotheses from literature to explain the profitability from technical rules. They ruled out data mining as an explanation for the early profitability of technical rules. Both out-of-sample analysis and adjustments to statistical tests indicated that the returns were genuine. Another possible explanation was the intervention operations of the central bank. If the central bank's target for the exchange rate differs from its fundamental value, then intervention may allow speculators to profit at the expense of the bank, this may create predictable trends in the exchange rate that can be detected by technical analysis. They suggested that for the profitability of technical analysis to constitute evidence of market inefficiency, one must establish that

the profits earned are not simply compensation for the risk incurred and behavioural models can reproduce the trending seen in foreign exchange markets and show that technical trading can be consistently profitable in certain circumstances.

2.3 Studies related to Central Bank Interventions

Dominguez (1993) investigated the influence of central bank interventions on the exchange rate variations. The study used daily and weekly US-Dollar/Deutsche Mark and US-Dollar/Yen exchange rates for the period 1985 to 1991. Using the GARCH model the study found that changes in monetary policies and intervention policies often influence the conditional variance of exchange rates. Further, it suggested that the volatility makes the Federal Bank to keep its interventions secret which is less than twenty per cent of all the intervention operations but also these secret interventions by both the Federal Bank and Bundesbank generally increase the exchange rate volatility over the period. The study also reported that interventions generally led to the reduction in both daily and weekly exchange rate volatility.

Dominguez and Frankel (1993) examined the significance of the foreign exchange intervention on the exchange rate through the portfolio channel. They have used the Fed, the Bundesbank and the Swiss National Bank (SNB) interventions (daily, weekly) for the period 1982 to 1988. On separating the Fed and the Bundesbank interventions they found that interventions had a significant impact on the exchange rate, despite of sterilized or unsterilized interventions. Further, interventions by the smaller central bank, such as the SNB were proved to be ineffective but combined interventions with the US had a statistically significant effect on the risk premium.

Hung (1995) studied the impact of the sterilized intervention on the US exchange rate volatility. Using the OLS estimation on the DM/Dollar and the Yen/Dollar daily interventions in the noise trading framework from 1985 to 1989, study showed that the US sterilize intervention reduced both the Yen/Dollar and the DM/ Dollar volatility during the 1985-1986 (post Plaza Accord) but increased during 1987-1989 (post Louvre Accord) period, in which market behaved similarly to the given conditions. Further, it supported that the Fed often intervenes covertly but, also at certain circumstances to activate the signalling channel it affected overtly.

Kaminsky and Lewis (1996) checked that whether the central bank intervention policy signalled a change in the U.S. future monetary policy from 1985 to 1990. Using a

Markov-Switching model, it found that interventions have a signalling effect on future monetary policy but, it conveys opposite signals which produced the negative effects of the intervention. Further, it also suggested that when traders perceive this intervention it imply to be very useful for future predictions.

Baillie and Osterberg (1997) examined the intervention of the US and the German central banks and their effectiveness. They have used the daily-nominal dollar exchange rate returns on the Martingale-GARCH model and found that there is little evidence of interventions that can consistently influence the level of exchange rate. Whenever any significance is found between the intervention and the exchange rate variation there was 'leaning against the wind' variety. Also, these interventions tend to increase the volatility than to calm disorderly markets.

Bayoumi and Eichengreen (1998) checked that the theory of Optimum Currency Areas explains the pattern of exchange rate variability and intervention across the countries. They took twenty-one industrial countries for the period 1963-1992 and examined the variation in the exchange rates. The study found that countries having a larger variation in exchange rates are more prone to larger asymmetric shocks and countries with stable exchange rates face the greater reduction in the value of the domestic currency when their exchange rates vary. Also, asymmetric shocks increase variation in exchange rates, whereas countries with small size and trade dependency reduce exchange rate variability by interventions.

Dominguez (1998) examined the central banks coordinated and unilateral interventions after the Plaza Agreement on the behaviour of exchange rates. It was investigated with the help of monetary and intervention policies by the G-3 (the US, the German and the Japanese) central banks over the 1977-1994 period. Using the GARCH models study came to the conclusion that both types of intervention policies increase exchange rate volatility. Further, open intervention in the mid-1980s appeared to have reduced the exchange rate volatility, otherwise, these interventions had greater exchange rate variation. Results of this study were similar to Dominguez (1993).

Fischer and Zurlinden (1999), investigated the effectiveness of Swiss interventions operated through a signalling or expectations channel by taking data on the days of intervention or a customer transaction. They analysed and found no evidence that subsequent interventions or that customer transactions are related to exchange-rate

movements. Their analysis also offers evidence that the time of the day has a significant bearing on the success of an intervention.

Beattie and Fillion (1999) examined the effectiveness of the official interventions in moderating intraday volatility of the CAN Dollar/ US Dollar exchange rate. They have used GARCH models on Canada's high-frequency intervention data from 1995 to 1997-and-a-half-year period, and estimating the effects of the intraday seasonal pattern, the daily volatility persistence, the macroeconomic news and the impact of central bank intervention on the volatility, they concluded that expected interventions had no impact on the reduction of volatility but unexpected interventions had. Further, they have also suggested that even expected intervention were effective only when Canadian dollar exceeded either limit of non-intervention band, also unexpected interventions were merely effective when it was done frequently.

Kim, Kortian and Sheen (2000) investigated the foreign exchange intervention policy by the Reserve bank of Australia in the period 1983-1997. To examine the effectiveness of the daily intervention on the US dollar/ Aus dollar exchange rate, GARCH model was used and results suggested that sustained and large interventions stabilized the exchange rate in terms of direction and volatility and without these interventions, foreign exchange market showed more volatility. Also, when the exchange rate moved sufficiently down and the central bank induced to intervene then, these interventions increased the volatility. It also supported that overt interventions have little effect on the exchange rate volatility.

Mundell (2000) presented a general view on the currency composition of the world in reference to the launching of Euro Currency in 1999. The whole paper was dedicated to the debate of one-currency one-world. Assessing the problem of volatility paper supported the fixed exchange rate regime among the 'Big Three' (the US dollar, the Euro and the Yen) to be the best solution. Further, it suggested that single currency among the 'Big Three' is not politically feasible therefore it can be solved by creating the world central bank producing a world currency backed by international assets, which will be advantageous for all the countries.

Neely (2000) has observed the US, the Swiss and the German daily interventions for the various time periods to analyze the changes in foreign exchange reserves as a proxy to intervention policy by the central banks. Using time series graphs, correlations and basic statistical tools, the study found that changes in reserves are positively correlated with

intervention policy but not significantly. Further, for Germany and Switzerland it was found that after adjusting the data for forex reserves, the correlation has increased and proved to be the better proxy for the intervention.

Dordoodian and Caporale (2001) analyzed the impact of the Federal Reserve interventions on the US exchange rate. Using the GARCH model on the daily interventions in the Yen/Dollar and the Mark/Dollar for the period of 1985 to 1997, they found that interventions had a significant impact on the uncertainty of the spot rates and it also increases the exchange rate volatility.

Sarno and Taylor (2001), studied the effectiveness of official intervention through portfolio balance channel and a signalling channel. They concluded that official intervention can be effective if the intervention is publicly announced and concerted and is consistent with the underlying stance of monetary and fiscal policy. They examined that the importance of portfolio balance channel has compacted over time primarily in major industrialized countries since international capital markets become increasingly integrated and the degree of substitutability between financial assets denominated in the major currencies increases. Intervention could be made more effective if intervention in the major currencies through the signalling channel.

Saacke (2002), has provided evidence by using daily data on foreign exchange interventions of both the Bundesbank and the Fed that central banks earn profits with interventions and that technical trading rules are unusually profitable on days on which interventions take place. He confirmed that Moving Average trading rules are highly profitable on days when central banks intervene and showed that the trading rules tend to bet against central banks. He found that trading rule returns on days that neither coincide with nor are preceded by interventions are positive and are about as large as trading rule returns for the entire sample. His results suggested that at short horizons the respondents do well to take chartism into account.

Sahadevan (2002) examined the central bank intervention policy and exchange rate volatility in the Indian context. Using the Chi-square and the Granger causality test on monthly data from 1995 to 2001, the study found that the intervention has a destabilizing effect on the exchange rate. Further, on changes in future monetary policy due to intervention signals, it suggested that the interventions have been used less significantly to impact the monetary policy.

Beine (2002) investigated the ex-ante exchange rate variation by the daily-central bank (the US, Germany and Japan) interventions over the period of 1985-1995. It measured expectation in volatility by implied volatilities estimated from at-the-money currency option prices. Using a Markov switching model (MS-GARCH) it suggested that intervention had stabilizing effects only when expected volatility was relatively high. Further, it suggested that in the Louvre period, the DEM-USD exchange rate presented stabilized effects even without the coordinated interventions. Also, in general, the stabilizing effect was inversely related to the market volatility.

Beine, Laurent and Lecourt (2002) investigated the weekly central bank interventions on the exchange rate volatility of the US, Germany and Japan over the period of 1985-1995. In this study, regime dependent GARCH models, along with time-varying transition probabilities (TVTP) model were used to observe the volatility. The study showed that the central bank interventions were effective in reducing volatility. Further, it also found that when the market is highly volatile and it expects the central bank to intervene then, these interventions have more stabilizing effects. Study also supported the notion that the coordinated central bank interventions have larger effects on the foreign exchange market. Further, it concluded that the effects of the signal sent by the central bank and its impact on the exchange rate is dependent to the current state of the market and the motivation behind the intervention.

Kim and Sheen (2002) checked the validity of the intervention determining factors such as the current exchange rate movements about the trend, the exchange rate volatility smoothing, the overnight interest rate differentials, the profitability and the foreign reserve inventory considerations. They took data of daily interventions by the Reserve Bank of Australia (RBA) over the period 1983 to 1997, using the probit and the friction models study found that there is significant evidence of these factors influencing the intervention. Also, that the RBA responded to calm the market only when it is of the manageable level and revealed its clear trend. Further, they found that the RBA responded to the interest rate differentials in order to dampen the excessive overshooting exchange rates but it does not necessarily make them profitable.

Ito (2002) checked the effectiveness of the Japanese foreign exchange interventions. Using the various regression analysis on the official data realized from 1991 to 2001 period, the study found that the dollar-purchasing interventions were carried out when the Yen/Dollar rate was below 125 and if it is above than 125, the dollar-selling intervention was carried out. This buying the dollar at a lower rate and selling it high, produced huge

profits from the realized capital gains, the unrealized capital gains and the interest rate differentials. Further, it also suggested that the interventions were found more effective in the later periods of the 1990s and the coordinated interventions with the US found to be 20-50 times more effective than solely Japanese intervention.

Dominguez (2003), examined the relationship (using high-frequency intraday data) between the efficacy of intervention operations and the state of the market at the moment that central bank intervention operations (and macro announcements) are made public to traders. He found that coordinated interventions have large effects on exchange rates, the timing of intervention operations matters, interventions that occur during heavy trading volume, that are closely tied to scheduled macro announcements, and that are coordinated with another central bank are the most likely to have large effects. Central bank interventions influence intra-daily foreign exchange returns and volatility.

Frenkel, Pierdzioch and Stadtmann (2004) examined the official interventions by the Bank of Japan and variation in the exchange rate over the period 1993-2000. They have used the GARCH model proposed by Neal and Tanner (1992) and Dominguez (1998) and found that there is a positive relation between intervention and the volatility in the Yen/US-Dollar exchange rate which supports the previous study, that secret intervention has increased the exchange rate volatility.

Watanabe and Harada (2004) investigated the effects of intervention policy by the Bank of Japan (BoJ) on the Yen/Dollar exchange rate level over the period 1991-2002. Using the GARCH models proposed by Bollerslev (1986) study found that the BoJ's intervention reduces volatility in short run after 1995 but it has neither an impact in short-run nor in long-run volatility in the early 1990s. Also, there was no effect of the Federal bank's coordinated intervention on the effective interventions by the BoJ which had stabilizing effects in the late 1990s and in early 2000.

Brissimis and Chionis (2004) explored the effects of foreign exchange intervention by the European Central Bank and the Bank of Japan on the Euro/USD and the Yen/USD exchange rates from 1999-2001. Using the GARCH model it was found that the intervention had more impact when secretly announced than publically in the case of the BoJ, but there was no evidence found in the support of the above for the ECB as the motivation of the BoJ was clearer to the market. Overall it was suggested that the foreign exchange market intervention will be effective only if it is linked with the effective macro policy coordination.

Moreno (2005), discussed the objectives for the central bank intervention in the foreign exchange market. He opined that the specific motives for intervention change with their level of economic and financial development. Central banks enter the foreign exchange market to prevent overshooting or slow the speed of adjustment in the exchange rate, and to supply liquidity during periods of financial stress. Central banks also enter the foreign exchange market to regulate the amount of foreign exchange reserves, either to accumulate the hard currency needed for intervention or to reduce reserves in order to lower carrying costs.

Kim and Sheen (2006) examined the effectiveness of the intervention policy by the Bank of Japan (BoJ) on the exchange rate returns over 1991-2004. Using the bivariate EGARCH model of the Yen/USD exchange rate and friction model for reaction function it was found that the BoJ was ineffective in pre-1995 but in post-1995, also its intervention was based on 'leaning against the wind' variety on the exchange rate trend. Further, it concluded that small interventions are more likely destabilizing in nature whereas large, sustained and coordinated intervention lead to stabilization.

Kearns and Manners (2006), used an event study to isolate the impact of changes in monetary policy on the exchange rate and presented a new evidence that all monetary surprises do not have the same effect on the exchange rate, unanticipated changes or revision to expectations (surprises) of future policy are found to have a much larger impact than anticipated change in monetary policy.

Barnett and Ozerturk (2006) developed a model to examine whether the interventions with complete secrecy or selective secrecy is effective for the foreign exchange rate. Based on the Kyle model they developed a microstructure framework and suggested that the selective secrecy is a helpful tool to make interventions effective and disregarded the complete secrecy in the high uncertain market which may lead to more volatility in the exchange rates. Further, even the selective secrecy is fruitful only when the central bank is targeting away from the fundamental values i.e. to move exchange rate against the fundamental base trade.

Ito (2007) checked the conceptual issues relating to the intervention on the Japanese economy. Using the data from 1991 to 2004 of the Yen/Dollar exchange rates and checked the effectiveness by the logit, the probit and the friction models. The study concluded that the interventions were effective when conducted infrequently and in the

large scale. Further, these interventions were found profitable as due to the interest rate differentials.

Égert and Lang (2007) examined the daily Croatian National Bank interventions on the foreign exchange rates from 1996 to 2004. On applying various GARCH models it was found that interventions had a little impact on the level of the exchange rate. Further, it also appreciated the view that post-2000 to 2004 the interventions were more effective as it also showed evidence of signalling, than in the late 1990s.

Hoshikawa (2008), analysed the effectiveness of Japanese intervention on exchange rate volatility using monthly data but their results were contrary to the results of previous studies. The difference between results was caused by a difference of monthly data and the daily data. He reported that intervention increases exchange rate volatility in the short run such as daily but reduced in monthly, high-frequency intervention stabilizes the exchange rate by reducing exchange rate volatility.

Bleaney and Francisco (2008) investigated the effect of the peg exchange rate system on the real, the nominal, the bilateral and the multilateral exchange rate volatility. Using the monthly data for one hundred and thirty-nine countries for the period of 1990 to 2006 it was found that both the nominal and the real bilateral volatility against the US-dollar increase with flexibility in the exchange rate, but it was less sensitive against the Swiss Franc. Further, it was suggested that until the exchange rate of the non-anchor currency and country's own currency against the anchor currency is inversely related, the bilateral volatility of non-anchor currency will tend to reduce with interventions. Further, they concluded that real effective exchange rate volatility along with real bilateral volatility against non-anchor currencies are higher under the independent floating exchange rate system and lower in crawling peg regime.

Seerattan and Spagnolo (2009), examined the sensitivity of the foreign exchange market to central bank intervention. Using the model, they separated periods of stable market conditions from volatile periods and looked at the dynamic of the causality effect under different market conditions. They analysed three developing markets, namely Croatia, Iceland and Jamaica and one developed market, Australia, for comparative purposes. They showed that direct intervention affects the probability of switching between states in the developed market but has little or no effect in the developing markets reviewed. They argued that this is due to specific intervention practices rather than market characteristics.

Additionally, they found that intervention purchases and sales tend to have different effects. Intervention should be used mostly in volatile market conditions when there are clear threats and policy objectives tends to be more clearly defined.

Berganza and Broto (2012) analyzed the link between variations in the exchange rate, Inflation Target (IT) and intervention policy of Thirty-Seven IT and non-IT emerging economies from 1995 to 2010. Pooled OLS with time dummies were used on nine-panel models and found that exchange rates were more volatile under IT, also interventions in IT countries explain greater volatility. The study suggested that countries with flexible Inflationary Targets are sustainable and also intervention induced in this regime were more effective than non-IT economies.

Ken Miyajima and Carlos Montoro (2013), in their study an impact of foreign exchange interventions on exchange rate expectations found that sterilised central bank foreign exchange intervention does not change the near term exchange rate expectations and they are directed primarily by fundamentals. A second interpretation was that dollar purchases can increase appreciation pressure, a decline in official reserves reduces investor confidence, and increase both capital outflows and depreciation pressure.

Cheng, Das and Shimatani (2013) examined the effectiveness of intervention policy by the Bank of Japan on daily the US-Dollar/Yen and the DEM/Yen volatility over the period of 1991-2006. Bi-power variation technique was used to decompose daily volatility and found that the intervention has increased both continuous and jump components of volatility. The study also found that the intervention policy was ineffective in influencing the foreign exchange returns which hold true for both coordinated and unilateral interventions. Also, it was found that neither the interventions by the BoJ were successful in stabilizing the exchange rates nor they were helpful to set the returns in the right direction.

Syarifuddin *et al.* (2014) measured the exchange rate volatility in Indonesia after the US crisis i.e. from 2008-2013. The study used the TGARCH model to examine the USD/IDR volatility and found that the Indonesian currency had a high continuous exchange rate volatility. It also confirmed that an increase in real interest rate parity causes appreciation in the domestic currency and on the other hand foreign-exchange-sale intervention decreases the exchange rate to little. Their results were similar to Dominguez (1998) that official purchase of dollar increase exchange rate volatility.

Catalán-Herrera (2016) studied the effectiveness of the central bank interventions in the foreign exchange market and examined the daily Guatemalan *quetzal*/ US-Dollar exchange rate returns under inflation for the period 2007-2012. To estimate central bank reaction function, á *la* Rosett friction model was used and found that there are selling and purchasing threshold effects in the interventions decisions by the central bank in the managed floating exchange rate regime. Also, there was no evidence found that the foreign exchange intervention conveys strong signal for future monetary policy action. To investigate the effect of conditional expectation of intervention and variation in daily exchange rate returns, the GARCH model was used and the result showed that there was no influence of interventions on the exchange rate level. Further, when there is higher expected inflation, the market believed that central bank will raise the interest rates which also appreciate the spot rate.

Kihangire (2017) examined the case of Uganda's central bank intervention to stabilize the foreign exchange market. The structural VAR model was used on the given intervention data, the excess demand for securities, the monetary aggregate overshooting, the consumer price index, the industrial production index, the exchange rate volatility, and the exchange rate misalignment from the period 1993 to 2010. Investigating the intervention in the Interbank Foreign Exchange Market (IFEM), the study found that the direct intervention of central bank in IFEM minimizes the short-term exchange rate volatility. Further, it suggested that the Bank of Uganda (BOU) should not ignore the changes in the money supply and the excess demand of the securities in the primary market as they have an indirect effect on the inflation and the intervention, respectively.

2.4 Studies Related to Forecasting

Canova (1993), applied multivariate Bayesian Time-varying coefficient (TVC) model and compared it with the Random Walk model to forecast the exchange rate of French France, Swiss Franc, German Marc, English Pound and Japanese Yen in terms of US dollar from 1979 to 1987. The performances of the respective models have been measured on the basis of two error functions Schwartz Criterion, Mean Absolute Deviation (MAD) and Theil U-statistic. The results of the study show that Time-varying coefficient (TVC) model is better than the Random Walk Model (RW).

Kamruzzaman and Sarkar (2003), applied Neural network using Back Propagation and scaled Conjugate Gradient learning algorithm to predict six currencies like US dollar,

New Zealand dollar, Singapore dollar, British Pound, Japanese Yen and Swiss Franc in terms of Australian Dollar on weekly data from January 1991 to July 2002. Autoregressive Integrated Moving Average Model (ARIMA) model has been compared with neural network based on five error indicators Mean Absolute Error (MAE), Normalized Mean Square Error (NMSE), Correct Downtrend (CD), Directional Symmetry (DS) and Correct Uptrend (CU). The architecture of the network consisted of three to seven hidden units with five thousand to ten thousand iterations on thirty different neural networks. The outcome of the study shows that neural network models are superior to linear ARIMA model signifying its appropriateness for modelling a financial time series.

Andreou & Zombanakis (2006), employed the Artificial Neural Network to forecast the exchange rate fluctuations in case of US Dollar and Japanese Yen in terms of Euro from October to December 2004 on five minutes observations of 15000 data points. Firstly the exchange rate was stated as the first difference of the natural logarithm and the Rescaled Range Statistics (R/S) analysis was performed to study the random behaviour. The result of the analysis depicts no long term pattern in the case of US Dollar/ Euro while the long-term pattern in the case of Yen/ Euro showed the misleading information. Multilayer Perceptron model with different network topologies as a sigmoid function, hyperbolic tangent function, sine function and Gaussian function has experimented with one to two hidden layers. Beside it, the actual results have also been compared with the predicted results. The results of the neural network model exhibited better prediction accuracy and the choice of suitable network topology plays an important role in the success of the neural network model.

Chen, Peng and Abraham (2006), applied flexible neural tree model for forecasting the exchange rate of Pound, Japanese Yen, and Euro in US terms on daily data from January 2000 to December 2002. Multilayered feed forward neural network (MLFN) has been compared with Flexible neural tree model (FNT) and Adaptive smoothing neural network (ASNN). The forecasting performance has been evaluated on two parameters such as normalized Mean Squared Error (NMSE) and Directional change statistics (Dstat). The outcome of the model depicts that Flexible neural tree model forecasting model superseded than the MLFN and the ASNN.

Lam, Fung and Yu (2008), evaluated the forecasting performance of exchange rate model by comparing the Purchasing Power Parity (PPP) model, Uncovered Interest rate Parity (UIP) model, Sticky Price (SP) monetary model, Bayesian Model Averaging (BMA) technique and Combined Forecast with Random Walk (RW) model. Three currencies Euro (EUR), British Pound (GBP) and Japanese Yen (YEN) have been considered for estimation covering the time period from 1973 to 2007. The variables of the study are exchange rate, price level, oil price, stock price, money supply, interest rate, real GDP and current account. For the evaluation of the respective models Root Mean Squared Error, t-ratio and the t-statistic has been applied. The results of the study show that PPP model, UIP model, SP model has produced better results than the Random Walk (RW) model in the case of EURO/USD and YEN/USD but not in the case of GBP/USD. No single model surpassed their counterparts but in some cases, the combined forecasts have an edge over the other models showing the minimum error.

Nawaz (2008), has compared the forecasting performance of different time series models as Box-Jenkins model (ARIMA), Exponential smoothening and the naïve models. The sample data of Indian Rupee against US dollar covering the period from September 1985 to June 2006 has been considered and the accuracy measured against various statistical measures such as Mean Absolute Error (MAE), Mean Squared Error (MSE), Mean Absolute Percentage Error (MAPE) and Root Mean Squared Error (RMSE). The stationarity of the models has been checked by the Correlogram, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) which has been achieved after the first differencing. The results of the study conclude that the exchange rates do not demonstrate a random walk and ARIMA model have produced superior results than its counterparts showing lowest error rate.

Botha and Pretorius (2009), applied Univariate time series model including the random walk model and the multivariate time series model on Rand/Dollar exchange rate from 1990:1 to 2006:4. The multivariate models as Vector Auto-Regressive (VAR), Vector Auto-Regressive Moving Average (VARMA) and Vector Error Correction model (VECM) has been compared with Univariate model Autoregressive Integrated Moving Average (ARIMA), Autoregressive Conditional Heteroscedasticity (ARCH) and Random Walk Model (RW). The stationarity and the cointegration in the respective models have been compared with augmented Dickey-Fuller (ADF) test and Johansen technique. In the short period, the multivariate (VARMA, VECM, and VAR) models produced better

results than the Univariate models (ARIMA, ARCH) except the RW model whereas in the long period VECM and VAR surpassed the Univariate models (ARIMA, ARCH).

Ince Onur (2010), in his study applied Purchasing Power Parity(PPP) and Taylor rule fundamentals for ten OECD countries(Australia, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, UK and USA) to estimate the out of sample exchange rate forecasting using the real-time data covering 1973 to 2009. Besides the above techniques, the econometric analysis based on panel estimation of the predictive regression has been performed. For out of sample forecasts, the sample has been divided into two parts, in the sample and out of sample. The in-sample element is utilized to know the equation's parameters and the out of sample element for out of sample forecasting. Out of sample forecasting performance has been evaluated on the basis of lowest Mean Squared Error (MSE). To measure the forecast accuracy of the two models Diebold-Mariano and West (DMW) and Clark West statistics have also been applied. The results of the study show that the panel estimation increases the predicting ability of the PPP model in comparison to the single equation model in the long run. The result also shows that the single equation estimation model with Taylor fundamentals provided better out of sample predictions than the panel models.

Corte and Tsiakas (2011), applied the statistical and econometric techniques on monthly observations from 1976 to 2010 to predict the exchange rates of Australian dollar (AUD), New Zealand Dollar (NZD), Japanese Yen (JPY), Canadian Dollar (CAD), Swiss Franc (CHF), British Pound (GBP) Deutsche Mark/Euro (EUR), Norwegian Kroner (NOK), and Swedish Kronor (SEK) in terms of US Dollar. Five models as Uncovered Interest Parity (UIP), Purchasing Power Parity (PPP), Monetary Fundamentals (MF), Taylor Rule (TR) and the Random Walk model (RW) have been compared on the basis of two measures as Mean Squared Error (MSE) and Root Mean Squared Error (RMSE). The outcome of the study shows that in out-of-sample forecasting, uncovered interest parity, Taylor rule, and purchasing power parity depicted better predictions than the random walk model. Moreover, the combined forecasts based on averaging methods are superior to individual models.

Maria and Eva (2011), examined the forecasting performance of the exchange rates applying Simple Exponential Smoothening technique, Simple Holt Winter's, Additive Holt Winter's namely Auto-Regressive Moving Average (ARIMA) model. They have

considered six currencies namely United States Dollar, Chinese Renminbi, Euro, Russian Rubel, British Pound and Japanese Yen in terms of Romanian Leu covering the sample period consisting of the daily exchange rates from 3rd January 2011 to 22 April 2011. For testing the stationarity in the case of ARIMA models Dicky Fuller test and Phillip-Perron unit root test has been used. Stationarity was found already in the case of Euro, Japanse Yen, US dollar and Chinese Renminbi whereas stationarity in the case of Russian Rubel and Great Britain Pound was achieved after the first difference. The forecast accuracy of the model has been evaluated on the basis of the lowest sum of squared error, root mean squared error, mean absolute error and bias proportion. The results indicated the appreciation of the Romanian lieu against the six currencies. In some cases, Exponential Smoothening is superior to ARIMA models. Though there is some difficulty in validating the ARIMA model yet these are effective for forecasting in the short period.

Dua and Ranjan (2011), employed Multivariate Vector Autoregressive (VAR) and Bayesian Vector Autoregressive model to predict the INR/US dollar exchange rate. The variables used in this study are exchange rate, money supply, real output, nominal interest rate, inflation and trade balance. Augmented Dicky Fuller Test has been performed to test the stationarity or unit root which has been achieved at first difference. The cointegrating relationship among the variables is checked by using Johansen and Juselius methodology. The forecasting performance of the model has been evaluated by Root Mean Square Error, Theil's U test, and Diebold-Mariano test. The models have been estimated from the monthly data from July 1996 to December 2006 and out of sample forecasts from January 2007 to June 2008 have been tested. The study concludes that monetary models depicted better results than the naïve model and the Bayesian VAR model showed good results to its corresponding VAR. Moreover, the forecasting precision can become better if the monetary model comprises of the volatility of capital inflows, forward premium and order flow. The central bank intervention information can improve the forecasts in the long period.

Engel, Mark and West (2012), extracted factors from a cross-sectional quarterly data and combined it with Taylor rule, Monetary and Purchasing Power Parity (PPP) models to forecast the in sample and out sample exchange rates from 1973:1-2007:4 of 17 OECD countries (United Kingdom, Switzerland, Sweden, Spain, Norway, Netherlands, Japan, Korea, Italy, Finland, Germany, France, Belgium, Denmark, Canada, Austria and Australia) in US terms. The variables considered in this study are price level in terms of

CPI, money supply as M1, output gap as HP de-trending and output as industrial production. The seasonality in the data has been removed by taking the average of the log levels. The conclusion of the study depicted that the late sample results from 1999 to 2007 showed good outcome in terms of less error than the early samples.

Yusuf Perwez and Asif Perwez (2012), in their study, applied Artificial Neural Network model for forecasting the Indian Rupee/ US Dollar from 1989 through 2009. They inspected the effects of several important neural network factors such as a number of hidden layers, hidden neurons, activation functions etc. on the network architecture of the neural network model. These factors are very important to capture the nonlinearity, chaotic behaviour and complex relationships in the data easily. Three layered neural network has been used to forecast the exchange rate with logistic activation function and linear activation function in the hidden layer and the output layer respectively. The forecasting performance of the model has been investigated by the three cost functions as Root Mean Square Error, Mean Absolute Error, and Mean Absolute Percentage Error. The results of the study show that the number of input nodes plays an important role in forecasting the respective time series. The artificial neural network is superior in handling the chaotic and non-linearity in the data.

Bryn, Gupta, Eyden (2013), in their study applied Dynamic Model Averaging (DMA) for forecasting Rand-Dollar and Rand-Pound exchange rates using quarterly data from 1970:1 to 1994:4 as the in sample and 1995:1 to 2011:3 as the out of sample forecast period. The forecasting performance of the model is then compared with the random walk model and the Bayesian model Averaging using forecast performance measures such as log predictive likelihood and Mean Squared Forecast Error (MSFE). The variables of the study are the exchange rate being the dependent variable and money variable, oil & gold have been taken as the deterministic variable. The variables have been considered as log differences except for the percentage change in growth rate or balance in current on current account which is expressed as a percentage of GDP. The Augmented Dicky Fuller Test (ADF), Dicky Fuller (GLS) test and Ng-Perron test were performed to test the stationarity which has been achieved at first difference level except for the money supply. The results of the study show that the Dynamic model averaging outperformed than the Bayesian model averaging and the random walk model.

Zorzi, Muck and Rubaszek (2013), has made a comparative analysis of Purchasing Power Parity (PPP) model with the Random Walk model to forecast the real exchange rates Australia (AUD), Canada (CAD), Euro Area (EUR), Japan (JPY), Mexico (MXN), New Zealand (NZD), Switzerland (CHF), the United Kingdom (GBP) and the United States (USD) on monthly data covering the period from 1975:1 and 2012:3. The data set has been evaluated from 1990:1 to 2012:3 whereas the out-of-sample predictions have been analyzed from one up to sixty months forward. The models are approximated by the rolling samples of 15 years starting from 1975:1-1989:12 to the end of 1990:2-2012:2. The forecasting performance has been judged with two parameters as the correlation coefficient between the forecasted and realized changes and the Mean Squared Forecast Errors (MSFEs). The results of the study elucidate that the PPP model is superior to the Random walk model both for short and long time period.

Rout, Majhi and Panda (2014), employed a combination of Autoregressive moving average (ARMA) and Differential based training (DE) the exchange rate of British Pound, Indian Rupees and Japanese Yen on daily data in terms of US dollar from 1973 to 2005. Each value of the data set was divided by the maximum value of the equivalent set so that it may lie between 0 and 1. The results of the respective models have been evaluated by comparing it with the four methods as ARMA-bacterial foraging optimization (BFO), ARMA-particle swarm optimization (PSO), ARMA-forward backward least mean square (FBLMS) and ARMA-cat swarm optimization (CSO). The performance of the out of the sample and in sample models has been measured by the two cost functions Mean Squared Error (MSE) and Mean Absolute Percentage Error (MAPE). The outcome of the study depicts that the combination of ARMA-DE based prediction model is better for both short and long range forecasts compared to its competitors.

Chandar, Sumathi and Sivanandam (2015) checked the prediction of the foreign exchange rate of Indian rupee with four (Pound Sterling, US Dollar, EURO and Japanese Yen) major currencies of the world. Using the data on 1205 days data on five various algorithms of Artificial Neural Networks (ANN), working on Back Propagation Neural Network (BPNN) it was found that among the five models Levenberg-Marquardt model proved to be the best model.

Babu and Reddy (2015) compared the three foreign exchange rate forecasting models on the Indian Rupee against the US dollar, British Pound, Euro and Japanese Yen. Observing

exchange rate data from 2010 to 2015 and applying ARIMA, nonlinear autoregressive Neural Network and nonlinear Fuzzy Neuron. They have concluded that ARIMA model outperforms the other model and proved to be the best model for forecasting in the case of India, as against the literature, which says that Neural Network has better performance than ARIMA.

Ca' Zorzi, Muck and Rubaszek (2015) analyzed the real foreign exchange rate forecasting with a different approach of considering Purchasing Power Parity (PPP) model. On applying half-life PPP (HL) model and compared with Random-Walk (RW) model and Autoregressive (AR) model for the nine countries (Australia, Canada, Euro area, Japan, Mexico, New Zealand, Switzerland, the United Kingdom and the United States) from 1975 to 2012, the have found that the HL model performed better in both the short and long term horizons for seven out of nine countries. Further, if the speed of mean reversion is estimated then the HL model is not a good model instead calibration is better. Also, the HL model is more accurate even for the nominal exchange rate forecasting for most of the countries.

Ngan (2016) examined the validity of the ARIMA model in forecasting Vietnam foreign exchange rate for the period 2016. By using the real foreign exchange rate data of the Vietnam Dong against the US Dollar from 2013 to 2015, the study found that in view of commercial stock banks ARIMA model proved to be absolutely suitable for the forecasting of the foreign exchange rate of the Vietnam Dong in short run.

Isenah and Olubusoye (2016) determined the best estimator of the GO-GARCH model for the prediction of foreign exchange rate forecasting of the Nigerian Naira against the five currencies the Danish Kroner, the Euro, the Japanese Yen, the British Pound Sterling and the Swiss Franc for the period 2009 to 2015. Considering four different estimators of GO-GARCH they concluded that for in-sample forecasting all the models performed equivalent but for the out-of-sample GO-GARCH models estimated with Non-linear Least Square (NLS) and Method-of-Moment (MM) outperform the other models and considered to be the best model for forecasting of the Nigerian Naira.

Fiĉura (2016) investigated the quest of the foreign exchange rate forecasting, conducting the study in two different phases by first choosing three different data mining methods (k-Nearest Neighbour, Ridge Regression and Multilayer Perceptron Feed-Forward Neural Networks) testing on their respective multi variants and then secondly applied them on

the given exchange rate time series. Ten simulated and real-world time series of ten exchange rates from the period 1999 to 2015 were applied and found that in simulation study none of the models was best, although feed-forward neural network was good in few time series but was inconsistent, also when applying the data mining models on the exchange rate time series it established that all the models had low profitability, but ridge regression method was profitable for most of the currencies. Finally, the study concluded that Euro-USD is most promising for the trading purposes.

Chen and Narala (2017) analyzed forecasting of the foreign exchange rate of the Indian rupee by the Feedforward Backpropagation Neural Network (FBNN) model. They have used monthly data of foreign exchange rates of the Indian rupee and the US dollar for the period 2001 to 2014 and prognosticated the foreign exchange rate for 2015. By using the six major factors which effect exchange rate and six neural networks they have concluded that prediction was great for first seven months of the year 2015 but in the later five months the deviation was significant, which shows that forecasting was good enough in short run than in long run.

Chojnowski and Dybka (2017) worked to improve the prediction of the foreign exchange rate forecasting by including the unobserved fundamentals (UNF) (credit–market, financial-market and price-market sentiments) along with observable fundamentals (OF). They have extracted these unobserved fundamentals from Google Trends. Observing monthly data on the exchange rate for Polish zioty (Poland) and Euro from 2004 to 2016 and included UNF in an extended form of VAR (Vector Autoregressive) model, found that including the market sentiments actually improved forecasting capabilities.

Sharma, Hota and Handa (2017) analyzed foreign exchange rate forecasting by comparing the two models: regression and ensemble regression. They have examined their models on the foreign exchange rate data of the Indian rupee against the US dollar and the Euro for the period November 2016 to July 2017 and found that ensemble regression technique with both bagging and boosting perform better than regression technique solely. Also, with an increase of N days, the prediction becomes more accurate for ensemble technique.

Thus it can be concluded that many studies relating to Indian Foreign exchange market have been conducted abroad as well as India but a glance of existing literature depicts that

a few studies have been conducted on survey-based data and especially on fundamental and non-fundamental analysis. Review of literature highlights that a limited number of studies have been conducted on volatility and forecasting of forex market of India. If we examine the policies of Reserve Bank on its interventions in the forex market hardly any study is conducted in this area. Thus a comprehensive study has been conducted to examine the relative importance of fundamental and non-fundamental factors that influence the foreign exchange market. This has been supplemented thorough examining the behaviour of forex market traders to know the level of importance assigned to fundamental and non-fundamental factors. Views of market participants were sought to study the impact of Central Bank interventions on the forex market. Extent of the volatility of the forex market was also assessed due to Central Bank interventions. In addition to the above, an appropriate non-linear model based on the neural network was recommended for forecasting foreign exchange movements.

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Database and Analytical Tools

Research designs give social scientists tools that help to determine what observations they are going to use to test their hypotheses (Abbott and McKinney). Research design is a strategic plan for a research project or research programme, it includes setting out the broad outline and key features of the work to be undertaken, including the methods of data collection and analysis to be employed, and showing how the research strategy addresses the specific aims and objectives of the study, and whether the research issues are theoretical or policy-oriented (Marshall, 1998). Research designs are types of inquiry within qualitative, quantitative, and mixed methods approach that provide specific direction for procedures in research design (Creswell, 2012).

Descriptive research uses quantitative methods to describe what is, describing, recording, analyzing, and interpreting conditions that exist. It involves some type of comparison or contrast and attempts to discover relationships between existing non-manipulated variables. Some form of statistical analysis is used to describe the results of the study (Best and Kahn, 2006).

The present study is based on the Primary as well as Secondary data for fulfilling objectives and testing hypotheses. These are explained in the following sections.

3.1 Primary Data

Survey strategy is a popular and common strategy used in business and management research (Saunders, Lewis, Thornhill, 2009). Choice of a survey strategy for present research is guided by research objectives, available literature, the amount of time and other resources available. The survey strategy is adopted for the present study to meet the first three objectives.

Primary data is collected from foreign exchange traders (survey units) at a particular point of time, regarding the influence of fundamental and non-fundamental factors (variables) on the foreign exchange market.

3.2 Population of the Study

The population of the study consists of foreign exchange traders registered with Reserve Bank of India (RBI) and Securities & Exchange Board of India (SEBI) and operating in Northern India. Previous studies classified traders as fundamentalists and

technicians/chartists (Taylor and Allen, 1992). Dealers are reported to be fundamentalists and brokers as technicians/chartists (Oberlechner, 2001). The foreign exchange traders for the present study are classified into three categories namely dealers, brokers/sub-brokers and investors (Cheung, Chinn and Marsh, 2004). Foreign exchange traders in India are spread throughout the country. However, due to constrictions of time and finance, the scope of study has been confined to the foreign exchange traders located in the northern region of India only.

3.3 Data Collection

The primary data was collected through a non-disguised structured questionnaire. The questionnaire was administered to 250 respondents selected on the basis of purposive sampling but due to inappropriate response, two questionnaires were not retained for analysis. The target respondents for the survey were 58 dealers registered with RBI (Reserve Bank of India), 94 brokers/sub-brokers registered with SEBI (Securities and Exchange Board of India) and 96 investors from Amritsar, Jalandhar, Ludhiana, Chandigarh, and Delhi. List of registered brokers and sub-brokers traders were obtained from the handbook of statistics on Indian securities market 2014, published by SEBI. Selection of cities was made on the basis of the highest number of registered brokers. From each city, major trading locations were identified and respondents were targeted accordingly. One investor from each broker office was selected on the basis of highest trading experience.

3.3.1 Pilot survey. The survey instrument was pretested and examined for validity and reliability. To ensure content validity of questionnaire items, discussions were held with 2 expert's having more than 20 years of experience in the foreign exchange market and 2 professors from the academic field. After four revisions consensus was formed among the suggestions of experts from two fields and questionnaires were administered on 60 brokers from Ludhiana. After a gap of 20 days' questionnaire was again administered to same 60 brokers.

Reliability for unidimensional measures was assessed through Cronbach alpha (α) and for other questions, where internal consistency between items/statements were not desired and reliability was assessed through test-retest reliability coefficients.

Table 3.1: ***Reliability coefficients of constituents of factors affecting the foreign exchange rate.***

S. No.	Factors (Constituents)		Number of items	Cronbach's Alpha
1.	Fundamental Factors		12	0.823
2.	Technical Factors	Turning Points	13	0.872
3.		Trends	13	0.898
4.	Behavioural Factors		5	0.640

Table 3.1 shows the reliability of constituents of factors affecting foreign exchange rate measured through Cronbach's α. Constituents of fundamental factors and technical factors show a high reliability, all Cronbach's α values are more than 0.82 (Cronbach, 1951, Nunnally, 1979 and Peter, 1979). However, the constituents of behavioural factors show acceptable level but relatively low reliability, Cronbach's α = 0.64. This is due to less number of items in behavioural factors. Fundamental factors have 12 items (factor constituents) and technical factors have 13 items each for turning points and trends (Cortina, 1993).

Table 3.2: ***Reliability coefficients of factors determining the foreign exchange rate.***

S. No	Factors that determine exchange rates	Correlations
1.	Fundamental factors	0.827**
2.	Technical factors	0.712**
3.	Behavioural factors	0.897**
4.	Speculation	0.711**
** Correlation is significant at the 0.01 level (2-tailed).		

Table 3.2 depicts the test-retest reliability coefficients of factors that determine the foreign exchange rate measured through Pearson's correlation coefficient. Behavioural factors showed high degrees of reliability, r = 0.89 followed by fundamental factors, r = 0.83. Technical factors and speculation showed the approximately the same degree of consistency between respondents, r = 0.71. However, all the factors showed a satisfactory degree of reliability, r > 0.70 (Furr & Bacharach, 2013). All Correlation coefficient are significant, p > 0.01.

Table 3.3: ***Reliability coefficients of statements related to the effect of speculation on the exchange rate.***

S. No	Effect of speculation on the exchange rate	Correlations
1.	Speculation increases exchange rate volatility	0.981**
2.	Speculation move exchange rates away from their fundamental levels	0.883**
3.	Speculation increases market liquidity	0.846**
4.	Speculation improves market efficiency	0.894**
** Correlation is significant at the 0.01 level (2-tailed).		

Table 3.3 represents the test-retest reliability coefficients of statements related to the effect of speculation on exchange rate measured through Pearson's correlation coefficient. All the statements showed a high degree of reliability, r > 0.84 (Furr, & Bacharach, 2013). All Correlation coefficient are significant, p > 0.01.

Table 3.4: ***Reliability coefficients of the usefulness of fundamental analysis and technical analysis in predicting trends and turning points.***

S. No	Usefulness of fundamental analysis and technical analysis in predicting trends and turning points		Correlations
1.	**Fundamental Factors**	Trends	0.963**
		Turning Points	0.949**
2.	**Technical Factors**	Trends	0.915**
		Turning Points	0.881**
** Correlation is significant at the 0.01 level (2-tailed).			

Table 3.4 depicts the test-retest reliability coefficients of the usefulness of fundamental analysis and technical analysis in predicting trends and turning points measured through Pearson's correlation coefficient. Consistency between respondents on fundamental factors is slightly higher than technical factors. However, all the factors showed a high degree of reliability, r > 0.88 (Furr, & Bacharach, 2013). All Correlation coefficient are significant, p > 0.01.

Table 3.5: ***Reliability coefficients of success rate achieved in foreign exchange trading on the basis of factors.***

S. No	Success rate achieved in foreign exchange trading on the basis of factors	Correlations
1.	Fundamental factors	0.897**
2.	Technical factors	0.705**
3.	Behavioural factors	0.890**
4.	Speculation	0.796**
** Correlation is significant at the 0.01 level (2-tailed).		

Table 3.5 shows, the test-retest reliability coefficients of the success rate achieved in foreign exchange trading on the basis of factors measured through Pearson's correlation coefficient. Success achieved through behavioural factors and fundamental factors showed high degrees of reliability, r = 0.89 followed by speculation, r = 0.80. Technical factors showed a somewhat low degree of consistency between respondents, r = 0.71. However, all the statements showed a satisfactory degree of reliability, r > 0.70 (Furr, & Bacharach, 2013). All Correlation coefficient are significant, p > 0.01.

Table 3.6: ***Reliability coefficients of statements related to the effect of central bank interventions on the foreign exchange rate.***

S. No	Statements related to the effect of central bank interventions on the foreign exchange rate	Correlations
1.	Do you agree that central bank intervention has an effect on the exchange rate	0.909**
2.	Do you believe that Central Bank interventions result in profit for chartists in short term?	0.853**
3.	Central Bank interventions increase exchange rate volatility	0.865**
4.	Central Bank interventions move exchange rates away from their fundamental levels	0.903**
5.	Central Bank interventions are usually conducted at the appropriate moment	0.970**
6.	Central Bank interventions achieve the desired goal	0.937**
** Correlation is significant at the 0.01 level (2-tailed).		

Table 3.6 represents the test-retest reliability coefficients of statements related to the effect of central bank interventions on foreign exchange rate measured through Pearson's correlation coefficient. All the statements showed a high degree of reliability, $r > 0.85$ (Furr, & Bacharach, 2013). All Correlation coefficient are significant, $p > 0.01$.

3.3.2 Profile of foreign exchange traders. The profile of the foreign exchange traders according to their current position and experience is given in table 3.7 and 3.8 respectively.

Table 3.7: ***Current position of foreign exchange traders.***

S. No.	Current Position	Frequency	Percent	Cumulative Percent
1.	Dealer (RBI registered)	58	23.39	23.39
2.	Broker (SEBI registered)	94	37.90	61.29
3.	Investor	96	38.71	100
	Total	248	100.0	

Table 3.7 shows the current position of foreign exchange traders in the foreign exchange market. Out of total 248 foreign exchange traders, data were collected from 58 dealers registered with RBI (Reserve Bank of India), 94 brokers/sub-brokers registered with SEBI (Securities and Exchange Board of India) and 96 investors.

Table 3.8: ***Trading experience of foreign exchange traders.***

S. No.	Trading Experience	Frequency	Percent	Cumulative Percent
1.	2 & Below	39	15.7	15.7

2.	3-4	46	18.5	34.3
3.	5-6	51	20.6	54.8
4.	7-8	45	18.1	73.0
5.	9-10	30	12.1	85.1
6.	Above 10	37	14.9	100.0
	Total	248	100.0	

Table 3.8 shows the classification of foreign exchange traders according to their total experience in foreign exchange trading. The groups of trading experience were formed on the basis of commencement of foreign exchange trading in Indian stock exchanges. Foreign exchange trading was started in India in currency futures on 29th August 2008 and currency options on 29th October 2010. Following this classification, 20.6 per cent of traders have trading experience of 5-6 years followed by 18.5 per cent (3-4 years), 18.1 per cent (7-8 years), 15.7 per cent (up to 2 years), 14.9 per cent (above 10 years) and 12.1 per cent (9-10 years).

Table 3.9: ***Gender of foreign exchange traders.***

S. No.	Gender	Frequency	Percent	Cumulative Percent
1.	Female	29	11.7	11.7
2.	Male	219	88.3	88.3
	Total	248	100.0	

Table 3.9 depicted that male foreign exchange traders had the majority (88.3 per cent) over the female traders (11.7 per cent). More than four-fifth of the foreign exchange traders belong to the male section, this shows that trading in foreign exchange market is dominated by males.

Table 3.10: ***Age of foreign exchange traders.***

S. No.	Age Group	Frequency	Percent	Cumulative Percent
1.	20 & Below	2	.8	.8
2.	21-30	102	41.1	41.9
3.	31-40	87	35.1	77.0
4.	41-50	42	16.9	94.0
5.	Above 50	15	6.0	100.0
	Total	248	100.0	

Age-wise foreign exchange traders were classified into five categories, viz. Below 20 years, between 21-30 years, 31-40 years, 41-50 years and 51 years and above. Table 4.10

shows that the majority (41.1 per cent) of the traders belonged to 21-30 years of age group followed by 35.1 per cent of 31-40 years' group, 16.9 per cent of 41-50 years of age group, 6.0 per cent of above 50 years of age and only two traders were below 20 age group.

Table 3.11: ***Educational qualification of foreign exchange traders.***

S. No.	Educational Qualification	Frequency	Percent	Cumulative Percent
1.	Higher Secondary	5	2.0	2.0
2.	Graduation	145	58.5	60.5
3.	Post-Graduation	98	39.5	100.0
	Total	248	100.0	

The educational qualification was classified into higher Secondary, graduation and post-graduation. Table 3.11 describes that majority of the respondents belong to graduation category (58.5 per cent) followed by post-graduation (39.5 per cent) and higher secondary qualification category (2.0 per cent). From the data, it can be concluded that more than 98 per cent of the total respondents possess above higher secondary educational qualification.

3.4 Hypothesis of the Study

Based on the review of related literature, the following hypotheses have been framed to meet the various objectives of the study:

3.4.1 In order to check whether fundamental factors differ significantly from non-fundamental factors in their ability to determine the exchange rate, following hypotheses were tested:

$H_0$1: There is no difference between fundamental factors and technical factors in their ability to determine the exchange rate.

$H_0$2: There is no difference between fundamental factors and behavioural factors in their ability to determine the exchange rate.

$H_0$3: There is no difference between fundamental factors and speculation in their ability to determine the exchange rate.

3.4.2 To know the importance given by foreign exchange traders to fundamental and non-fundamental factors while trading in the foreign exchange market, following hypotheses were tested:

$H_0$4: There is no difference between the success rate achieved in foreign exchange trading through fundamental factors and technical factors.

$H_0$5: There is no difference between the success rate achieved in foreign exchange trading through fundamental factors and behavioural factors.

$H_0$6: There is no difference between the success rate achieved in foreign exchange trading through fundamental factors and speculation.

$H_0$7: Fundamental factors do not differ significantly in their ability to influence foreign exchange rates.

$H_0$8: Technical factors (trading techniques) do not differ significantly in their ability to predict turning points in foreign exchange rates.

$H_0$9: Technical factors (trading techniques) do not differ significantly in their ability to predict trends in foreign exchange rates.

$H_0$10: Behavioral factors do not differ significantly in their ability to influence foreign exchange trading decisions of traders.

$H_0$11: Foreign exchange traders do not differ significantly in their views regarding the effect of speculation on exchange rate volatility.

$H_0$12: Foreign exchange traders do not differ significantly in their views regarding the effect of speculation on the movement of exchange rate away from their fundamental levels.

$H_0$13: Foreign exchange traders do not differ significantly in their views regarding the effect of speculation on increase in liquidity in the foreign exchange market.

$H_0$14: Foreign exchange traders do not differ significantly in their views regarding the effect of speculation on improvement in market efficiency.

3.4.3 To assess and identify the impact of central bank interventions on the foreign exchange market in general, following hypotheses were tested:

$H_0$15: Foreign exchange traders do not differ significantly in their views regarding the effect of central bank interventions on the foreign exchange rate.

$H_0$16: Foreign exchange traders do not differ significantly in their views regarding the effect of central bank interventions on exchange rate volatility.

$H_0$17: Foreign exchange traders do not differ significantly in their views regarding central bank interventions moves the exchange rate away from their fundamental levels.

$H_0$18: Foreign exchange traders do not differ significantly in their views regarding central bank interventions are conducted at an appropriate moment.

$H_0$19: Foreign exchange traders do not differ significantly in their views regarding central bank interventions achieve the desired goal.

3.5 Analysis of Primary Data

Data in the present study has been analyzed with bar charts, pie charts and tables. Descriptive analysis of data was undertaken using various tools like averages, variance, kurtosis and skewness for normality test and outlier detection. Correlation, t-test and ANOVA have been used for inferential analysis. Following parametric and non-parametric techniques were used for inferential analysis and hypotheses testing:

3.5.1 T-test. A t-test examines differences in the mean scores of a parametric dependent variable across two groups or conditions (the independent variable). The t-test outcome is based on differences in mean scores between groups and conditions, in relation to the 'standard error' of the differences (Mayers, 2013). The t-test can be classified into two categories:

i. ***Independent-means t-test.*** This test is used when there are two experimental conditions and different participants were assigned to each condition (this is sometimes called the independent-measures or independent-samples t-test) (Field, 2013).

$$t = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}} \qquad \ldots (3.1)$$

$\overline{X_1}$: Mean of group 1.

$\overline{X_2}$: Mean of group 2.

$\sqrt{\frac{s_p^2}{n_1} + \frac{s_p^2}{n_2}}$: Standard error of the sampling distribution of differences.

Assumptions of independent-means t-test:

- The independent variable must be categorical and must be represented by two independent groups (scores come from different people).
- The dependent variable must be measured on interval or ratio scale.
- Data of both groups should be reasonably normally distributed.

ii. ***Dependent-means t-test***. This test is used when there are two experimental conditions and the same participants took part in both conditions of the experiment (this test is sometimes referred to as the matched-pairs or paired-samples t-test) (Field, 2013).

$$t = \frac{\overline{D} - \mu_D}{S_D/\sqrt{N}} \qquad \text{... (3.2)}$$

$\overline{D}$: Mean difference between samples.

μ_D: Expected difference between population means.

$S_D/\sqrt{N}$: The standard error of the differences

Assumptions of a dependent-means t-test:

- Scores must come from same people in both groups.
- Data must be measured at an interval or ratio scale.
- Difference between data of two groups should be reasonably normally distributed.

3.5.2 Independent one-way ANOVA. One-way ANOVAs are employed to address research questions that focus on the difference in the means of one dependent variable and one independent variable with two or more levels (Alistair, 2002).

$$F = \frac{MS_M}{MS_R} \qquad \text{... (3.3)}$$

Model mean square (MS_M) = $\frac{SS_M}{df_M}$

SS_M: Total variation explained by the model.

df_M: Degree of freedom of model.

Residual mean square (MS_M) = $\frac{SS_R}{df_R}$

SS_R: Total variation due to extraneous factors.

df_R: Degree of freedom of residual.

Assumptions of independent one-way ANOVA:

- Scores must come from same different people in all groups.
- The dependent variable has been measured on an interval scale or ratio scale.
- The variances of the groups based on the levels of the independent variable are equal and
- The distribution of scores in each group is normally distributed.

3.5.3 Repeated one-way ANOVA. An ANOVA technique used when respondents are exposed to more than one treatment condition and repeated measurements are obtained (Naresh Malhotra). Helmert contrast function available in SPSS under repeated measure ANOVA was performed to compare the overall success rate of fundamental factors with non-fundamental factors and to compare the overall ability of fundamental factors with non-fundamental factors in determining the foreign exchange rate.

$$F = \frac{MS_M}{MS_R} \qquad \ldots (3.4)$$

Model mean square (MS_M) = $\frac{SS_M}{df_M}$

SS_M: Total variation explained by the model.

df_M: Degree of freedom of model.

Residual mean square (MS_M) = $\frac{SS_R}{df_R}$

SS_R: Total variation due to extraneous factors.

df_R: Degree of freedom of residual.

Assumptions of repeated one-way ANOVA:

- Scores must come from same people in all groups.
- Data must be measured on an interval scale or ratio scale.
- Variances of the differences between groups or conditions should be equal (assumption of sphericity).

- Difference between data of repeated groups should be reasonably normally distributed.

3.5.4 Mann-Whitney test. This test is used to test differences between two conditions when different participants have been used in each condition. This test is the non-parametric equivalent of the independent *t*-test (Field, 2013). Data for an independent-samples t-test can also be analyzed by using nonparametric procedures. If the assumptions of the independent-samples t-test are met, the parametric test is a more powerful analysis than nonparametric alternatives. If the normality assumption for an independent-samples t-test is not met, the nonparametric alternative may be more powerful in some circumstances (Samuel B. Green, 2004).

$$U = \min(U_1, U_2) \qquad \ldots (3.5)$$

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

$$U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2$$

n_1: Size of sample 1.

n_2: Size of sample 2.

R_1: Adjusted rank sum for sample 1.

R_2: Adjusted rank sum for sample 2.

3.5.5 Kruskal–Wallis test. If the normality assumption of the independent one-way ANOVA *F* test is violated, we can use the Kruskal-Wallis rank test. The Kruskal-Wallis test has the same power relative to the one-way ANOVA *F* test that the Wilcoxon rank sum test has relative to the *t*-test (Mark l. Berenson). The Kruskal-Wallis test is used in situations where there is one independent variable with three or more levels and the design is between-subjects. However, unlike the ANOVA, the Kruskal-Wallis test is used either when the data are ordinal or when the assumptions of population normality or homogeneity of variance are questionable (Statistics Plain and Simple, 3rd Ed. By Sherri Jackson).

$$H = \frac{12}{N(N-1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(N+1) \qquad \ldots (3.6)$$

N: Total sample size.

R: Sum of ranks for each group.

n_i: Sample size of a particular group.

3.5.6 Effect size (ES). Effect size mean the degree to which the phenomenon is present in the population or the degree to which the null hypothesis is false (Cohen, 1988). An effect size (ES) is simply an amount of something that might be of interest. ES estimates from data are our best guide to population ESs (Cumming, 2013). Effect sizes for parametric tests in the present study are calculated using GPower version 3.1, which is based on Cohen's d. For non-parametric tests, the effect size is estimated with equation manually (Fritz, Catherine, Morris and J. Richler, 2012).

Table 3.12: ***Guidelines for interpretation of effect size (Cohen, 1988).***

Effect Size Type	Cohen's d for T-test	Cohen's d for ANOVA	r for Mann-Whitney
Small effect size	.2	.10	.1
Medium effect size	.5	.25	.3
Large effect size	.8	.40	.5

$$d = \frac{\mu_1 - \mu_2}{\sigma} \qquad \text{... (3.7)}$$

μ_1: Population mean of group 1.

μ_2: Population mean of group 2.

σ: Standard deviations in the two populations.

$$d_z = \frac{|\mu_z|}{\sigma_z} = \frac{|\mu_x| - |\mu_y|}{\sqrt{\sigma_x^2 + \sigma_y^2 - 2\rho_{xy}\,\sigma_x\sigma_y}} \qquad \text{... (3.8)}$$

μ_x, μ_y: Population means.

$\sigma_x \; and \; \sigma_y$: Standard deviation in either population.

ρ_{xy}: Correlation between the two random variables.

μ_z: Population Mean.

σ_z: Population standard deviation.

$$f = \frac{\sigma_m}{\sigma} \qquad \text{... (3.9)}$$

σ_m: Standard deviation of the group means.

σ: common standard deviation within each of the groups.

$$r = \frac{Z}{\sqrt{N}} \qquad \ldots (3.10)$$

Z: z-score for the groups.

$\sqrt{N}$: number of total observations.

3.5.7 Checking of assumptions for parametric tests:

- For ensuring reasonably normally distributed data, normality assumption was checked through the values of skewness and kurtosis. Skewness and kurtosis values between +/-2 (Cameron, 2004) is considered reasonably normal.

- Levene's test was applied to check significant deviations from the assumption of homogeneity of variance. Levene's test tests the null hypothesis that variances of the groups are the same. If Levene test is significant ($p < .05$), it means that the variances of groups are not equal. All places where Levene's value was significant results of Welch's F and Brown-Forsythe F tests have been reported, as these tests are not based on the assumption of homogeneity of variance on the level of the independent variable.

- Mauchly's test was performed to check the assumption of sphericity. Mauchly's test tests the null hypothesis that variances of the difference between a pair of groups are the same. If Mauchly's test significant ($p < .05$), it means that the variances of the difference between a pair of groups are not equal. All places where Mauchly's test is significant ($p < 0.05$) two corrections were applied i.e. Greenhouse-Geisser and Huynh-Feldt. Both values of Greenhouse-Geisser and Huynh-Feldt correction (ê) are compared to the lower bound. The more closer these values are to 1 rather than lower bound the more homogeneous are the variances of differences, and hence the closer the data are to being spherical (Field, 2013).

Analysis of data collected from the pilot survey revealed that reliability of fundamental, non-fundamental and their constituents are satisfactory. Therefore, the research instrument is suitable for final administration to respondents. Profile of foreign exchange dealers exhibited that male respondents were significantly higher than their

female counterparts, the experience of most of the respondents varies from 3 to 8 year and age between 21 to 40 years. Majority of respondents were graduated and post-graduated.

3.6 Secondary Data

It has been experienced that the foreign exchange market is distinguished by it's chaotic, non-linear, volatile and the noisy behaviour. So it has been a gigantic task for the researchers to know the extent of volatility due to Central Bank interventions and forecast the exchange rate in the near future.

3.6.1 Study period and Sources of Secondary Data. In order to examine the extent of volatility due to Central Bank interventions weekly data on the exchange rate and intervention cover a period from the first week of April 1997 to last week of March 2017. The study also generated forecasts of the Indian foreign exchange market covering United States Dollar (USD), Great Britain Pound (GBP), Euro (EUR) and Japanese Yen (JPY) in terms of Indian rupee (INR) on daily basis from 4th January 1999 to 31st March 2017. Secondary data has been culled from the websites of RBI (http://rbi.org.in) and OECD (http://www.oecd.org)

The brief explanation of the techniques used to analyse secondary data are as follows:

3.6.2 Volatility models. Volatility is the measurement of risk of a particular instrument or an asset. It refers to the uncertainty and risk due to changes in the value of the stock, asset, security and investment (Jenkins, 2012). Foreign exchange rate volatility refers to the number of variations in the foreign exchange rate due to the inflow and outflow of the respective currencies. Volatility is of two types: Historical Volatility and Implied Volatility (Downey, 2011). Historical volatility is a number of deviations in the past market price of an asset or movements in the currency value, whereas implied volatility is elucidated as forward-looking and is forecasted through movement of exchange rate by approximation of what will occur in the near future.

In the financial economics literature, there are various methods to estimate volatility (Lyons, 2005). The simple method to measure the volatility is the standard deviation which has been derived from a square root of the squared deviation of the average return from a sample of observations (Engle, 2004). It is described as:

$$\sigma = \sqrt{\frac{1}{n-1}\sum_{t-1}^{n}(\mathrm{R_t} - \overline{\mathrm{R}})^2} \quad \ldots (3.11)$$

where R is the return, n is the number of observation and $\overline{R}$ is the average return of the sample.

The daily return is the first difference in the natural logarithm of the exchange rate of successive days calculated by the following equation:

$$R_t = 100 * \log \frac{E_t}{E_{t-1}} \quad \ldots (3.12)$$

Where R_t is the logarithmic daily return, E_t is the current price of an asset and E_{t-1} is the previous price of an asset at time t respectively.

3.6.2.1 ARCH family models. Autoregressive Conditional Heteroscedasticity (ARCH) model is the widely applied technique to model the attitude of the investor not towards the probable returns but towards uncertainty also (Asteriou and Hall, 2007). The ARCH model was developed by Engle (1982) and his student Bollerslev (1986) contributed an advanced Generalised Auto Regressive Conditional Heteroscedastic (GARCH) model. However, there are some improved models such as EGARCH, TGARCH, NGARCH, QGARCH, GARCH-M, GJR-GARCH, and FGARCH etc. which are used to estimate volatility. The ARCH model states that the conditional variance is a linear combination of its squared error (ARCH term).

The equation of the model is given by:

$$R_t = a_0 + \beta' X_t + \varepsilon_t \quad \ldots (3.13)$$

$$h_t = a + \sum_{j=1}^{p} \alpha_t \, \varepsilon^2{}_{t-j} \quad \ldots (3.14)$$

where $h_t$is the variance captured by lagged squared residual terms (ε_t).

3.6.2.2 GARCH model. The GARCH model was first developed by Tim Bollerslev in 1986 which states that the conditional variance is a linear combination its squared error (ARCH term) and a part of lagged conditional variance (GARCH). However, we used a GARCH (1, 1), model. The equations of the model are given by:

$$R_t = C_0 + C_1 INT_t + \varepsilon_t \quad \ldots (3.15)$$

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

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \varphi_0 \, |INT_t| \quad \ldots (3.16)$$

$$R_t = \log\left(\frac{s_t}{s_{t-1}}\right) * 100 \qquad \ldots (3.17)$$

$$INT_t = \log\left(\frac{res_t}{res_{t-1}}\right) * 100 \qquad \ldots (3.18)$$

Where R_t is Indian Rupee- US Dollar bilateral exchange rate and R_t is the exchange rate return calculated by equation (3.17). A positive (negative) value indicate depreciation (appreciation) of Indian Rupee , INT_t is the variable for capturing the net intervention operations of RBI, a positive (negative) value represent net purchase (sale) of US dollar, which is considered to be the changes in the foreign currency assets (res_t) of RBI, and ε_t is the disturbance term, $\varepsilon_t = \sqrt{\sigma_t^2}.\ v_t$, v_t is the white noise error term. $\lceil\ \rceil$ is the absolute value operator. I_t Is the information available to the market participants at the time $t-1$. To make sure that the model (GARCH) is well-specified $\alpha_0 > 0$, $\alpha_1 > 0$ and $\beta \geq 0$ be required to hold. Sum of $\alpha_1 + \beta$ is capturing the persistence of volatility, if the sum of $\alpha_1 + \beta$ is close to unity; it shows the high persistence of volatility due to shocks

We used purchase and sale intervention separately for understanding such effects both in mean and variance equation.

$$R_t = C_0 + \delta_1 D_1 INT_t + \delta_2 D_2 INT_t + \varepsilon_t \qquad \ldots (3.19)$$

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

$$\varepsilon_t = \sqrt{\sigma_t^2}.v_t$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 + \varphi_1\ D_1 |INT_t| + \varphi_2 D_2 |INT_t| \qquad \ldots (3.20)$$

D_1 = 1 if $INT_t > 0$ and Zero otherwise (Reaction to appreciation pressure)

D_2 = 1 if $INT_t < 0$ and Zero otherwise (Reaction to depreciation pressure)

Where δ_1 and δ_2 measure the exchange rate's reaction to buying and selling operations respectively. Similarly φ_1 and φ_2 measures the impact of purchase and sale of foreign currency on the volatility of the exchange rate.

- **Tests of Heteroskedasticity.** Having an equal variance indicate that the disturbances are homoscedastic or otherwise the disturbances are heteroskedastic (Asteriou and Hall, 2007, Gujrati and Sangeeta, 2012). Before applying the volatility models, the disturbances or error term should be heteroskedastic. In the present study, we have used the ARCH test to detect the heteroscedasticity. The equations of the model are as follows:

The LM test is performed after obtaining the residuals from the Ordinary Least Square Model (OLS) of a conditional mean equation following an Autoregressive (AR) process or Moving Average (MA) process or a mixture of AR and MA process. An ARMA (1,1) model is described as:

$$X_t = \alpha X_{t-i} + \varepsilon_t + \beta \varepsilon_{t-i} \quad \ldots (3.21)$$

After obtaining residuals from the equation (3.21) regress the squared error term with a constant and its q lags, described as:

$$\varepsilon_t^2 = \delta_0 + \sum_{i=1}^{q} \delta_i \, \varepsilon_{t-1}^2 + v_t \quad \ldots (3.22)$$

Then it is checking the null hypothesis of absence of ARCH effect up to the q lag order against the alternative hypothesis of the presence of ARCH effect

It is a Lagrange multiplier (LM) test for autoregressive conditional heteroscedasticity (ARCH) in the residuals as given by Engle in 1982 (Asteriou and Hall, 2007; Eviews-5 user guide, pp. 602). Its test statistic is calculated from an auxiliary test regression. We run the regression in order to test whether there is ARCH effect up to order q in the residuals or not:

$$e^2{}_t = \beta_0 + \left(\sum_{s=1}^{q} \beta_s \, e^2{}_{t-s} \right) + v_t \ldots (3.23)$$

where e is the residual with lagged squared residual up to order q. Formulate the null and the alternate hypothesis. The null hypothesis of homoscedasticity is:

$$H_0: \delta_1 = \delta_2 = \cdots = \delta_q = 0$$

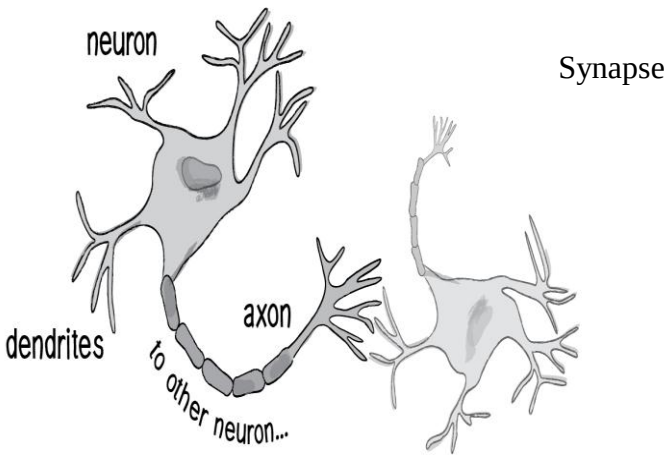
$$H_1: \delta_1 = \delta_2 = \cdots = \delta_q \neq 0$$

If p< α ($\alpha = 0.05$), then hypothesis of No ARCH effect is rejected.

3.6.3. Forecasting Models

Artificial Neural Network (ANN) model. Neural networks are the parallel processing system of the biological nervous system that has the ability to learn and is made up of interconnected elements motivated by the computing performance of the human brain (Hornik, 1989, Bishop, 2005, Dunne, 2007, Rajshekhran and Pai, 2012). These are the abridged limitations of the human nervous system that perform calculations like logical inference, image processing, character recognition, cognition and so on (Mecknelis, 2005, Kamruzzaman et al.2006, Majumder and Hussian, 2007, Rajshekhran and Pai, 2012). So these are called Neural Networks (NN), Artificial Neural System (ANS) or Artificial Neural network (ANN) or Parallel Distributed Processors (PDP). In the human brain, a neuron consists of Soma (Cell body) which is attached to input channels called Dendrites and the output channel called Axon. The Dendrites admits the inputs which are processed by the Soma and the processed data is transferred by the Axon into Stimuli (output) (Sethi and Jain, 1991). The Axon is linked to a gap at the end of the dendrite link called Synaptic junction (Synapse, Figure 3.1) (Rajshekhran and Pai, 2012) which connects it to another neuron.

Figure 3.1- Structure of a Neuron



Model of Artificial Neural network

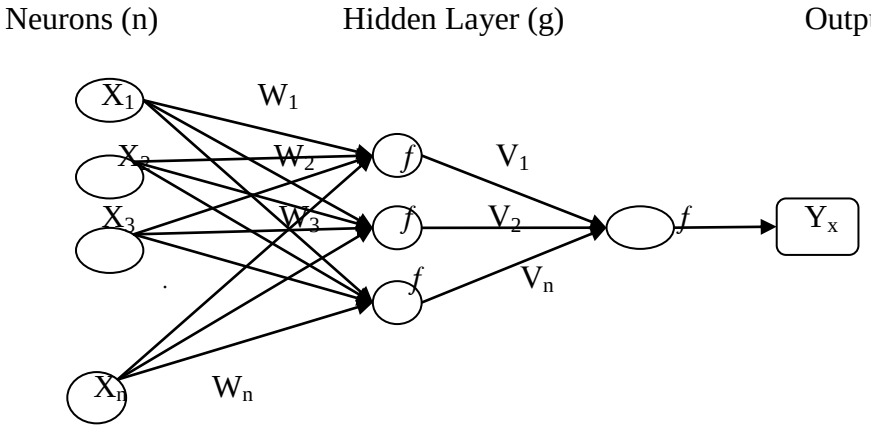
In the ANN model the inputs X_1, X_2, X_3, ..., Xn are transferred through weighted links as depicted in figure 2.2. There is two processing stage one at the hidden node and other at the output node. In the processing stage, the weighted sum of the inputs is calculated and is passed through the mathematical activation function. Multilayered Feed Forward Network (MFNN) is made up of complex artificial neurons which perform three processing functions as shown in figure 2.2. The weights W_1,W_2, W_3…,W_n and V_1, V_2,V_3…,V_n connects the input neuron 'n' to the hidden layer 'g' and the hidden neuron 'g' to the output neuron 'Y' respectively. The information flows from left to the right and the inputs are passed through the hidden layer g to the output layer Y. The relationship between the input and the output depends upon the following equation

$$X = \sum_{i=1}^{n} WiXi$$

$$= W_1X_1+W_2X_2+W_3X_{3+} ...+W_nX_n \quad \textbf{...} \ (3.24)$$

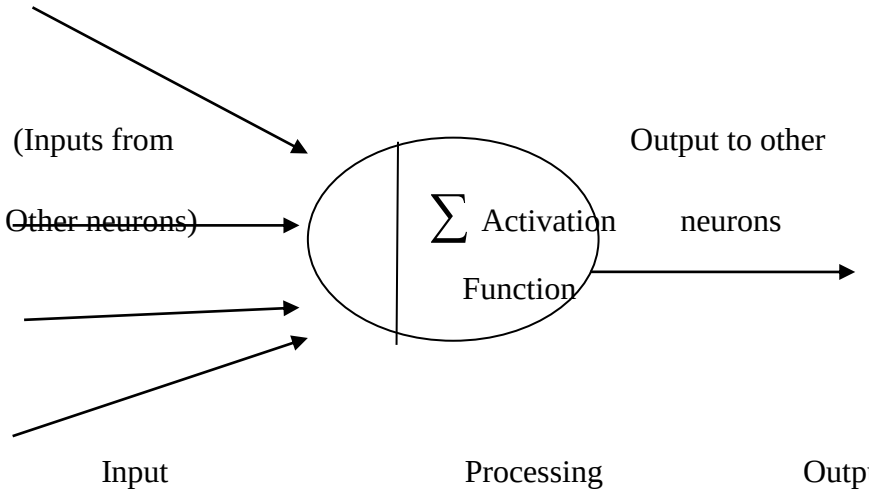
where X_1, X_2,, X_3,...,X_n are the inputs and W_1, W_2, W_3,, ... ,W_n is the weights attached to the input nodes respectively.

Figure 3.2- Artificial Neural Network Architecture



In ANN the activation functions are used for both hidden and the output layers. It gets the inputs from neurons and passes to others after processing (Figure 2.3) depending upon the type of activation function used.

Figure 3.3- Neural Network Processing Stage

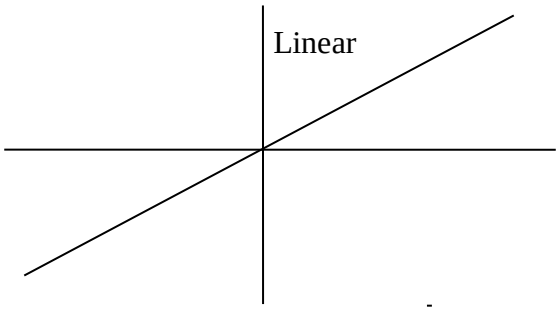


Types of Activation Function- In the case of ANN, in order to get the final output, the weighted sum is passed through a filter called the transfer function or the activation function (Rajshekhran and Pai, 2012) which transforms the output from the input range so that the output may not be too large. The major types of activation functions are:

I) Linear (Identity) function- In this function, the range of the output is between –inf (-∞) and +inf (+∞) as follows:

$$f(x) = x \quad \ldots (3.25)$$

Figure 3.4- Linear Function

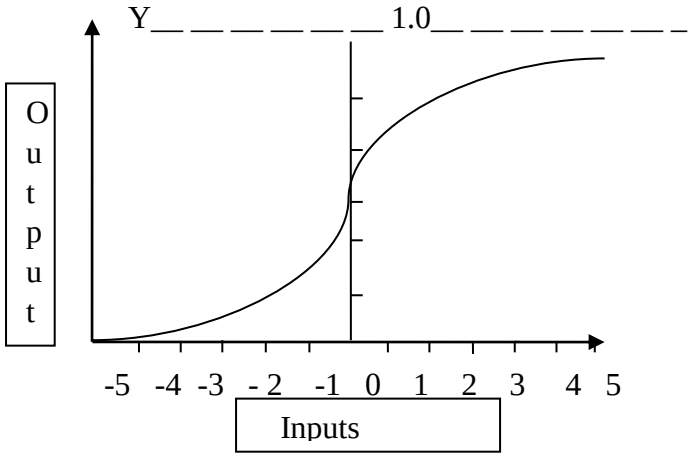


II) Logistic (Sigmoid) Function- This Activation function varies between the values 0 and 1 or -1 and +1 as follows:

$$f(x) = \frac{1}{1+e^{-\alpha}} \ldots (3.26)$$

where α is the slope of the parameter adjusting the brusqueness of the function.

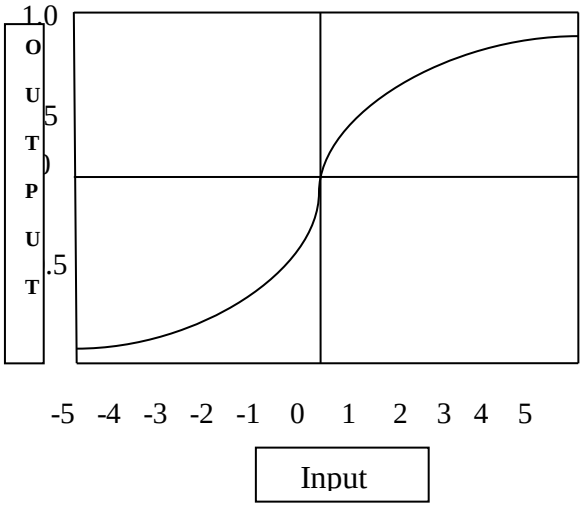
Figure 3.5- Logistic Function



III) Hyperbolic Tangent Function- This function is easily defined as the ratio between the hyperbolic sine and the cosine functions or expanded as the ratio of the half difference and the half sum of two exponentially functions in the points 'x' and '–x '.The output ranges between -1 and +1. The Tanh function is depicted as follows:

$$f(x) = \frac{sinx}{cosx} = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}} \quad \ldots (3.27)$$

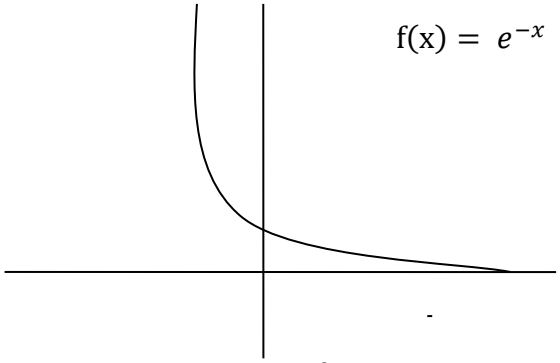
Figure 3.6- Hyperbolic Tangent Function



IV) Exponential function- Exponential function is the negative function which exponentially calculates the value of the inputs ranging between 0 and +inf as

$$f(x) = e^{-x} \quad \ldots (3.28)$$

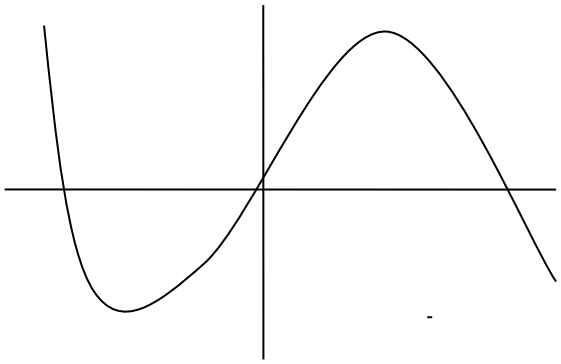
Figure 3.7- Exponential Function



V). Sine function- It is a trigonometric function having the output range between 0 and +1 and is suitable in case of radially-distributed data as depicted in the figure:

$$f(x) = \mathrm{Sin}(x) \quad \ldots (3.29)$$

Figure 3.8- Sine Function



Neural Networks Architecture

Inputs and Outputs- In ANN, the input layer transfers the data to the next layer i.e. hidden layer. Before that, the input data is pre-processed through scaling and being converted to the numerical form (Majumder and Hussian, 2007). The output layer is similar to the input layer with one exception that it transmits the information from the network to the outer world. Beside that, the pre-processing through scaling technique is required to facilitate the proper network learning process in a suitable manner. Data pre-processing is the evaluation and the transformation of the input and output variables to reduce the noise, identifying the trend relationship and flattening the distribution of the variables (Amrendra Kumar). Data can be normalized through scaling in the following ways-

- Rescaling- It is called linear transformation in which the maximum and minimum values of the data is considered with an interval of [0,1] through the following formula:

$$Y' = \frac{Y - \min(Y)}{\max(Y) - \min(y)} \quad \ldots (3.30)$$

- Standardisation- It is called statistical normalization and is mostly used in Support Vector Machines, Neural networks, and logistic regression through the following formula:

$$Y' = \frac{Y - \overline{Y}}{\sigma} \quad \ldots (3.31)$$

- Simple normalization- It is the common form of normalization in which the minimum value of the data is considered. The formula is:

$$Y' = \frac{Y_0}{Y_{max}} \quad \ldots (3.32)$$

Hidden Layer & Number of hidden neurons- The hidden layer and its nodes play an important role in the effective implementation of ANN. In the network, the nodes in the hidden layer help in detecting the pattern of the data in such a way that the input and the output mapping can be performed proficiently. Moreover, one hidden layer is adequate for most of the forecasting problems (Zhang, et al.1998). However increasing the size of the hidden layer will increase the processing power of the network, but it complicates the training process and the errors are difficult to be traced to G B Hua (1996). If there are few neurons in the hidden layer, it can stop the network from mapping the inputs into outputs. Furthermore, too many neurons will lead to the risk of overloading the network (Hamid, 2004). There is no basis to determine the number of hidden units or layers in the network. Though too many hidden units will lead to the risk of overfitting of the data yet the forecasting accuracy can be achieved. Moreover, a number of weights will lengthen the estimating time of the model (Gonzalez, 2000; Gupta and Kashyap, 2015). In our study, we have taken one hidden layer for finding out a suitable network because in literature one hidden layer is sufficient to capture all the information about the data. In NN architecture we have considered only one output node and lagged values of the target variable is taken as inputs (Gupta and Kashyap, 2016).

Learning Rate & Momentum- During the training, the neuron weights are regulated by the correction term called learning rate. The learning time is increased by the small value of the learning rate thereby reducing the chances of getting the optimal solution. Similarly, the large values of the learning rate will lessen the learning time thereby lead to no learning (Panda, C. 2011). The convergence rate is improved by adding the momentum term which helps in remembering the previous corrective term so that the current training process is improved. More emphasis is given to the current correction term than the previous term if there is large momentum value. Similarly, less emphasis is given to the current correction term than the previous term if there is small momentum value. Learning is of two types:

- Supervised learning- In this learning, the correct classification from the data source is assigned first and then the data is trained accordingly. Such techniques are used mostly in Multi-Layer feed forward Perceptron (MLP) models (Rajshekhran and Pai, 2012, Sathya and Abraham, 2013).
- Unsupervised learning- This learning recognizes the pattern class information through the trial and error approach and the system discovers of its own by adjusting to the structural character in the input pattern (Rajshekhran and Pai, 2012).

Backpropagation algorithm- In order to minimize the Sum of Squared Error (SSE), Backpropagation algorithm using steepest gradient technique is used. There are two stages for the application of generalized delta rule to backpropagation. In the 1st stage, in order to produce the output, the input is propagated forwardly and the desired output is compared with the actual output. In the second stage, the weight changes are made after the creation of backward pass so as to minimize the sum of squared error as expected between the actual and the desired output (David E. Rumelhart, et al.1986). In order to reduce the error, the weights W_i are updated in the jth training cycle as per the following expression:

$$\Delta W_i(\mathrm{j}) = -\beta \frac{\partial \lambda}{\partial W_i} + \alpha \Delta W_i (\mathrm{j}-1) \quad \ldots (3.33)$$

where β is the learning rate used to control the speed of the training process and α is the momentum factor.

For neural network modelling, firstly the network is trained. After that, it is tested and validated. There is no agreement on how to divide the data for training, testing and validation. In the literature, most of the researchers have suggested dividing the data as 60:20:10, 70:20:10 or 80:10:10 (Kamruzzaman and Sarker 2003, Haofei Zou et al. 2007 etc.). In our study, we have divided 80 per cent data for training, 10 per cent for testing and 10 per cent for validation purpose respectively because it considers maximum data points for training the ANN model (Gupta and Kashyap, 2015).

Loss Functions- In order to evaluate the models of Forecasting, the popular loss functions considered in the present study are the Sum of Squared Error (SSE), Root Mean Squared Error (RMSE) and Mean Square Error (MSE) (Gupta and Kashyap, 2015). These functions are illustrated as follows:

$$SSE'\lambda' = (Yx - \hat{Y}x)^2 \quad \dots (3.34)$$

$$RMSE = \sqrt{\frac{(Yx - \hat{Y}x)^2}{p}} \quad \dots (3.35)$$

$$MSE = \frac{1}{p}\sum_{x=1}^{p} Yi \quad \dots (3.36)$$

For primary as well as secondary data analyses and the interpretation of the results in consistent with the objectives, various statistical, econometric and artificial intelligence tools and techniques have been employed with the help of software like SPSS, GPower, E-views (Student Version), Statistica (Courtesy NIT, Jalandhar) and Microsoft Excel.

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Analysis of Fundamental and Non-Fundamental Factors: An Empirical Analysis

The present chapter deals with the analysis of data regarding the ability of fundamental and non-fundamental factors to determine exchange rate and importance given by foreign exchange traders to these factors while trading in the foreign exchange market.

4.1 Analysis of Difference in Fundamental and Non-Fundamental Factors Ability to Determine Exchange Rate

Comparison of fundamental factors and non-fundamental factors for predicting exchange rate movements have been investigated by many researchers such as Taylor and Allen (1992), Lui and Mole (1998), Saacke (2002), Gehrig and Menkhoff (2006), Bhanumurthy (2006), Fischer, Isakova and Termechiko (2007). Identification of the usefulness of one factor over another has been the major focus of most of these studies. In order to check whether fundamental factors differ significantly from non-fundamental factors in their ability to determine the exchange rate, following hypotheses were tested.

$H_0$1: *There is no difference between fundamental factors and technical factors in their ability to determine the exchange rate.*

$H_0$2: *There is no difference between fundamental factors and behavioural factors in their ability to determine the exchange rate.*

$H_0$3: *There is no difference between fundamental factors and speculation in their ability to determine the exchange rate.*

To test the hypotheses $H_0$1- $H_0$3, paired sample t-test was performed. The results of paired samples t-tests for the difference between the success rate achieved in foreign exchange trading through fundamental factors and non-fundamental factors have been given in table 4.1 and table 4.2.

Table 4.1: *Paired samples descriptive statistics for difference ability of fundamental and non-fundamental factors to determine the exchange rate.*

		Mean	N	Std. Deviation	Std. Error Mean	Skewness	Kurtosis
$H_0$1	**Fundamental Factors**	6.25	248	1.189	.075	-1.961	.478
	Technical Factors	5.51	248	1.313	.083	-.893	.519
$H_0$2	**Fundamental Factors**	6.25	248	1.189	.075	-1.961	.478
	Behavioural Factors	4.21	248	1.375	.087	-.364	-.423
$H_0$3	**Fundamental Factors**	6.25	248	1.189	.075	-1.961	.478
	Speculation	5.19	248	1.596	.101	-.644	-.186

Table 4.1 shows the descriptive statistics for hypotheses $H_0$1 – $H_0$3 i.e. the mean, the number of participants (N), the standard deviation of the sample and standard error of mean for each condition and pair. A paired sample t-test is a parametric test based on normal distribution; it becomes necessary to ensure that all the assumptions of the test are satisfied. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked. So, before performing the paired sample t-test, it was assured that assumptions of normality of sampling distribution are fairly met and the data are measured on an interval scale.

Skewness values for the difference between the ability of factors vary between -1.961 and -0.364 which is within the acceptable limits of the normal distribution (+/-2). Kurtosis values for the difference between the ability of factors vary between -0.423 and 0.519 which is within the acceptable limits of the normal distribution (+/-2) (Cameron, 2004). So, the distribution can be accepted as fairly normal.

Hypothesis $H_0$1 compares the ability of fundamental and technical factors. Ability to determine the exchange rate through Fundamental factors (M= 6.25, SD= 1.19) found to be greater than through technical factors (M= 5.51, SD= 1.31). Hypothesis $H_0$2 compares the ability of fundamental and behavioural factors. Ability to determine the exchange rate through fundamental factors (M= 6.25, SD= 1.19) found to be greater than through Behavioural factors (M= 4.21, SD= 1.37). Hypothesis $H_0$3 compares the ability of fundamental factors and speculation. Ability to determine exchange rate through Fundamental factors (M= 6.25, SD= 1.19) found to be greater than through speculation (M= 5.19, SD= 1.60). For final confirmation of these results, the difference was checked through pair sample t-test and the same is reported in table 4.2.

Table 4.2: ***Paired samples test for difference ability of fundamental and non-fundamental factors to determine the exchange rate.***

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
$H_0$1	**Fundamental Factors – Technical Factors**	.746	1.651	.105	.540	.952	7.117	247	**.000**
$H_0$2	**Fundamental Factors - Behavioural Factors**	2.044	1.729	.110	1.828	2.261	18.619	247	**.000**
$H_0$3	**Fundamental Factors – Speculation**	1.069	2.174	.138	.797	1.341	7.739	247	**.000**

Table 4.2 shows the results of Paired difference t-test used to analyse the average difference between conditions. The results indicate mean difference, the standard deviation of differences, standard error of differences, confidence interval at 95% level, the value of paired t-test, the degree of freedom and 2-tailed level of significance at 5%.

$H_0$1: There is no difference between fundamental factors and technical factors in their ability to determine the exchange rate.

On average, foreign exchange traders viewed the ability of fundamental factors significantly greater than the ability of technical factors, $t(248) = 7.11$, $p < 0.001$. So, the null hypothesis that there is no difference between fundamental factors and technical factors in their ability to determine exchange rate is rejected.

$H_0$2: There is no difference between fundamental factors and behavioural factors in their ability to determine the exchange rate.

On average, foreign exchange traders viewed success through fundamental factors significantly greater than success through behavioural factors, $t(248) = 18.62$, $p < 0.001$. So, the null hypothesis that there is no difference between fundamental factors and behavioural factors in their ability to determine exchange rate is rejected.

$H_0$3: There is no difference between fundamental factors and speculation in their ability to determine the exchange rate.

On average, foreign exchange traders viewed success through fundamental factors significantly greater than success through speculation, t (248) = 7.74, p < 0.001. This represented a large effect, dz= 0.52. So, the null hypothesis that there is no difference between fundamental factors and speculation in their ability to determine exchange rate is rejected.

4.1.1. Importance of Factors Affecting Foreign Exchange Rate over Different Forecast Horizons

Table 4.3 displays the importance of factors affecting foreign exchange rate over forecast horizons that varies from intraday to more than one year. For the purpose of this study, medium run refers to periods shorter than 6 months and long run refers to periods more than 6 months.

Table 4.3: ***Importance of factors affecting foreign exchange rate over different forecast horizons***

	Intraday	Medium Period			Long period			
Factors	**Intraday**	**1 Week**	**1 Month**	**3 Months**	**6 Months**	**1 Year**	**>1 Year**	**Total**
Fundamental Factors	5 (2.0)	5 (2.0)	5 (2.0)	10 (4.0)	60 (24.2)	131 (52.8)	32 (12.9)	248
Technical Factors	80 (32.3)	111 (44.8)	45 (18.1)	5 (2.0)	4 (1.6)	2 (0.8)	1 (0.4)	248
Behavioural Factors	70 (28.2)	144 (58.1)	27 (10.9)	5 (2.0)	2 (0.8)	0	0	248
Speculation	211 (85.1)	29 (11.7)	5 (2.0)	1 (0.4)	1 (0.4)	0	1 (0.4)	248

For fundamental factors, 52.8 per cent of traders believe that effect of fundamentals is observable over a period of 1 year, the majority (89.9 per cent) of traders believe that effect is from 6 months to more than a year. Technical factor seems to have an effect over a short period as majority 77.1 percent viewed its importance over intraday and 1 week, 44.8 percent of traders believe that importance of technical factors over a time period of 1week. Like technical, importance of behavioural factors also have importance over a short period, as the majority (86.3 percent) of traders believe that its influence ranges from intraday to 1 week. For speculation, 85.1 percent of traders believe that the effect of speculation is over intraday (very short period).

4.2. Analysis of Difference in Success Rate Achieved Though Fundamental and Non-Fundamental Factors

In order to check whether the success rate achieved by foreign exchange traders through fundamental factors differ significantly from the success rate achieved through non-fundamental factors, following hypotheses were tested.

$H_0$4: *There is no difference between the success rate achieved in foreign exchange trading through fundamental factors and technical factors.*

$H_0$5: *There is no difference between the success rate achieved in foreign exchange trading through fundamental factors and behavioural factors.*

$H_0$6: *There is no difference between the success rate achieved in foreign exchange trading through fundamental factors and speculation.*

To test hypotheses $H_0$4- $H_0$6, paired sample t-test was performed. The results of paired samples t-tests for the difference between the success rate achieved in foreign exchange trading through fundamental factors and non-fundamental factors have been given in table 4.4 and table 4.5 respectively.

Table 4.4 shows the descriptive statistics for hypotheses $H_0$4 – $H_0$6 i.e. the mean, the number of participants (N), the standard deviation of the sample and standard error of mean for each condition and pair. A paired sample t-test is a parametric test based on normal distribution, it becomes necessary to ensure that all the assumptions of the test are satisfied. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked. So, before performing the paired sample t-test, it was assured that assumptions of normality of sampling distribution are fairly met and the data are measured on an interval scale.

Table 4.4: ***Paired samples descriptive statistics for the difference in success rate achieved through fundamental and non-fundamental factors.***

		Mean	N	Std. Deviation	Std. Error Mean	Skewness	Kurtosis
$H_0$4	**Success based on Fundamental Factors**	6.35	248	1.055	.067	-1.835	.732
	Success based on Technical Factors	5.38	248	1.260	.080	-.366	-.536
$H_0$5	**Success based on Fundamental Factors**	6.35	248	1.055	.067	-1.835	.732
	Success based on Behavioural Factors	3.54	248	1.411	.090	.114	.407
$H_0$6	**Success based on Fundamental Factors**	6.35	248	1.055	.067	-1.835	.732
	Success based on Speculation	3.61	248	1.767	.112	.396	-.668

Skewness values for the difference between the success of factors vary between -1.835 and 0.114 which show that the distribution is a little negatively skewed but within the acceptable limits of the normal distribution (+/-2). Thus, the distribution can be accepted as fairly normal. Kurtosis values for the difference between the success of factors vary between -0.668 and 0.732 which indicates that the distributions are little leptokurtic and platykurtic but within the acceptable limits of the normal distribution (+/-2) (Cameron, 2004). So, the distribution can be accepted as fairly normal.

Hypothesis $H_0$4 compares the success rate achieved by foreign exchange traders through fundamental and technical factors. Success through Fundamental factors (M=6.35, SD= 1.06) found to be greater than through technical factors (M=5.38, SD= 1.26). Hypothesis $H_0$5 compares the success rate achieved by foreign exchange traders through fundamental and Behavioural factors. Success through Fundamental factors (M=6.35, SD= 1.06) found to be greater than through Behavioural factors (M=3.54, SD= 1.41). Hypothesis $H_0$6 compares the success rate achieved by foreign exchange traders through fundamental and speculation. Success through Fundamental factors (M=6.35, SD= 1.06) found to be greater than through speculation (M=3.61, SD= 1.77). For final confirmation of these results, the difference was checked through pair sample t-test and the same is reported in table 4.5.

Table 4.5: ***Paired samples test for difference in success rate achieved through fundamental and non-fundamental factors***

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
$H_0$5	Success based on Fundamental Factors - Success based on Technical Factors	.976	1.742	.111	.758	1.194	8.820	247	.000
$H_0$6	Success based on Fundamental Factors - Success based on Behavioural Factors	2.810	1.795	.114	2.586	3.035	24.653	247	.000
$H_0$7	Success based on Fundamental Factors - Success based on Speculation	2.746	2.434	.155	2.442	3.050	17.768	247	.000

Table 4.5 shows the results of Paired difference t-test used to analyse the average difference between conditions. The results indicate Mean difference, Standard deviation of differences, Standard error of differences, confidence interval at 95% level, the value of paired t-test, the degree of freedom and 2-tailed level of significance at 5%. The hypotheses results are as follows:

$H_0$4: There is no difference between the success rate achieved in foreign exchange trading through fundamental factors and technical factors.

On average, foreign exchange traders viewed success through fundamental factors significantly greater than success through technical factors, t (248) = 8.82, p< 0.05. So, the null hypothesis that there is no difference between the success rate achieved in foreign exchange trading through fundamental factors and technical factors is rejected.

$H_0$5: There is no difference between the success rate achieved in foreign exchange trading through fundamental factors and behavioural factors.

On average, foreign exchange traders viewed success through fundamental factors significantly greater than success through behavioural factors, t (248) = 24.65, $p < 0.05$. So, the null hypothesis that there is no difference between the success rate achieved in foreign exchange trading through fundamental factors and behavioural factors is rejected.

$H_0$6: There is no difference between the success rate achieved in foreign exchange trading through fundamental factors and speculation.

On average, foreign exchange traders viewed success through fundamental factors significantly greater than success through speculation, t (248) = 17.77, $p< 0.05$. So, the null hypothesis that there is no difference between the success rate achieved in foreign exchange trading through fundamental factors and speculation is rejected.

4.3. Analysis of Difference in the Ability of Fundamental Factors (Constituents) Influence Foreign Exchange Rates

Various constituents of fundamental factors were compared with each other by Lui and Mole (1998) to identify constituents that influence foreign exchange rate significantly higher than others. In order to check whether constituents of fundamental factors differ in their ability to influence foreign exchange rates, following hypotheses were tested.

$H_0$7: *Fundamental factors do not differ significantly in their ability to influence foreign exchange rates*

The results of one way repeated measures ANOVA for the difference in the ability of fundamental factors to influence foreign exchange rates, have been given in table 4.5, table 4.6, table 4.7 and Table 4.8 respectively.

Table 4.5.1: ***Descriptive statistics for constituents of fundamental factors***

Fundamental Factors (Constituents)	Mean	Std. Deviation	N	Sum/ Score	Ranks
Inflation	6.13	1.03	248	1521	3
Interest Rates	6.24	1.05	248	1547	1
Balance of Payment position	4.85	1.33	248	1204	10
Unemployment	4.50	1.36	248	1115	11
Political Stability	5.02	1.28	248	1244	8
GDP	5.77	1.28	248	1430	5
Budget Deficit	5.50	1.21	248	1363	7
Rating by Major CRA	5.71	1.22	248	1417	6
Monetary Policy	6.23	1.03	248	1544	2

Central Bank Intervention	5.90	1.09	248	1462	4
Stock Market Operations	4.97	1.30	248	1233	9

Table 4.5.1 shows the descriptive statistics i.e. the mean, the standard deviation of the sample and the number of participants (N) for various constituents of fundamental factors. Interest rates (M= 6.24, SD= 1.05) and monetary policy rates (M= 6.23, SD= 1.03) received highest score followed by inflation (M= 6.13, SD= 1.03), central bank interventions (M= 5.90, SD= 1.09) and rating by major credit rating agencies (M= 5.71, SD= 1.22). Unemployment (M= 4.50, SD= 1.36) and balance of payment position (M= 4.85, SD= 1.33) received lowest scores followed by stock market operations (M= 4.97, SD= 1.30), political stability (M= 5.02, SD= 1.28) and budget deficit (M= 5.50, SD= 1.21).

Table 4.6: ***Mauchly's test of sphericity for the difference in the ability of fundamental factors to influence the foreign exchange rate.***

Within-Subjects Effect	**Mauchly's W**	**Approx. Chi-Square**	**df**	**Sig.**	**Epsilon[b]**		
					Greenhouse-Geisser	**Huynh-Feldt**	**Lower-bound**
Fundamental Factors	.229	358.616	54	.000	.731	.755	.100

Table 4.6 indicates that to check the assumption of sphericity, Mauchly's test was performed. Mauchly's test is significant ($p < 0.05$) so, the assumption of sphericity has been violated. As the variances of the differences between levels are not equal, two corrections were applied i.e. Greenhouse-Geisser and Huynh-Feldt. Both values of correction, ê (0.73 and 0.76) are closer to 1 rather than lower bound of 0.10. The closer that ê is to 1.00, the more homogeneous are the variances of differences, and hence the closer the data are to being spherical.

Table 4.7: ***Tests of within-subjects effects for the difference in the ability of fundamental factors to influence the foreign exchange rate.***

Source		**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Fundamental Factors	**Sphericity Assumed**	911.068	10	91.107	83.831	.000	.244

	Greenhouse-Geisser	911.068	7.307	124.689	83.831	.000	.244
	Huynh-Feldt	911.068	7.552	120.646	83.831	.000	.244
	Lower-bound	911.068	1.000	911.068	83.831	.000	.244
Error (Fundamental Factors)	**Sphericity Assumed**	2684.386	2470	1.087			
	Greenhouse-Geisser	2684.386	1804.754	1.487			
	Huynh-Feldt	2684.386	1865.238	1.439			
	Lower-bound	2684.386	247.000	10.868			

Table 4.7 shows the results of ANOVA for the within-subject variable. As correction factor was applied to the assumption of sphericity, so, the corrections results (Greenhouse-Geisser and Huynh-Feldt) in the observed F were checked. F-statistic of Greenhouse-Geisser and Huynh-Feldt both are significant, $p < 0.001$.

Table 4.8: ***Multivariate tests for difference in the ability of fundamental factors to influence the foreign exchange rate.***

Effect		**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**	**Partial Eta Squared**
Fundamental Factors	**Pillai's Trace**	.645	43.290[b]	10.000	238.000	.000	.629
	Wilks' Lambda	.355	43.290[b]	10.000	238.000	.000	.629
	Hotelling's Trace	1.819	43.290[b]	10.000	238.000	.000	.629
	Roy's Largest Root	1.819	43.290[b]	10.000	238.000	.000	.629

Multivariate tests shown by table 4.8 confirms the results of table 5.7 as $p < 0.001$. These statistics were checked because the assumption of sphericity is satisfied through the correction factor.

Mauchly's test indicated that the assumption of sphericity had been violated, χ^2 (54) = 358.62, $p < 0.05$, thus the degree of freedom (df) were corrected using Greenhouse-Geisser and Huynh-Feldt estimates of sphericity (ê= 0.73, 0.76). The results show that the ability of fundamental factors to influence foreign exchange rates differs significantly from each other, F (7.30, 1804.75) = 83.83, $p < 0.001$ (Greenhouse-Geisser), F (7.55, 1865.24) = 83.83, $p < 0.001$ (Huynh-Feldt estimates).

4.3.1 Importance of Fundamental Factors Affecting Foreign Exchange Rate over Different Forecast Horizons

Table 4.9 depicts the importance of various constituents of fundamental factors over forecast horizons that vary from intraday to more than a year. Inflation, interest rates credit rating, monetary policy and central bank intervention have influence over foreign exchange rate in short period.

Table 4.9: ***Importance of fundamental factors affecting foreign exchange rate over different forecast horizons.***

	Intraday	Medium Period			Long Period			
Fundamental Factors	**Intraday**	**1 Week**	**1 Month**	**3 Months**	**6 Months**	**1 Year**	**>1 Year**	**Total**
Inflation	8 (3.1)	48 (18.5)	120 (46.2)	58 (22.3)	10 (3.8)	14 (5.4)	2 (0.8)	248
Interest Rates	41 (15.8)	113 (43.5)	69 (26.5)	26 (10)	9 (3.5)	1 (0.4)	1 (0.4)	248
BOP Position	5 (1.9)	9 (3.5)	28 (10.8)	91 (35)	78 (30)	35 (13.5)	14 (5.4)	248
Unemployment	5 (1.9)	3 (1.2)	12 (4.6)	82 (31.5)	97 (37.3)	39 (15)	22 (8.5)	248
Political Stability	2 (0.8)	4 (1.5)	16 (6.2)	64 (24.6)	89 (34.2)	63 (24.2)	22 (8.5)	248
GDP	0	5 (1.9)	15 (5.8)	33 (12.7)	76 (29.2)	91 (35)	40 (15.4)	248
Budget Deficit	3 (1.2)	5 (1.9)	13 (5)	40 (15.4)	84 (32.3)	89 (34.2)	26 (10)	248
Credit Rating	7 (2.7)	25 (9.6)	107 (41.2)	56 (21.5)	36 (13.8)	22 (8.5)	7 (2.7)	248
Monetary Policy	11 (4.2)	54 (20.8)	115 (44.2)	56 (21.5)	17 (6.5)	7 (2.7)	0	248
Central Bank Intervention	6 (2.3)	42 (16.2)	98 (37.7)	89 (34.2)	19 (7.3)	5 (1.9)	1 (4)	248
Stock Market Operations	11 (4.2)	8 (3.1)	39 (15)	92 (35.4)	87 (33.5)	19 (7.3)	4 (1.5)	248

Fundamental factors that have influence over the long run are GDP and budget deficit. BOP position, unemployment, political stability and stock market operations have influenced both in medium and long run primarily from 3 months to a year. Inflation, interest rates, credit rating, monetary policy and central bank interventions found to have relatively important in the medium period (1 week to 3 months).

4.4 Analysis of Difference in the Ability of Technical Factors (Trading Techniques) to Predict Turning Points in Foreign Exchange Rates.

Review of literature revealed that the ability of technical analysis in predicting turning points differ from one technical analysis technique to another. Lee, Pan and Liu (2001), found that moving averages significantly dominates prediction of turning points in the foreign exchange market. In order to check whether technical factors (trading techniques) factors differ in their ability to predict turning points in foreign exchange rates, following hypotheses were tested.

$H_0$8: *Technical factors (trading techniques) do not differ significantly in their ability to predict turning points in foreign exchange rates.*

The results of one way repeated measures ANOVA for the difference in the ability of technical factors to predict turning points in foreign exchange rates, have been given in table 4.10, table 4.11, table 4.12 and table 4.13 respectively.

Table 4.10: ***Descriptive statistics for technical factors ability to predict turning points in foreign exchange rates.***

Technical Trading Techniques	Mean	Std. Deviation	N
Filters	3.76	1.294	197
Moving Averages	5.59	1.024	197
Channel Rule	4.31	1.102	197
Fibonacci Retracement	4.54	1.163	197
Candlesticks	5.39	1.267	197
Relative Strength Indicator	6.04	1.061	197
Stochastic	6.15	1.110	197
The rate of Change Indicator	6.21	1.130	197
William %R	6.10	1.223	197
Moving Average Convergence Divergence	6.21	.998	197
Bollinger Bands	6.04	1.029	197
Average Directional Movement Index	5.53	1.095	197
Neural Networks	5.22	1.257	197

Table 4.10 shows the descriptive statistics i.e. the mean, the standard deviation of the sample and the number of participants (N) for various constituents of technical factors. Rate of Change Indicator (M= 6.21, SD= 1.13) and Moving Average Convergence Divergence (M= 6.21, SD= 0.98) received highest score followed by Stochastic (M=

6.15, SD= 1.11), William %R (M= 6.10, SD= 1.22), Bollinger Bands (M= 6.04, SD= 1.03) and Relative Strength Indicator (M= 6.04, SD= 1.06). Filters (M= 3.76, SD= 1.29) and Channel Rule (M= 4.31, SD= 1.10) received lowest scores followed by Fibonacci Retracement (M= 4.54, SD= 1.16), Neural Networks (M= 5.22, SD= 1.26), Candlesticks (M= 5.39, SD= 1.27), Average Directional Movement Index (M= 5.53, SD= 1.09) and Moving Averages (M= 5.59, SD= 1.02).

Table 4.11: ***Mauchly's test of sphericity for the difference in the ability of technical factors to predict turning points in foreign exchange rates.***

Within-Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Technical Factors: Turning Points	.018	766.315	77	.000	.524	.543	.083

Table 4.11 indicates that to check the assumption of sphericity, Mauchly's test was performed. Mauchly's test is significant ($p < 0.05$) so, the assumption of sphericity has been violated. As the variances of the differences between levels are not equal, two corrections were applied i.e. Greenhouse-Geisser and Huynh-Feldt. Both values of correction, ê (0.52 and 0.54) are closer to 1 rather than lower bound of 0.08. The closer that ê is to 1.00, the more homogeneous are the variances of differences, and hence the closer the data are to being spherical.

Table 4.12: ***Tests of within-subject's effects for the difference in the ability of technical factors to predict turning points in foreign exchange rates***

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.
Technical Factors: Turning Points	Sphericity Assumed	1544.705	12	128.725	134.190	.000
	Greenhouse-Geisser	1544.705	6.285	245.766	134.190	.000
	Huynh-Feldt	1544.705	6.516	237.060	134.190	.000
	Lower-bound	1544.705	1.000	1544.705	134.190	.000
Error (Technical Factors: Turning	Sphericity Assumed	2256.218	2352	.959		
	Greenhouse-Geisser	2256.218	1231.914	1.831		

Points)	**Huynh-Feldt**	2256.218	1277.154	1.767		
	Lower-bound	2256.218	196.000	11.511		

Table 4.12 shows the results of ANOVA for the within-subject variable. As correction factor was applied to the assumption of sphericity, so, the corrections results (Greenhouse-Geisser and Huynh-Feldt) in the observed F were checked. F-statistic of Greenhouse-Geisser and Huynh-Feldt both are significant, $p < 0.001$.

Table 4.13: ***Multivariate Tests for the difference in the ability of technical factors to predict turning points in foreign exchange rates.***

Effect		**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**
Technical Factors Turning Points	**Pillai's Trace**	.782	55.360	12.000	185.000	.000
	Wilks' Lambda	.218	55.360	12.000	185.000	.000
	Hotelling's Trace	3.591	55.360	12.000	185.000	.000
	Roy's Largest Root	3.591	55.360	12.000	185.000	.000

Multivariate tests shown by table 4.13 confirms the results of table 4.12 as $p < 0.001$. These statistics were checked because the assumption of sphericity is satisfied through the correction factor.

Mauchly's test indicated that the assumption of sphericity had been violated, χ^2 (77) = 766.31, $p < 0.05$, thus the degree of freedom (df) were corrected using Greenhouse-Geisser and Huynh-Feldt estimates of sphericity (ê= 0.52, 0.54). The results show that the ability of technical factors to predict turning points in foreign exchange market differs significantly from each other, F (6.28, 1231.91) = 134.19, $p < 0.001$ (Greenhouse-Geisser), F (6.51, 1277.15) = 134.19, $p < 0.001$ (Huynh-Feldt estimates).

4.5 Analysis of Difference in the Ability of Technical Factors (Trading Techniques) to Predict Trends in Foreign Exchange Rates

In order to check whether technical factors (trading techniques) differs in their ability to predict in foreign exchange rates, following hypotheses were tested.

$H_0$9: *Technical factors (trading techniques) do not differ significantly in their ability to predict the trend in foreign exchange rates.*

The results of one way repeated measures ANOVA for the difference in the ability of technical factors to predict trends in foreign exchange rates, have been given in table 4.14, table 4.15, table 4.16 and table 4.17 respectively.

Table 4.14: ***Descriptive statistics for technical factors ability to predict the trend in foreign exchange rates.***

Technical Trading Techniques	Mean	Std. Deviation	N
Filters	3.65	1.306	197
Moving Averages	5.98	1.176	197
Channel Rule	4.26	1.378	197
Fibonacci Retracement	4.35	1.334	197
Candlesticks	4.81	1.274	197
Relative Strength Indicator	5.13	1.336	197
Stochastic	5.15	1.334	197
Rate of Change Indicator	5.02	1.396	197
William %R	5.10	1.336	197
Moving Average Convergence Divergence	5.05	1.422	197
Bollinger Bands	5.31	1.422	197
Average Directional Movement Index	6.21	1.356	197
Neural Networks	5.35	1.461	197

Table 4.14 shows the descriptive statistics i.e. the mean, the standard deviation of the sample and the number of participants (N) for various constituents of technical factors. Average Directional Movement Index (M= 6.21, SD= 1.36) and Moving Averages (M= 5.98, SD= 1.18) received highest score followed by Neural Networks (M= 5.35, SD= 1.46), Bollinger Bands (M= 5.31, SD= 1.42), Stochastic (M= 5.15, SD= 1.33), Relative Strength Indicator (M= 5.13, SD= 1.33) and William %R (M= 5.10, SD= 1.34). Filters (M= 3.65, SD= 1.30) and Channel Rule (M= 4.26, SD= 1.39) received lowest scores followed by Fibonacci Retracement (M= 4.35, SD= 1.33), Candlesticks (M= 4.81, SD= 1.27), Rate of Change Indicator (M= 5.02, SD= 1.40) and Moving Average Convergence Divergence (M= 5.05, SD= 1.42).

Table 4.15: ***Mauchly's test of sphericity for the difference in the ability of technical factors to predict trends in the foreign exchange market.***

Within-Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Technical Factors Trends	.024	714.755	77	.000	.568	.591	.083

Table 4.15 indicates that to check the assumption of sphericity, Mauchly's test was performed. Mauchly's test is significant ($p<0.05$) so, the assumption of sphericity has been violated. As the variances of the differences between levels are not equal, two corrections were applied i.e. Greenhouse-Geisser and Huynh-Feldt. Both values of correction, ê (0.57 and 0.59) are closer to 1 rather than lower bound of 0.08. The closer that ê is to 1.00, the more homogeneous are the variances of differences, and hence the closer the data are to being spherical.

Table 4.16: ***Tests of within-subject's effects for the difference in the ability of technical factors to predict trends in the foreign exchange market.***

Source		Type III Sum of Squares	Df	Mean Square	F	Sig.
Technical Factors Trends	Sphericity Assumed	1082.137	12	90.178	97.279	.000
	Greenhouse-Geisser	1082.137	6.816	158.769	97.279	.000
	Huynh-Feldt	1082.137	7.087	152.697	97.279	.000
	Lower-bound	1082.137	1.000	1082.137	97.279	.000
Error (Technical Factors Trends)	Sphericity Assumed	2180.324	2352	.927		
	Greenhouse-Geisser	2180.324	1335.898	1.632		
	Huynh-Feldt	2180.324	1389.016	1.570		
	Lower-bound	2180.324	196.000	11.124		

Table 4.16 shows the results of ANOVA for the within-subject variable. As correction factor was applied to the assumption of sphericity, so, the corrections results (Greenhouse-Geisser and Huynh-Feldt) in the observed F were checked. F-statistic of Greenhouse-Geisser and Huynh-Feldt both are significant, $p < 0.001$.

Table 4.17: ***Multivariate tests for difference in the ability of technical factors to predict trends in the foreign exchange market.***

Effect		Value	F	Hypothesis df	Error df	Sig.
Technical Factors Trends	Pillai's Trace	.783	55.631[b]	12.000	185.000	.000
	Wilks' Lambda	.217	55.631[b]	12.000	185.000	.000
	Hotelling's Trace	3.608	55.631[b]	12.000	185.000	.000
	Roy's Largest Root	3.608	55.631[b]	12.000	185.000	.000

Multivariate tests shown by table 4.17 confirms the results of table 5.16 as $p < 0.001$. These statistics were checked because the assumption of sphericity is satisfied through the correction factor.

Mauchly's test indicated that the assumption of sphericity had been violated, χ^2 (77) = 714.75, $p < 0.05$, thus the degree of freedom (df) were corrected using Greenhouse-Geisser and Huynh-Feldt estimates of sphericity (ê= 0.57, 0.59). The results show that the ability of technical factors to predict trends in foreign exchange market differs significantly from each other, F (6.81, 1335.90) = 97.28, $p < 0.001$ (Greenhouse-Geisser), F (7.09, 1389.02) = 97.30, $p < 0.001$ (Huynh-Feldt estimates).

4.5.1: Predictability of Market Trend Over Different Time Horizons

Figure 4.1 shows the predictability of market trend over different time horizon for three categories of foreign exchange traders i.e. dealers, brokers and investors. For dealers' predictability increases with increase in the time period, as predictability over the long run (6 months and more) is higher than short run (less than 6 months) and intraday. Broker/sub-brokers and investors showed a similar pattern for predictability of market trend. For both the group intraday and short-run predictability is higher than long-run predictability. This indicates that brokers and investors have opposite views for predictability of market trend.

Figure 4.1: Predictability of market trend over different time horizons

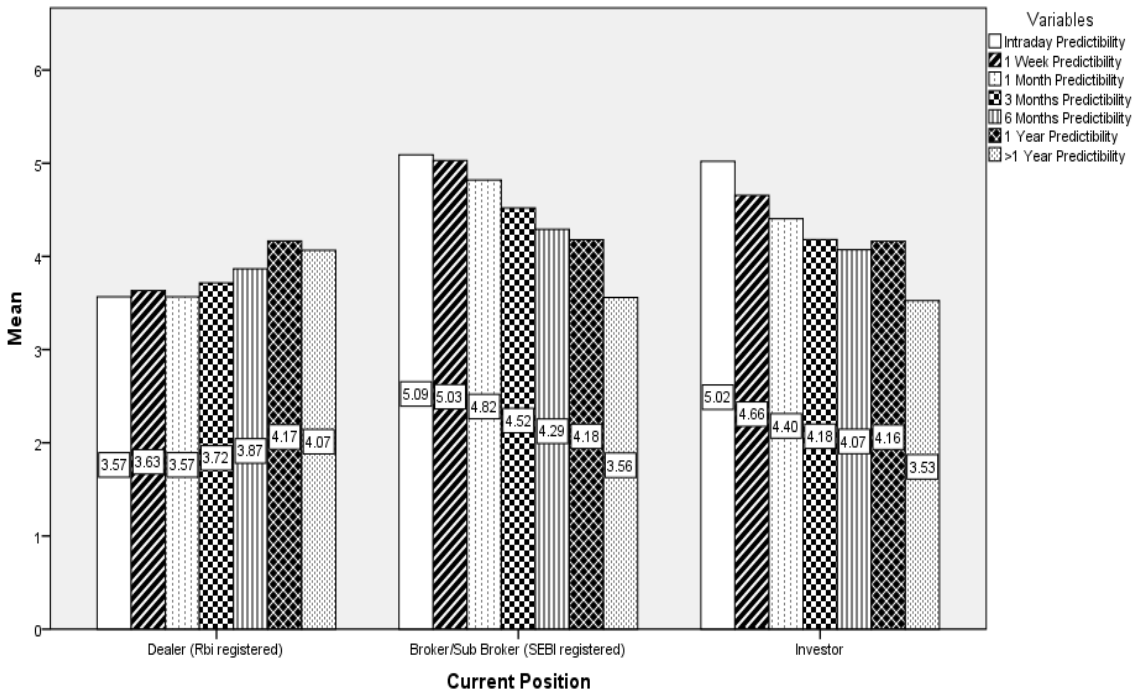
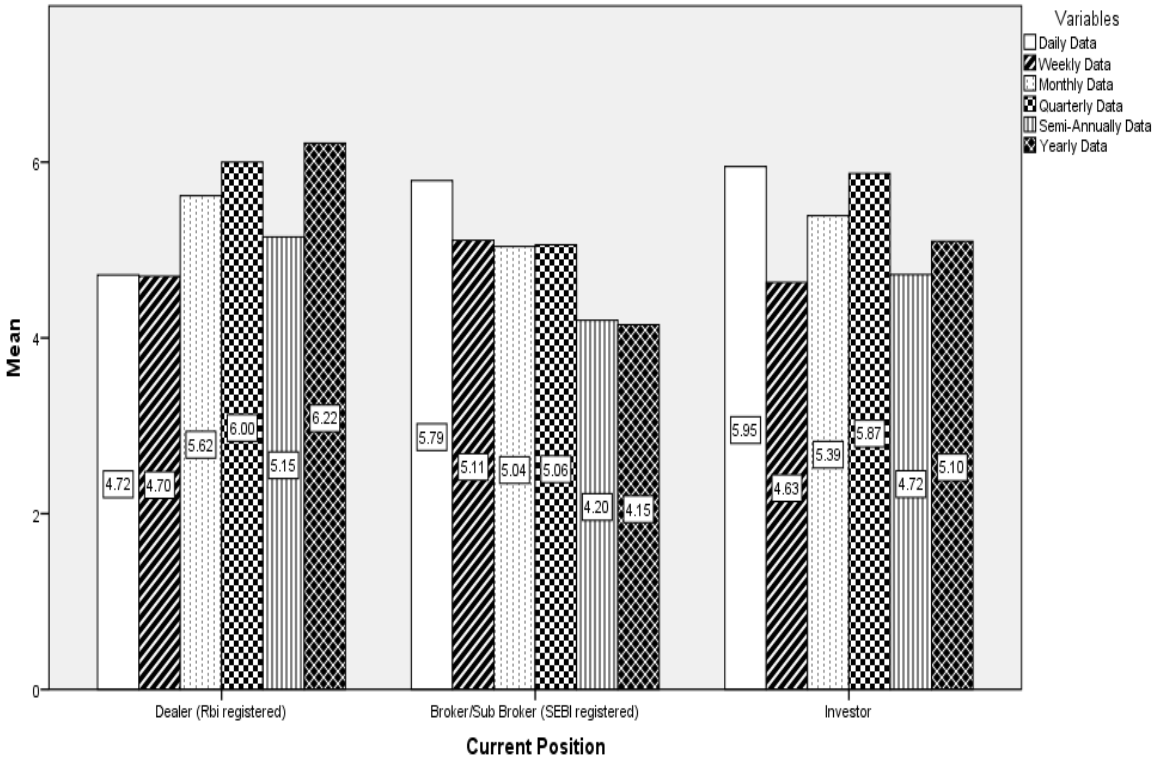


Figure 4.2: Importance of data in predicting trends



4.5.2 Importance of Data in Predicting Trends:

Figure 4.2 shows (mean value after round off) importance of data over different time horizon for prediction of market trend for three categories of foreign exchange traders i.e. dealers, brokers and investors. Dealers rely more on monthly, quarterly and yearly data for prediction of trends in the foreign exchange market. Brokers' preference for data for prediction of the market trend was quite different from dealers, as they preferred daily data followed by weekly, monthly and quarterly. Investor showed high reliance on intraday and quarterly data. Therefore, the importance of data for the prediction of the market trend is different for different category of traders. Dealers preferred long-run data, whereas brokers/sub-brokers showed a high preference for daily data. Investors rely on both daily and long-run data.

4.6 ANALYSIS OF DIFFERENCE IN THE ABILITY OF BEHAVIOURAL FACTORS TO INFLUENCE FOREIGN EXCHANGE TRADING DECISIONS OF TRADERS

Behavioural factors identified from literature includes bandwagon effect, over-reaction to news, market judgements, peer & social influences and rumours. Osterberg and Humes (1993) found that incorrect news and rumours play a substantial role in the foreign exchange market. Allport & Postman (1947) and Rosnow (1991), concluded that importance of the events and amount of doubt involved in the matter increase the occurrences of rumours. In order to check whether the behavioural factors differ in their ability to influence foreign exchange trading decisions of traders, following hypotheses were tested:

$H_0$10: *Behavioural factors do not differ significantly in their ability to influence foreign exchange trading decisions of traders.*

The results of one way repeated measures ANOVA for the difference in the ability of behavioural factors to influence foreign exchange trading decisions of traders, have been given in table 4.18, table 4.19, table 4.20 and table 4.21 respectively.

Table 4.18: ***Descriptive statistics for behavioural factors ability to influence foreign exchange trading decisions of traders.***

	Mean	Std. Deviation	N
Bandwagon Effects	4.04	1.60	248
Over-reaction to News	4.68	1.56	248
Market Judgements	4.28	1.39	248
Peer and Social Influences	4.04	1.48	248
Rumors	4.61	1.72	248

Table 4.18 shows the descriptive statistics i.e. the mean, the standard deviation of the sample and the number of participants (N) for various constituents of behavioural factors. Over-reaction to news (M= 4.68, SD= 1.56) received highest score followed by Rumors (M= 4.61, SD= 1.72), Market Judgements (M= 4.28, SD= 1.39), Bandwagon Effects (M= 4.04, SD=1.60) and Peer and Social Influences (M= 4.04, SD= 1.48).

Table 4.19: ***Mauchly's test of sphericity for the difference in the ability of behavioural factors to influence foreign exchange trading decisions of traders.***

Within-Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Behavioural Factors	.762	66.507	9	.000	.877	.891	.250

Table 4.19 indicates that to check the assumption of sphericity, Mauchly's test was performed. Mauchly's test is significant ($p<0.05$) so, the assumption of sphericity has been violated. As the variances of the differences between levels are not equal, two corrections were applied i.e. Greenhouse-Geisser and Huynh-Feldt. Both values of correction, ê (0.87 and 0.89) are closer to 1 rather than lower bound of 0.25. The closer that ê is to 1.00, the more homogeneous are the variances of differences, and hence the closer the data are to being spherical.

Table 4.20: ***Tests of within-subject's effects for the difference in the ability of behavioural factors to influence foreign exchange trading decisions of traders.***

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Behavioural Factors	**Sphericity Assumed**	92.604	4	23.151	15.977	.000
	Greenhouse-Geisser	92.604	3.509	26.391	15.977	.000

	Huynh-Feldt	92.604	3.566	25.969	15.977	.000
	Lower-bound	92.604	1.000	92.604	15.977	.000
Error (Behavioural Factors)	**Sphericity Assumed**	1425.796	984	1.449		
	Greenhouse-Geisser	1425.796	863.201	1.652		
	Huynh-Feldt	1425.796	877.222	1.625		
	Lower-bound	1425.796	246.000	5.796		

Table 4.20 shows the results of ANOVA for the within-subject variable. As correction factor was applied to the assumption of sphericity, so, the corrections results (Greenhouse-Geisser and Huynh-Feldt) in the observed F were checked. F-statistic of Greenhouse-Geisser and Huynh-Feldt both are significant, $p < 0.001$.

Table 4.21: ***Multivariate tests for difference in the ability of behavioural factors to influence foreign exchange trading decisions of traders.***

Effect		**Value**	**F**	**Hypothesis df**	**Error df**	**Sig.**
Behavioural Factors	**Pillai's Trace**	.240	19.133	4.000	243.000	.000
	Wilks' Lambda	.760	19.133	4.000	243.000	.000
	Hotelling's Trace	.315	19.133	4.000	243.000	.000
	Roy's Largest Root	.315	19.133	4.000	243.000	.000

Multivariate tests shown by table 4.21 confirms the results of table 5.20 as $p < 0.001$. These statistics were checked because the assumption of sphericity is satisfied through the correction factor.

Mauchly's test indicated that the assumption of sphericity had been violated, χ^2 (9) = 66.51, $p < 0.05$, thus the degree of freedom (df) were corrected using Greenhouse-Geisser and Huynh-Feldt estimates of sphericity (ê= 0.87, 0.89). The results show that the ability of behavioural factors to predict trends in foreign exchange market differs significantly from each other, F (3.51, 863.20) = 15.98, $p < 0.001$ (Greenhouse-Geisser), F (3.57, 863.20) = 15.98, $p < 0.001$ (Huynh-Feldt estimates).

4.7 Analysis of Difference in the Views of Foreign Exchange Traders Regarding Effect of Speculation on Increase in Exchange Rate Volatility

Cheung and Wong (2000), from their study, reported that perceived to increase market volatility. In order to check whether the views of traders regarding the effect of

speculation on increase in exchange rate volatility differ significantly from each other, following hypotheses were tested:

$H_0$11: *Foreign exchange traders do not differ significantly in their views regarding the effect of speculation on increase in exchange rate volatility.*

The results of Kruskal-Wallis test for the difference in the views of foreign exchange traders regarding the effect of speculation on increase in exchange rate volatility have been given in table 4.22, table 4.23, table 4.24 and table 4.25 respectively.

Table 4.22: ***Descriptive statistics for the views of foreign exchange traders regarding the effect of speculation on increase in exchange rate volatility.***

Traders	Mean	Std. Deviation	N	Skewness	Kurtosis
Dealer (RBI Registered)	5.93	1.40	58	-1.30	.887
Broker/ Sub Broker (SEBI Registered)	6.45	1.18	94	-2.86	9.14
Investor	6.62	.77	95	-3.01	12.93
Total	6.39	1.14	260		

Table 4.22 shows the descriptive statistics for hypotheses $H_0$11 i.e. the mean, the number of participants (N), the standard deviation of the sample and standard error of mean for each condition and pair. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked.

Skewness values vary between -3.01 and -1.30 which shows that the distributions are outside the acceptable limits of the normal distribution (+/-2). Thus, the distribution is not normal. Kurtosis values vary between 0.887 and 12.93 which are outside the acceptable limits of the normal distribution (+/-2) (Cameron, 2004). So, the distribution of data across three groups violated the assumption of normality for one-way independent ANOVA. As data does not satisfy normality assumption of one-way independent ANOVA, the hypothesis has been tested with Kruskal-Wallis test (H).

Hypothesis $H_0$11 compares views of foreign exchange traders regarding the effect of speculation on increase in exchange rate volatility. Combined mean (M= 6.39, SD= 1.14) is on the higher end of the 7-point scale, which means all traders viewed that speculation increases exchange rate volatility. As mean for all categories of traders, dealer group (M=

5.93, SD= 1.40), broker/sub-broker group (M= 6.45, SD= 1.18) and Investor group (M=6.62, SD= 0.77) is greater than the median of scale (4), which shows that all traders strongly agreed that speculation highly influences exchange rate volatility. For final confirmation of these results, the difference between their views was checked through the Kruskal-Wallis test and the same is reported in table 5.23.

Table 4.23: ***Kruskal Wallis test statistics for views of foreign exchange traders regarding the effect of speculation on increase in exchange rate volatility.***

Chi-square			13.460
df			2
Asymp. Sig.			.001
Monte Carlo Sig.	.001[a]		.000[a]
	.000	Lower Bound	.000
		Upper Bound	.001
a. Based on 10000 sampled tables with starting seed 2000000			

Table 4.23 shows the results of the Kruskal Wallis Test. Monte Carlo estimate of significance is significant (two-tailed), $p < 0.001$. So, there is a significant difference in the views of foreign exchange traders regarding the effect of speculation on increase in exchange rate volatility. To see which group differs Mann-Whitney tests with Bonferroni correction was conducted on groups. The results of the Mann-Whitney test are reported in table 4.24 and table 4.25.

Table 4.24: ***Ranks for the dealer and broker/sub-broker group regarding the effect of speculation on increase in exchange rate volatility.***

CBI result in Profit for Chartists	Current Position	N	Mean Rank	Sum of Ranks
Dealer and Broker/ Sub Broker Group	Dealer (RBI registered)	58	65.13	3777.50
	Broker/Sub Broker (SEBI registered)	94	83.52	7850.50
	Total	152		
Dealer and Investor	Dealer (RBI registered)	58	63.67	3693.00
	Investor	95	85.14	8088.00
	Total	153		
Broker/ Sub Broker Group and Investor	Broker/Sub Broker (SEBI registered)	94	93.94	8830.00
	Investor	95	96.05	9125.00
	Total	189		

Table 4.24 shows summarized data for Dealer and Broker/ Sub Broker group after they have been ranked. The investor group has the highest mean rank (85.14 and 96.05) than the dealer (63.67) and broker/sub-broker group (93.94) which means that it has a greater number of high scores within it. However, to see whether mean ranks for these groups are significantly different from each other, Mann-Whitney test (*U*) was applied.

Table 4.25: ***Mann-Whitney tests statistics for the difference in the views of traders regarding the effect of speculation on increase in exchange rate volatility.***

CBI result in Profit for Chartists			Dealer and Broker/Sub Broker Group	Dealer and Investor Group	Broker/Sub Broker and Investor Group
Mann-Whitney U			2066.500	1982.000	4365.000
Wilcoxon W			3777.500	3693.000	8830.000
Z			-2.934	-3.423	-.344
Asymp. Sig. (2-tailed)			.003	.001	.731
Monte Carlo Sig. (2-tailed)	.003[b]		.001[b]	.728[b]	.889[a]
	.002	.000	.717	.000	.880
	.005	.002	.739	.001	.897
a. Based on 10000 sampled tables with starting seed			926214481	11314643744	624387341

Table 4.25 provides test statistics for the Mann-Whitney test, the Wilcoxon procedure and the corresponding z-score. As Bonferroni correction has been applied, the critical level of significance used for three comparisons was 0.05/3 = 0.0167. The Mann-Whitney test is significant (two-tailed), $p < 0.001$ for Dealer and Broker/Sub Broker group & dealer group and Investor Group. So, dealer group differs significantly from broker/sub broker and investor group regarding the effect of speculation on increase in exchange rate volatility. The Mann-Whitney test is non-significant (two-tailed), $p > 0.0167$ for broker/sub-broker group. Thus, there is no significant difference in the views of broker/sub-broker group and investor group regarding the effect of speculation on increase in exchange rate volatility.

The results show that the views of foreign exchange traders regarding the effect of speculation on increase in exchange rate volatility, differs significantly from each other, $H(2) = 13.46$, $p < 0.001$. Mann-Whitney tests were used to follow up this finding. A Bonferroni correction was applied, so all results are reported at a 0.0167 level of significance. It appeared that Broker/Sub Broker views regarding the effect of speculation

on increase in exchange rate volatility were significantly higher than dealer group (U= 2066.50, $p < 0.001$). Investor views regarding the effect of speculation on increase in exchange rate volatility were significantly higher than dealer group (U= 1982, $p < 0.001$). However, no significant difference was found in the views of broker/sub-broker group and investor group (U= 4365, $p > 0.0167$).

4.8 Analysis of Difference in the Views of Foreign Exchange Traders Regarding Effect of Speculation on Movement of Exchange Rate Away from their Fundamental Levels

Cheung and Chinn (2001), Fischer, Isakova and Termechiko (2007), tried to extract the influence of speculation on fundamental levels of the exchange rate. In order to check whether traders differ in their views that the speculation results in movement of exchange rate away from their fundamental levels, following hypotheses were tested:

$H_0$12: *Foreign exchange traders do not differ significantly in their views regarding the effect of speculation on the movement of exchange rate away from their fundamental levels.*

The results of one-way ANOVA for the difference in the views of foreign exchange traders regarding the effect of speculation on the movement of exchange rate away from their fundamental levels have been given in table 4.26, table 4.27, table 4.28 and table 4.29 respectively.

Table 4.26: ***Descriptive Statistics for the views of foreign exchange traders regarding the effect of speculation on the movement of exchange rate away from their fundamental levels.***

Traders	Mean	Std. Deviation	N	Skewness	Kurtosis
Dealer (RBI Registered)	5.17	1.666	58	-.745	-.114
Broker/ Sub Broker (SEBI Registered)	5.10	1.489	94	-.578	-.194
Investor	5.67	1.380	95	-1.227	1.357
Total	5.34	1.510	247		

Table 4.26 shows the descriptive statistics for hypotheses $H_0$12 i.e. the mean, the number of participants (N), the standard deviation of the sample, standard error of mean,

skewness and kurtosis for the group. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked.

Skewness values vary between -1.23 and -0.75, which shows that the distributions are within the acceptable limits of the normal distribution (+/-2). The values of kurtosis vary between -0.19 and 1.360.53 which is within the acceptable limits of the normal distribution (+/-2) (Cameron, 2004). So, the distribution of data across three groups satisfied the assumption of normality for one-way independent ANOVA. As data satisfy normality assumption, the hypothesis has been tested with one-way independent ANOVA.

Hypothesis $H_0$12 compares views regarding the effect of speculation on the movement of exchange rate away from their fundamental levels. Combined mean (M= 5.34, SD= 1.51) is close to median (4) of a 7-point scale, which means all traders viewed that speculation moves exchange rate away from their fundamental levels but the effect is not highly influential. Dealer group (M= 5.17, SD= 1.66), Investor group (M= 5.67, SD= 1.38) and Broker/sub-broker group (M= 5.10, SD= 1.50) agreed that speculation moves exchange rate away from their fundamental levels. To see whether views of trades differ from each other, the difference between their views was checked through one-way independent ANOVA and the same is reported in table 4.28.

Table 4.27: ***Test of Homogeneity of Variances for the views of foreign exchange traders regarding the effect of speculation on the movement of exchange rate away from their fundamental levels.***

Levene Statistic	df1	df2	Sig.
1.784	2	244	.170

Another assumption of one-way independent ANOVA is that the variances of groups being compared should be equal. Table 5.27 shows the result of Levene's test which tests the null hypothesis that the variances of the groups are the same. Levene test is significant, p > .05, so we can say that the variances of groups are equal.

Table 4.28: ***ANOVA for the views of foreign exchange traders regarding the effect of speculation on the movement of exchange rate away from their fundamental.***

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	17.811	2	8.905	4.000	**.020**
Within Groups	543.298	244	2.227		
Total	561.109	246			

Table 4.28 depicts that F-ratio estimate of combined between-group effect is significant (two-tailed), $p<0.05$. So, there is a significant difference in the views of foreign exchange traders regarding the effect of speculation on the movement of exchange rate away from their fundamental levels. To see which groups differ from the other one post-hoc contrast (Tukey HSD) test was conducted on groups.

Table 4.29: ***Tukey HSD tests for the views of foreign exchange traders regarding the effect of speculation on the movement of exchange rate away from their fundamental levels.***

	(I) Current Position	(J) Current Position	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	Dealer (Rbi registered)	Broker/Sub Broker (SEBI registered)	.077	.249	.949	-.51	.66
		Investor	-.501	.249	.111	-1.09	.09
	Broker/Sub Broker (SEBI registered)	Dealer (Rbi registered)	-.077	.249	.949	-.66	.51
		Investor	-.578*	.217	**.022**	-1.09	-.07
	Investor	Dealer (Rbi registered)	.501	.249	.111	-.09	1.09
		Broker/Sub Broker (SEBI registered)	.578*	.217	**.022**	.07	1.09
*. The mean difference is significant at the 0.05 level.							

Table 4.29 gives the statistics for Tukey HSD contrast. Views of Investors regarding the effect of speculation on the movement of exchange rate away from their fundamental levels are significantly higher than dealers ($p < 0.05$) and brokers/sub-brokers ($p < 0.001$), Therefore, views of foreign exchange traders regarding the effect of speculation on the movement of exchange rate away from their fundamental levels.

There was a significant difference in the views of foreign exchange traders regarding the effect of speculation on the movement of exchange rate away from their fundamental

levels, F (2, 244) = 4, $p < 0.05$. Contrast results revealed that investor group differs significantly from the broker/sub-broker group, $p < 0.05$ (2-tailed), and the investor group, $p < 0.05$.

4.9 Analysis of Difference in the Views of Foreign Exchange Traders Regarding Effect of Speculation on Increase in Liquidity in Foreign Exchange Market

Fischer, Isakova and Termechiko (2007), in their study, analysed the effect of speculation on foreign exchange liquidity. In order to check whether the views of traders regarding the effect of speculation on increase in liquidity in foreign exchange market differ significantly from each other, following hypotheses were tested:

$H_0$13: *Foreign exchange traders do not differ significantly in their views regarding the effect of speculation on increase in liquidity in the foreign exchange market.*

The results of the Kruskal-Wallis test for the difference in the views regarding the effect of central bank interventions on exchange rate volatility have been given in table 4.30, 4.31 and table 4.32 respectively.

Table 4.30: ***Descriptive Statistics for the views of foreign exchange traders regarding the effect of speculation on increase in liquidity in the foreign exchange market.***

Traders	Mean	Std. Deviation	N	Skewness	Kurtosis
Dealer (RBI Registered)	5.53	1.419	58	-.355	-.522
Broker/ Sub Broker (SEBI Registered)	5.86	1.215	94	-1.314	2.248
Investor	5.73	1.270	95	-1.286	2.000
Total	5.67	1.303	247		

Table 4.30 shows the descriptive statistics for hypotheses $H_0$13 i.e. the mean, the number of participants (N), the standard deviation of the sample and standard error of mean for each condition and pair. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked.

Skewness values vary between -1.29 and -0.36 which shows that the distributions are outside the acceptable limits of the normal distribution (+/-2). Kurtosis values vary between -0.52 and 2.248 which are outside the acceptable limits of the normal

distribution (+/-2) (Cameron, 2004). So, the distribution of data across three groups violated the assumption of normality for one-way independent ANOVA. As data does not satisfy normality assumption of one-way independent ANOVA, the hypothesis has been tested with Kruskal-Wallis test (H).

Hypothesis $H_0$13 compares views of foreign exchange traders regarding the effect of speculation on increase in liquidity in the foreign exchange market. Combined mean (M= 5.67, SD= 1.303) is on the higher end of the 7-point scale, which means all traders viewed that speculation increases liquidity in the foreign exchange market. As mean for all categories of traders, dealer group (M= 5.53, SD= 1.42), broker/sub-broker group (M= 5.86, SD= 1.22) and Investor group (M= 5.73, SD= 1.27) is greater than the median of scale (4), which shows that all traders strongly agreed that speculation highly influences liquidity in the foreign exchange market. For final confirmation of these results, the difference between their views was checked through the Kruskal-Wallis test and the same is reported in table 4.31.

Table 4.31: ***Test statistics for the views of foreign exchange traders regarding the effect of speculation on increase in liquidity in the foreign exchange market.***

Chi-square			9.194
Df			2
Asymp. Sig.			.010
Monte Carlo Sig.	Sig.		.010[a]
	99% Confidence Interval	Lower Bound	.007
		Upper Bound	.012
a. Based on 10000 sampled tables with starting seed 299883525.			

Table 4.31 shows the results of the Kruskal Wallis Test. Monte Carlo estimate of significance is significant (two-tailed), $p < 0.05$. So, there is a significant difference in the views of foreign exchange traders regarding the effect of speculation on increase in liquidity in the foreign exchange market. To see which group differs Mann-Whitney tests with Bonferroni correction was conducted on groups. The results of the Mann-Whitney test are reported in table 5.32 and table 5.33.

Table 4.32: ***Ranks for the dealer and broker/sub-broker group regarding the effect of speculation on increase in liquidity in the foreign exchange market.***

CBI result in Profit for Chartists	Current Position	N	Mean Rank	Sum of Ranks
Dealer and Broker/Sub Broker Group	Dealer (RBI registered)	60	67.27	4036.00
	Broker/Sub Broker (SEBI registered)	100	88.44	8844.00
	Total	160		
Dealer and Investor Group	Dealer (RBI registered)	60	69.54	4172.50
	Investor	100	87.08	8707.50
	Total	160		
Dealer and Broker/Sub Broker Group	Broker/Sub Broker (SEBI registered)	100	103.50	10350.00
	Investor	100	97.50	9750.00
	Total	200		

Table 4.32 displays summarized data for Dealer and Broker/ Sub Broker group after they have been ranked. Broker/sub-broker group has the higher mean rank (103.50, 88.44) investor group (97.50) and dealer group (67.27) which means that it has a greater number of high scores within it. However, to see whether mean ranks for these groups are significantly different from each other, Mann-Whitney test (*U*) was applied.

Table 4.33 provides test statistics for the Mann-Whitney test, the Wilcoxon procedure and the corresponding z-score. As Bonferroni correction has been applied, the critical level of significance used for three comparisons was 0.05/3 = 0.0167. The Mann-Whitney test is significant (two-tailed), $p < 0.001$ for Dealer and Broker/Sub Broker group. So, dealer group differs significantly from broker/sub-broker regarding the effect of speculation on increase in liquidity in the foreign exchange market. The Mann-Whitney test is non-significant (two-tailed), $p>0.0167$ for dealer and investor group & broker/sub-broker group and investor group. Thus, there is no significant difference in the views of dealer group and investor group & broker/sub-broker group and investor group regarding the effect of speculation on increase in liquidity in the foreign exchange market.

Table 4.33: ***Mann-Whitney tests statistics for the difference in the views of traders regarding the effect of speculation on increase in liquidity in the foreign exchange market.***

CBI result in Profit for Chartists	Dealer and Broker/Sub Broker Group	Dealer and Investor Group	Broker/Sub Broker and Investor Group
Mann-Whitney U	2206.000	2342.500	4700.000
Wilcoxon W	4036.000	4172.500	9750.000

Z			-2.896	-2.393	-.766
Asymp. Sig. (2-tailed)			**.004**	**. 017**	.444
Monte Carlo Sig. (2-tailed)	Sig.		**.004**[a]	**.019** [a]	.451 [a]
	99% Confidence Interval	Lower Bound	.002	.015	.438
		Upper Bound	.006	.022	.464
a. Based on 10000 sampled tables with starting seed			926214481	1314643744	624387341

The results show that the views of foreign exchange traders regarding the effect of speculation on increase in liquidity in the foreign exchange market, differs significantly from each other, H (2) = 9.19, p < 0.05. Mann-Whitney tests were used to follow up this finding. A Bonferroni correction was applied, so all results are reported at a 0.0167 level of significance. It appeared that Broker/Sub Broker views regarding the effect of speculation on increase in liquidity in foreign exchange market were significantly higher than dealer group (*U*= 2206, r= -0.23. Broker/sub-broker group views regarding the effect of speculation on increase in liquidity in foreign exchange market were higher but not significantly different from investor group (*U*= 4700, r= -0.05). No significant difference was found in the views of dealer group and investor group (*U*= 2342.50, r= -0.19).

4.10 Analysis of Difference in the Views of Foreign Exchange Traders Regarding Effect of Speculation on Improvement in Market Efficiency.

Fischer, Isakova and Termechiko (2007), analysed the effect of speculation on improvement in foreign exchange market efficiency. In order to check whether the views of traders regarding the effect of speculation on improvement in market efficiency differ significantly from each other, the following hypothesis was tested:

$H_0$14: *Foreign exchange traders do not differ significantly in their views regarding the effect of speculation on improvement in market efficiency.*

The results of one-way ANOVA for the difference in the views of foreign exchange regarding the effect of speculation on improvement in market efficiency have been given in table 4.34, table 4.35 and table 4.36 respectively.

Table 4.34: ***Descriptive statistics for the views of foreign exchange traders regarding the effect of speculation on improvement in market efficiency.***

Traders	Mean	Std. Deviation	N	Skewness	Kurtosis
Dealer (RBI Registered)	4.53	1.667	58	.00	-1.04
Broker/ Sub Broker (SEBI Registered)	4.22	1.546	94	-.43	-.12
Investor	4.32	1.823	95	-.19	-.76
Total	4.33	1.683	247		

Table 4.34 shows the descriptive statistics for hypotheses $H_0$14 i.e. the mean, the number of participants (N), the standard deviation of the sample, standard error of mean, skewness and kurtosis for the group. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked.

Skewness values vary between -0.43 and 0.00, which shows that the distributions are within the acceptable limits of the normal distribution (+/-2). The values of kurtosis vary between -1.04 and -0.12 which is within the acceptable limits of the normal distribution (+/-2) (Cameron, 2004). So, the distribution of data across three groups satisfied the assumption of normality for one-way independent ANOVA. As data satisfy normality assumption, the hypothesis has been tested with one-way independent ANOVA.

Hypothesis $H_0$14 compares views regarding the effect of speculation on improvement in market efficiency. Combined mean (M= 4.33, SD= 1.68) is close to median (4) of a 7-point scale, so all traders viewed that speculation improves market efficiency but the effect is not highly influential. Dealer group (M= 4.53, SD= 1.67), Investor group (M= 4.32, SD= 1.82) and Broker/sub-broker group (M= 4.22, SD= 1.55) agreed that speculation improves efficiency of foreign exchange market. To see whether views of trades differ from each other, the difference between their views was checked through one-way independent ANOVA and the same is reported in table 4.36.

Table: 4.35: ***Test of homogeneity of variances for the views of foreign exchange traders regarding the effect of speculation on improvement in market efficiency.***

Levene Statistic	df1	df2	Sig.
1.930	2	244	.147

Another assumption of one-way independent ANOVA is that variances of groups being compared should be equal. Table 4.35 shows the result of Levene's test which tests the null hypothesis that the variances of the groups are the same. Levene test is not

significant, p > .05, so we can say that the variances of groups are equal. As variances in the group are same, results of one-way independent ANOVA (F) reported in table 4.35.

Table 4.36: ***ANOVA for the views of foreign exchange traders regarding the effect of speculation on improvement in market efficiency.***

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.511	2	1.756	.618	.540
Within Groups	693.266	244	2.841		
Total	696.777	246			

Table 4.36 depicts the ANOVA statistics for the views of foreign exchange traders regarding the effect of speculation on improvement in market efficiency. F-ratio estimate of combined between-group effect is non-significant (two-tailed), p > 0.05. So, there is no significant difference in the views of foreign exchange traders regarding the effect of speculation on improvement in market efficiency.

Analysis of fundamental and non-fundamental factors revealed that Fundamental factors ability to determine foreign exchange rate was significantly higher than non-fundamental factors. However, the relevance of fundamental factors was found to be significant in long-period (6 months and more). It expresses that traders rely more on fundamentals than non-fundamentals. Dependence of traders on non-fundamental factors for determination of foreign exchange found to be higher than fundamentals in a very short period (intraday) and medium period (1 week to 3 months). Success rate achieved through fundamental factors found to be significantly higher than technical factors. However, the usefulness of a factor may vary for prediction of trends and turning points. Technical factors were considered somewhat more useful in predicting turning points in the foreign exchange market than fundamental factors. Interest rates were found to be a relatively important fundamental factor in exchange rate prediction. Over reaction to the news was reported to be a factor with the highest ability followed by rumours, market judgement, bandwagon effects and peer & social influences. All traders believe that speculation increase liquidity but do not improve market efficiency in the foreign exchange market.

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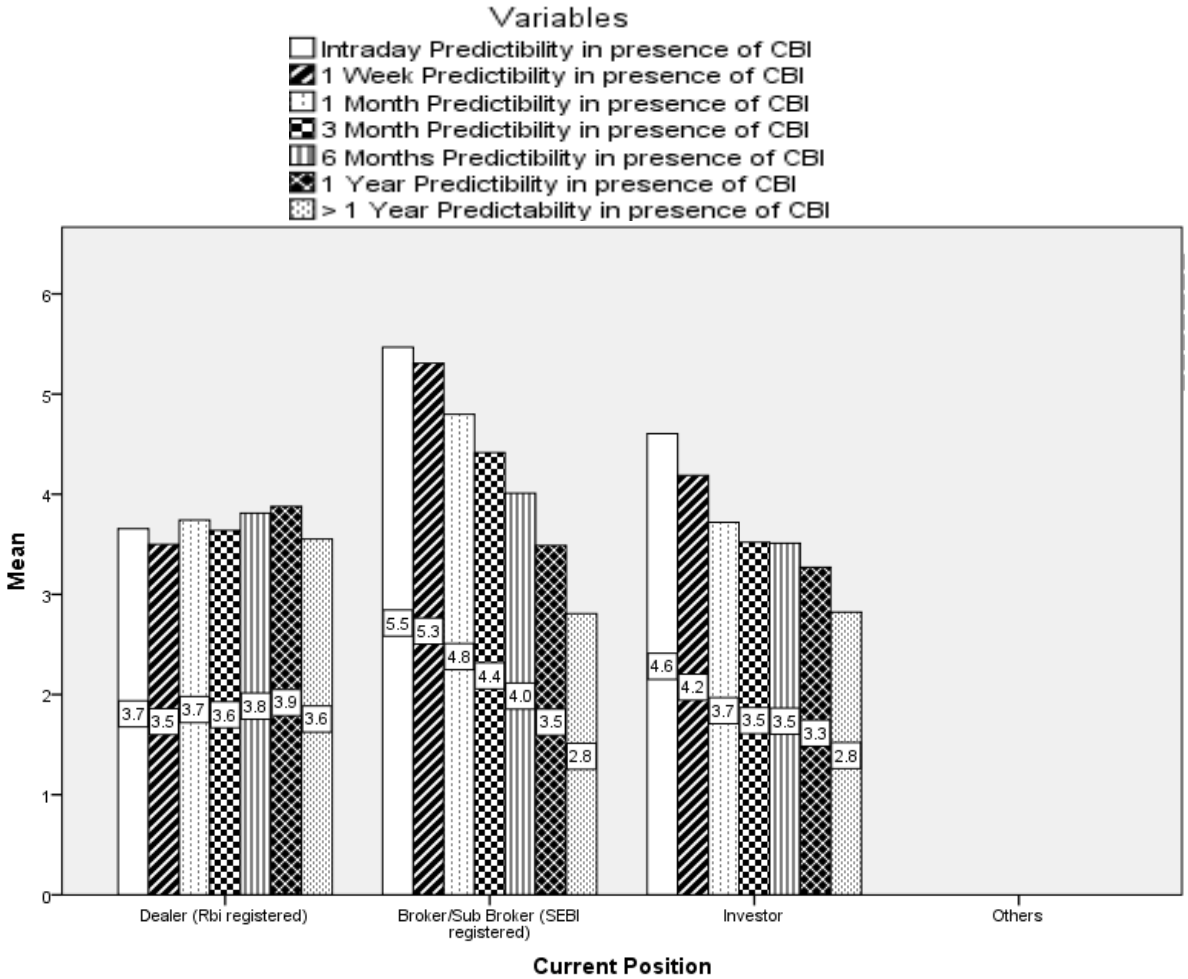
Impact of Central Bank Interventions: An Empirical Verification

Review of studies related to central bank intervention exhibited that central bank intervention has emerged as a separate factor that exerts significant influence on the foreign exchange rate. This chapter assesses and identifies the impact of central bank interventions on the foreign exchange market in general and technical rules profitability in particular.

5.1 Descriptive Statistics for Central Bank Interventions

Figure 5.1 reports the degree of predictability of foreign exchange in the presence of central bank interventions for three categories of foreign exchange traders.

Figure 5.1: Predictability of foreign exchange in the presence of central bank interventions

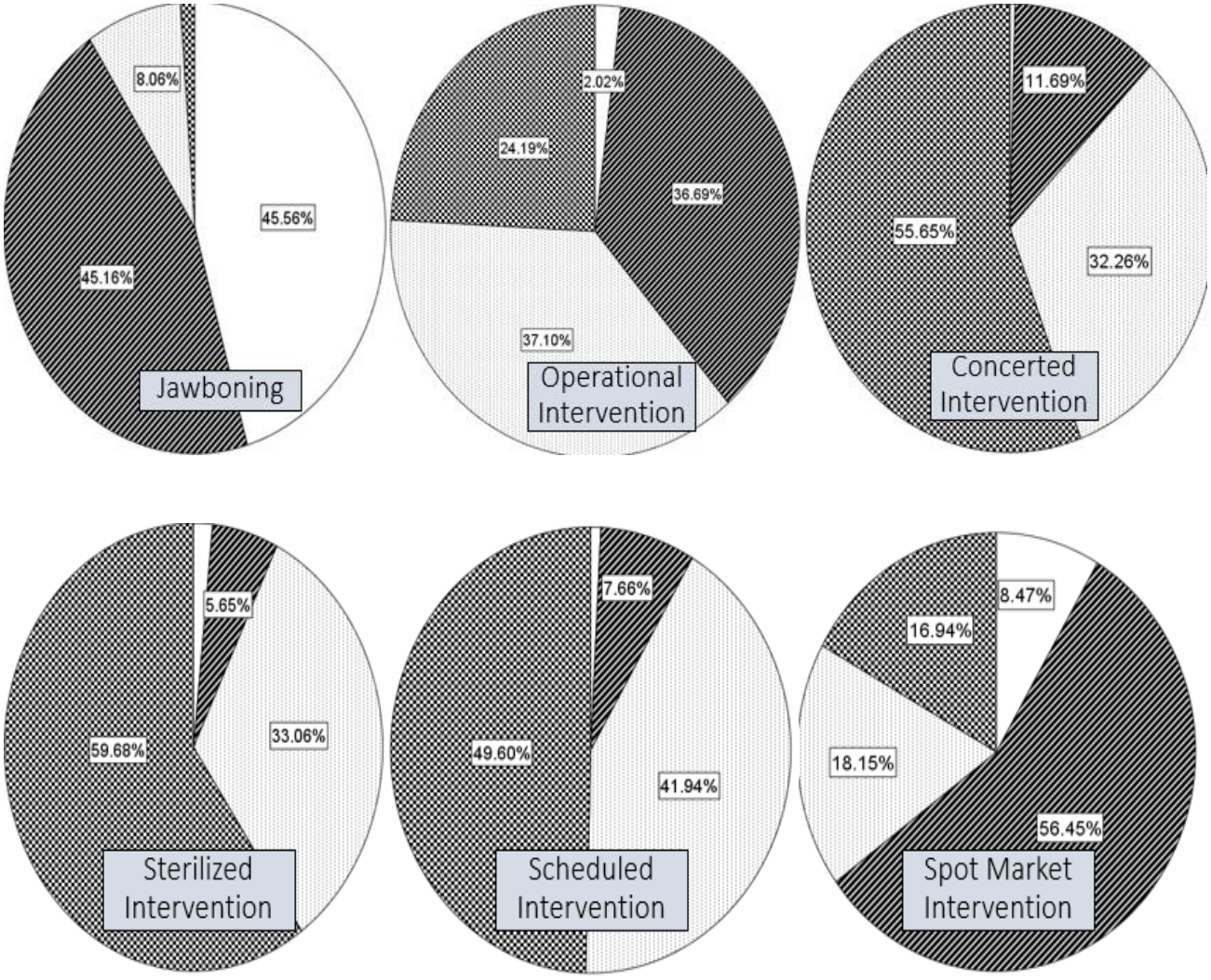


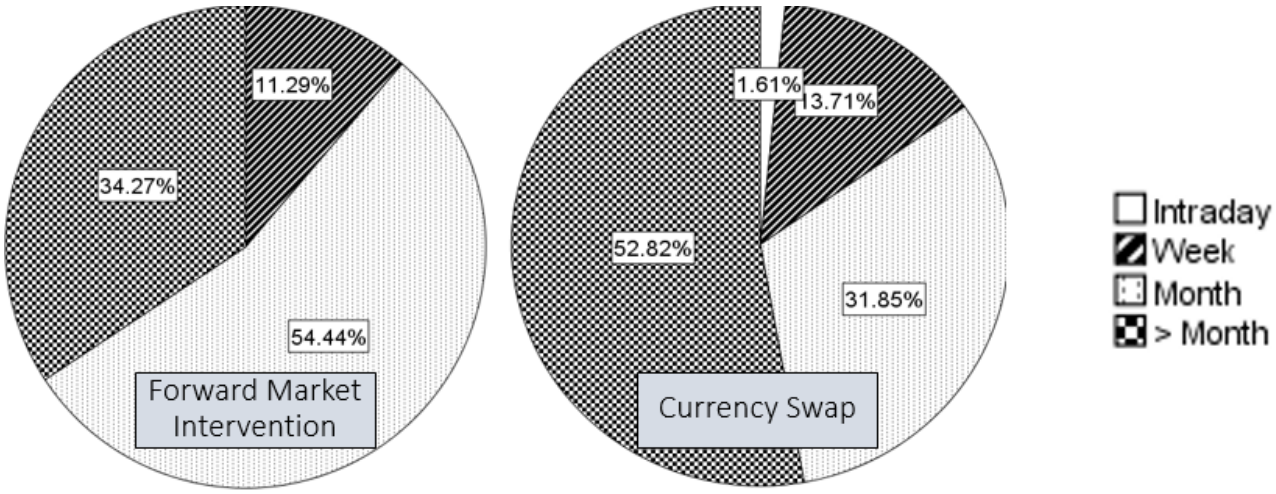
Dealers were indifferent in their opinions about the prediction of the exchange rate in the presence of central bank interventions. The degree of predictability over intraday, medium and long run was almost equal for dealers. However, brokers/sub-brokers and

investor believe to have high predictability in intraday and medium run. As time period increases predictability decreases for broker/sub broker and investor category.

Figure 5.2 shows different types of interventions with their influence on foreign exchange rate over different time periods. Jawboning (45.56 per cent) have influence over an intraday and week period, spot market (56.45 per cent) have influence over a week and forward market intervention (53.85 per cent) have to influence over a period of a month. The major influence of operational intervention is reported to be over a week (36.69 per cent) and a month (37.10 per cent). Concerted intervention (55.65 per cent), sterilized intervention (59.68 per cent), scheduled intervention (49.60 per cent) and currency swap (52.82) have a major influence on exchange rate over a period of more than a month.

Figure 5.2: Influence of interventions on exchange rate over different time periods





5.2 Analysis of Difference in the Views of Foreign Exchange Traders Regarding Effect of Central Bank Interventions on Foreign Exchange Rate

The literature on central bank intervention revealed that many researchers in their studies such as Cheung and Wong (2000), Fischer, Isakova and Termechiko (2007), Miyajima and Montoro (2013), have tried to extract influence of central bank intervention on the foreign exchange rate. In order to check whether the views of traders regarding the effect of central bank interventions on foreign exchange rate differ significantly from each other, following hypotheses were tested:

$H_0$1: *Foreign exchange traders do not differ significantly in their views regarding the effect of central bank interventions on the foreign exchange rate.*

The results of the Kruskal-Wallis test for the difference in the views of foreign exchange traders regarding the effect of central bank interventions on foreign exchange rates have been given in table 5.1 and table 5.2, respectively.

Table 5.1: ***Descriptive Statistics for the views of foreign exchange traders regarding the effect of central bank interventions on the foreign exchange rate.***

Traders	Mean	Std. Deviation	N	Skewness	Kurtosis
Dealer (RBI Registered)	6.43	.975	58	-3.325	16.118
Broker/ Sub Broker (SEBI Registered)	6.49	.864	94	-1.651	1.763
Investor	6.53	.894	96	-1.992	3.368

Table 5.1 shows the descriptive statistics for hypotheses ($H_0$1) i.e. the mean, the number of participants (N), the standard deviation of the sample and standard error of mean for each condition and pair. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked.

Skewness values vary between -3.325 and -1.651 which shows that the distributions are outside the acceptable limits of the normal distribution (+/-2). Thus, the distribution is not normal. Kurtosis values vary between 1.763 and 16.118 which indicates that the distributions highly leptokurtic and outside the acceptable limits of the normal distribution (+/-2) (Cameron, 2004). So, the distribution of data across three groups violated the assumption of normality for one way independent ANOVA. As data does not satisfy normality assumption of one way independent ANOVA, the hypothesis has been tested with Kruskal-Wallis test (H).

Hypothesis $H_0$1 compares views of foreign exchange traders regarding the effect of central bank interventions on the foreign exchange rate. As mean for all categories of traders, dealer group (M= 6.43, SD= 0.97), broker/sub-broker group (M= 6.49, SD= 0.86) and Investor group (M=6.53, SD= 0.89) is greater than the median of scale (4), which shows that all traders strongly agreed that central bank interventions have an effect on foreign exchange rate. For final confirmation of these results, the difference between their views was checked through the Kruskal-Wallis test and the same is reported in table 53.B.

Table 5.2: ***Kruskal Wallis Test Statistics for views of foreign exchange traders regarding the effect of central bank interventions on the foreign exchange rate.***

Chi-square			1.511
Df			2
Asymp. Sig.			.470
Monte Carlo Sig.	Sig.		.470[c]
	99% Confidence Interval	Lower Bound	.457
		Upper Bound	.483
a. Based on 10000 sampled tables with starting seed 2000000.			

Table 5.2 displays the results of the Kruskal Wallis Test. Monte Carlo estimate of significance is not significant, p > 0.05. So, there is no significant difference in the views

of foreign exchange traders regarding the effect of central bank interventions on the foreign exchange rate

The results revealed that the views of foreign exchange traders regarding the effect of central bank interventions on foreign exchange rate do not differ significantly from each other, H (2) = 1.51, p > 0.05. The null hypothesis that foreign exchange traders do not differ significantly in their views regarding the effect of central bank interventions on the foreign exchange rate is accepted.

5.3 Analysis of Difference in the Views of Foreign Exchange Traders Regarding Effect of Central Bank Interventions on Exchange Rate Volatility

Baillie and Osterberg (1997), Beine and Laurent (2003), Dominguez (1998), Edison, Casin, and Liang (2003), Dominguez (2003) in their studies found that central bank interventions are associated with higher exchange rate volatility. In order to check whether the views of traders regarding the effect of central bank interventions on exchange rate volatility differ significantly from each other, following hypotheses were tested:

$H_0$2: *Foreign exchange traders do not differ significantly in their views regarding the effect of central bank interventions on exchange rate volatility.*

The results of the Kruskal-Wallis test for the difference in the views regarding the effect of central bank interventions on exchange rate volatility have been given in table 6.3, table 6.4, table 6.5 and table 5.6 respectively.

Table 5.3: ***Descriptive Statistics for the views of foreign exchange traders regarding the effect of central bank interventions on exchange rate volatility.***

	Mean	Std. Deviation	N	Skewness	Kurtosis
Dealer (RBI Registered)	2.12	1.156	58	1.027	1.074
Broker/ Sub Broker (SEBI Registered)	3.90	1.742	94	.075	-.924
Investor	2.06	1.311	96	1.680	2.935

Table 5.3 shows the descriptive statistics for hypotheses ($H_0$2) i.e. the mean, the number of participants (N), the standard deviation of the sample and standard error of mean for each condition and pair. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked.

Skewness values vary between 0.075 and 1.680 which shows that the distributions are within the acceptable limits of the normal distribution (+/-2). But, values of kurtosis vary between -0.924 and 2.935 which is outside the acceptable limits of the normal distribution (+/-2) (Cameron, 2004). So, the distribution of data across three groups violated the assumption of normality for one way independent ANOVA. As data does not satisfy normality assumption of one way independent ANOVA, the hypothesis has been tested with Kruskal-Wallis test (H).

Hypothesis ($H_0$2) compares views regarding the effect of central bank interventions on exchange rate volatility. As mean for the dealer (M= 2.12, SD= 1.16) and Investor group (M= 2.06, SD= 1.31) is close to 2, which shows dealers and investors disagreed that central bank interventions result in exchange rate volatility. Mean for broker/sub-broker (M= 3.90, SD= 1.742) is close to the median of scale (4), which shows that brokers/sub-brokers believe that there is some effect of central bank interventions on exchange rate volatility but the effect is very low. For final confirmation of these results, the difference between their views was checked through the Kruskal-Wallis test and the same is reported in table 5.4.

Table 5.4: ***Kruskal Wallis Test Statistics for the views of foreign exchange traders regarding the effect of central bank interventions on exchange rate volatility.***

Chi-square			65.091
Df			2
Asymp. Sig.			.000
Monte Carlo Sig.	Sig.		.000[a]
	99% Confidence Interval	Lower Bound	.000
		Upper Bound	.000
a. Based on 10000 sampled tables with starting seed 1314643744.			

Table 5.4 shows the results of the Kruskal Wallis Test. Monte Carlo estimate of significance is significant (two-tailed), $p < 0.001$. So, there is a significant difference in the views of foreign exchange traders regarding the effect of central bank interventions on exchange rate volatility. To see which group differs Mann-Whitney tests with Bonferroni correction was conducted on groups. The results of the Mann-Whitney test are reported in table 5.5 and table 5.6.

Table 5.5: ***Ranks for Dealer and Broker/Sub Broker Group regarding the effect of central bank interventions on exchange rate volatility.***

CBI increases Exchange Rate Volatility	Current Position	N	Mean Rank	Sum of Ranks
Dealer and Broker/Sub Broker Group	Dealer (RBI registered)	58	49.04	2844.50
	Broker/Sub Broker (SEBI registered)	94	93.44	8783.50
	Total	152		
Dealer and Investor Group	Dealer (RBI registered)	58	80.70	4680.50
	Investor	96	75.57	7254.50
	Total	154		
Broker/Sub Broker and Investor Group	Broker/Sub Broker (SEBI registered)	94	124.39	11692.50
	Investor	96	67.21	6452.50
	Total	190		

Table 5.5 exhibits summarized data for Dealer and Broker/Sub Broker group after they have been ranked. Broker/Sub Broker group has the highest mean rank (93.44) than the dealer (49.04) and investor group (67.21) which means that it has a greater number of high scores within it. However, to see whether mean ranks for these groups are significantly different from each other, Mann-Whitney test (*U*) was applied.

Table 5.6: ***Mann-Whitney tests Statistics for the difference in the views of traders regarding the effect of central bank interventions on exchange rate volatility.***

CBI increases Exchange Rate Volatility			Dealer and Broker/Sub Broker Group	Dealer and Investor Group	Broker/Sub Broker and Investor Group
Mann-Whitney U			1133.500	2598.500	1796.500
Wilcoxon W			2844.500	7254.500	6452.500
Z			-6.133	-.730	-7.309
Asymp. Sig. (2-tailed)			.000	.466	.000
Monte Carlo Sig. (2-tailed)	Sig		.000[b]	.462[b]	.000[b]
	99% Confidence Interval		.000	.449	.000
			.000	.475	.000
a. Based on 10000 sampled tables with starting seed			926214481.	1314643744	624387341

Table 5.6 provides test statistics for the Mann-Whitney test, the Wilcoxon procedure and the corresponding z-score. As Bonferroni correction has been applied, the critical

level of significance used for three comparisons was 0.05/3 = 0.0167. The Mann-Whitney test is significant (two-tailed), $p < 0.001$ for Dealer and Broker/Sub Broker group & Broker/Sub Broker group and Investor Group. So, Broker/Sub Broker group differs significantly from dealer group and investor group regarding the effect of central bank interventions on exchange rate volatility. The Mann-Whitney test is non-significant (two-tailed), $p > 0.0167$ for Dealer and Investor Group. Thus, there is no significant difference in the views of dealer group and investor group regarding the effect of central bank interventions on exchange rate volatility.

The results show that the views of foreign exchange traders regarding the effect of central bank interventions on exchange rate volatility differs significantly from each other, $H(2) = 65.09$, $p < 0.001$. Mann-Whitney tests were used to follow up this finding. A Bonferroni correction was applied, so all results are reported at a 0.0167 level of significance. It appeared that Broker/Sub Broker views regarding the effect of central bank interventions on exchange rate volatility were significantly higher than dealer group (U= 1133.50) and investor group (U= 1796.50). However, no significant difference was found in the views of dealer group and investor group (U= 2598.50).

5.4 Analysis of Difference in the Views of Foreign Exchange Traders Regarding Central Bank Interventions Move Exchange Rate Away from their Fundamental Levels

Review of literature of studies by Cheung and Chinn (2001), Fischer, Isakova and Termechiko (2007), Menkhoff and Taylor (2006), revealed the trivial effect of central bank interventions on the movement of the exchange rate from their fundamental levels. In order to check whether the views of traders regarding the effect of central bank interventions on the movement of exchange away from rate away from their fundamental levels differ significantly from each other, the following hypothesis was tested:

$H_0$3: *Foreign exchange traders do not differ significantly in their views regarding central bank interventions moves the exchange rate away from their fundamental levels.*

The results of Kruskal-Wallis test for the difference in the views of foreign exchange traders regarding central bank interventions moves exchange rate away from their fundamental levels, have been given in table 5.7, table5.8, table 5.9 and table 5.10, respectively.

Table 5.7: ***Descriptive Statistics for the views of foreign exchange traders regarding central bank interventions moves exchange rate away from their fundamental levels.***

Traders	Mean	Std. Deviation	N	Skewness	Kurtosis
Dealer (RBI Registered)	2.03	1.302	58	1.968	4.546
Broker/ Sub Broker (SEBI Registered)	3.38	1.653	94	.473	-.361
Investor	1.79	1.230	96	1.932	3.973

Table 5.7 demonstrates the descriptive statistics for hypotheses ($H_0$3) i.e. the mean, the number of participants (N), the standard deviation of the sample and standard error of the mean for each condition and pair. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked.

Skewness values vary between 0.47 and 1.97, which exhibits that the distributions are within the acceptable limits of the normal distribution (+/-2). But the values of kurtosis vary between -0.36 and 4.55 which is outside the acceptable limits of the normal distribution (+/-2) (Cameron, 2004). So, the distribution of data across three groups violated the assumption of normality for one way independent ANOVA. As data does not satisfy normality assumption of one way independent ANOVA, the hypothesis has been tested with Kruskal-Wallis test (H).

Hypothesis ($H_0$3) compares opinions regarding the effect of central bank interventions on exchange rate volatility. As mean for the dealer (M= 2.03, SD= 1.30) is 2 and for Investor group (M= 1.79, SD= 1.23) it is close to 2, which shows dealers and investors disagreed that central bank interventions move exchange rate away from their fundamental levels. Mean for broker/sub-broker (M= 3.38, SD= 1.65) is close to the median of scale (4), which shows that brokers/sub-brokers believe that there is some effect of central bank interventions on the movement of exchange rate away from their fundamental levels but the effect is very low. For final confirmation of these results, the difference between their views was checked through the Kruskal-Wallis test and the same is reported in table 5.8.

Table 5.8: ***Kruskal Wallis Test Statistics for the views of foreign exchange traders regarding central bank interventions moves exchange rate away from their fundamental levels.***

Chi-square	59.262
Df	2

Asymp. Sig.			.000
Monte Carlo Sig.	Sig.		.000[a]
	99% Confidence Interval	Lower Bound	.000
		Upper Bound	.000
a. Based on 10000 sampled tables with starting seed 2000000.			

Table 5.8 shows the results of the Kruskal Wallis Test. Monte Carlo estimate of significance is significant (two-tailed), $p < 0.001$. So, there is a significant difference in the views of foreign exchange traders regarding the effect of central bank interventions on the movement of exchange rate away from their fundamental levels. To see which group differs in their views Mann-Whitney tests with Bonferroni correction was conducted on groups. The results of the Mann-Whitney test are reported in table 5.9 and table 5.10.

Table 5.9: ***Ranks for Dealer and Broker/Sub Broker Group regarding central bank interventions moves exchange rate away from their fundamental levels.***

CBI moves Exchange Rate away from Fundamentals	Current Position	N	Mean Rank	Sum of Ranks
Dealer and Broker/Sub Broker Group	Dealer (RBI registered)	58	52.76	3060.00
	Broker/Sub Broker (SEBI registered)	94	91.15	8568.00
	Total	152		
Dealer and Broker/Sub Broker Group	Dealer (RBI registered)	58	86.64	4909.00
	Investor	96	73.19	7026.00
	Total	154		
Dealer and Broker/Sub Broker Group	Broker/Sub Broker (SEBI registered)	94	123.46	11605.00
	Investor	96	68.13	6540.00
	Total	190		

Table 5.9 shows summarized data for Dealer and Broker/Sub Broker group after they have been ranked. Broker/Sub Broker group has the highest mean rank (91.15, 123.46) than the dealer (52.76, 86.64) and investor group (68.130, 73.19) which means that it has a greater number of high scores within it. However, to see whether mean ranks for these groups are significantly different from each other, Mann-Whitney test (*U*) was applied.

Table 5.10: ***Mann-Whitney tests Statistics for the difference in the views of traders regarding central bank interventions moves exchange rate away from their fundamental levels.***

CBI moves Exchange Rate away from Fundamentals			Dealer and Broker/Sub Broker Group	Dealer and Investor Group	Broker/Sub Broker and Investor Group
Mann-Whitney U			1349.00	2370.00	1884.00
Wilcoxon W			3060.00	7026.00	6540.00
Z			-5.341	-1.685	-7.167
Asymp. Sig. (2-tailed)			.000	.092	.000
Monte Carlo Sig. (2-tailed)	Sig.		.000[a]	.092[a]	.000[a]
	99% Confidence Interval	Lower Bound	.000	.084	.000
		Upper Bound	.000	.099	.000
a. Based on 10000 sampled tables with starting seed			299883525	926214481	1314643744

Table 5.10 provides test statistics for the Mann-Whitney test, the Wilcoxon procedure and the corresponding z-score. As Bonferroni correction has been applied, the critical level of significance used for three comparisons was 0.05/3 = 0.0167. The Mann-Whitney test is significant (two-tailed), $p < 0.001$ for Dealer and Broker/Sub Broker group & Broker/Sub Broker group and Investor Group. So, Broker/Sub Broker group differs significantly from dealer group and investor group regarding the effect of central bank interventions on exchange rate volatility. The Mann-Whitney test is non-significant (two-tailed), $p > 0.0167$ for Dealer and Investor Group. Thus, there is no significant difference in the views of dealer group and investor group regarding the effect of central bank interventions on exchange rate volatility.

The results show that the views of foreign exchange traders regarding the effect of central bank interventions on exchange rate volatility differs significantly from each other, $H(2) = 59.262$, $p < 0.001$. Mann-Whitney tests were used to follow up this finding. A Bonferroni correction was applied, so all results are reported at a 0.0167 level of significance. It appeared that Broker/Sub Broker views regarding the effect of central bank interventions on the movement of exchange rate away from their fundamental were significantly higher than dealer group (U= 1349.00) and investor group (U= 1884.00). However, no significant difference was found in the views of dealer group and investor group (U=2370.00).

5.5 Analysis of Difference in the Views of Foreign Exchange Traders Regarding Central Bank Interventions are Conducted at Appropriate Moment.

In order to check whether the views of traders regarding central bank interventions are conducted at appropriate moment differ significantly from each other, the following hypothesis was tested:

$H_0$4: *Foreign exchange traders do not differ significantly in their views regarding central bank interventions are conducted at an appropriate moment.*

The results of Kruskal-Wallis test for the difference in the views of foreign exchange traders regarding central bank interventions are conducted at the appropriate moment, have been given in table 5.11, table 5.12, table 5.13, table 5.14, table 5.15 and table 5.16, respectively.

Table 5.11: ***Descriptive Statistics for the views of foreign exchange traders regarding central bank interventions are conducted at an appropriate moment.***

Current Position	Mean	Std. Deviation	N	Skewness	Kurtosis
Dealer (RBI Registered)	5.47	1.429	58	-.843	-.254
Broker/ Sub Broker (SEBI Registered)	4.02	1.422	94	0.214	-.194
Investor	4.45	1.621	96	-.291	-.581

Table 5.11 shows the descriptive statistics for hypotheses ($H_0$20) i.e. the mean, the number of participants (N), the standard deviation of the sample and standard error of mean for each condition and pair. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked.

Skewness values vary between -0.85 and 1.92, which shows that the distributions are within the acceptable limits of the normal distribution (+/-2). The values of kurtosis vary between -0.63 and -0.18 which is within the acceptable limits of the normal distribution (+/-2) (Cameron, 2004). So, the distribution of data across three groups satisfied the assumption of normality for one way independent ANOVA. As data satisfy normality assumption, the hypothesis has been tested with one way independent ANOVA.

Hypothesis ($H_0$4) compares views regarding central bank interventions are conducted at an appropriate moment. All traders, Dealer group (M= 5.47, SD= 1.43), broker/sub-broker (M= 4.04, SD= 1.42) and Investor group (M= 4.45, SD= 1.62) agreed that central bank interventions are conducted at the appropriate moment, as their mean values are

greater than median of scale (4). To see whether views of trades differ from each other, the difference between their views was checked through one-way independent ANOVA and the same is reported in table 5.13.

Another assumption of one-way independent ANOVA is that the variances of groups being compared should be equal. Table 5.12 shows the result of Levene's test which tests the null hypothesis that the variances of the groups are the same. Levene test is non-significant, $p > .05$, so we can say that the variances of groups are equal.

Table 5.12: ***Test of Homogeneity of Variances for the views of foreign exchange traders regarding central bank interventions are conducted at an appropriate moment.***

Levene Statistic	df1	df2	Sig.
1.917	2	245	.149

Table 5.13: ***ANOVA for the views of foreign exchange traders regarding central bank interventions are conducted at an appropriate moment.***

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	75.727	2	37.863	16.741	.000
Within Groups	554.128	245	2.262		
Total	629.855	247			

Table 5.13 depicts the ANOVA statistics for the views of foreign exchange traders regarding central bank interventions are conducted at an appropriate moment. F-ratio estimate of combined between-group effect is significant (two-tailed), $p < 0.001$. So, there is a significant difference in the views of foreign exchange traders regarding central bank interventions are conducted at an appropriate moment. To see which groups differ contrast tests were conducted on groups. The results of the contrasts are reported in table 5.14, table 5.15 and table 5.16.

Table 5.14: ***ANOVA Tests for the views of foreign exchange traders regarding central bank interventions are conducted at an appropriate moment.***

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	75.727	2	37.863	16.741	.000
Within Groups	554.128	245	2.262		
Total	629.855	247			

Table 5.14 indicates results of ANOVA which compares groups assuming homogeneity of variance between them. The tests confirm sig. difference as $p < 0.001$.

Table 5.15: ***Contrast Coefficients for the views of foreign exchange traders regarding central bank interventions are conducted at an appropriate moment.***

Contrast	Current Position		
	Dealer (RBI registered)	Broker/Sub Broker (SEBI registered)	Investor
1	1	-1	0
2	1	0	-1
3	0	1	-1

Table 5.15 shows the representation of contrasts. Contrast 1 compares dealer group with broker/sub-broker group, Contrast 2 compares dealer group with investor group and Contrast 3 compares broker/sub-broker group with an investor group. The results of these contrasts are displayed by table 5.16.

Table 5.16: ***Tukey HSD Tests for the views of foreign exchange traders regarding central bank interventions are conducted at an appropriate moment.***

(J) Current Position	Mean Difference (I-J)	Std. Error	Sig.
Dealer - Broker/Sub Broker	1.444*	.251	.000
Dealer - Investor	1.018*	.250	.000
Broker/Sub Broker - Investor	-.427	.218	.126

Table 5.16 gives the statistics for each contrast. Only values reported assuming equal variances are reported because the Levene test result was not significant. Post hoc Contrast results are significant (two-tailed) for Dealer - Broker/Sub Broker and Dealer - Investor. So, dealer group differs significantly from broker/sub-broker group ($p < 0.001$), dealer group differs significantly from investor group ($p < 0.001$) Therefore, views of foreign exchange traders regarding central bank interventions are conducted at appropriate moment differs significantly from each other.

There was a significant difference in the views of foreign exchange traders regarding central bank interventions are conducted at an appropriate moment, $F(2, 245) = 16.74$, $p < 0.001$. Tukey HSD Post hoc contrast results revealed that dealer group differs significantly from broker/sub-broker group, $p < 0.001$ (2-tailed), dealer group differs significantly from an investor group, $p < 0.001$ (2-tailed), $r = 0.32$.

5.6 Analysis of Difference in the Views of Foreign Exchange Traders Regarding Central Bank Interventions Achieve the Desired Goal

In order to check whether the views of traders about central bank interventions achieve the desired goal significantly differ from each other, following hypotheses were tested:

$H_0$5: *Foreign exchange traders do not differ significantly in their views regarding central bank interventions achieve the desired goal.*

The results of one-way ANOVA for the difference in the views of foreign exchange traders regarding central bank interventions achieve the desired goal, have been given in table 5.17, table 5.18, table 5.19, table 5.20, table 5.21 and table 5.22, respectively.

Table 5.17: ***Descriptive Statistics for the views regarding central bank interventions achieve the desired goal.***

	Mean	Std. Deviation	N	Skewness	Kurtosis
Dealer (RBI Registered)	5.53	1.524	58	-.976	.432
Broker/ Sub Broker (SEBI Registered)	3.70	1.458	94	.472	-.157
Investor	4.86	1.448	96	-.523	-.153

Table 5.17 displays the descriptive statistics for hypotheses ($H_0$5) i.e. the mean, the number of participants (N), the standard deviation of the sample, and standard error of mean, skewness and kurtosis for the group. Although, in large data set (N > 30), the assumption of normality is likely to be satisfied (Due to the central limit theorem). But to prevent large deviation from normality, values of skewness and kurtosis were checked.

Skewness values vary between -.97 and 0.47, which shows that the distributions are within the acceptable limits of the normal distribution (+/-2). The values of kurtosis vary between -0.15 and 0.43 which is within the acceptable limits of the normal distribution (+/-2) (Cameron, 2004). So, the distribution of data across three groups satisfied the assumption of normality for one way independent ANOVA. As data satisfy normality assumption, the hypothesis has been tested with one way independent ANOVA.

Hypothesis ($H_0$5) compares views regarding central bank interventions achieve the desired goal. Dealer group (M= 5.53, SD= 1.52) and Investor group (M= 4.86, SD= 1.44) agreed that central bank interventions achieve the desired goal, as their mean values are greater than the median (4) of scale. Values of Broker/sub-broker group (M= 3.70, SD=

1.45) are close to the median of scale but lower than other two groups. To see whether views of trades differ from each other, the difference between their views was checked through one-way independent ANOVA and the same is reported in table 5.18.

Table 5.18: ***Test of Homogeneity of Variances for the views of foreign exchange traders regarding central bank interventions achieve the desired goal.***

Levene Statistic	df1	df2	Sig.
.210	2	245	.811

Another assumption of one-way independent ANOVA is that the variances of groups being compared should be equal. Table 5.18 shows the result of Levene's test which tests the null hypothesis that the variances of the groups are the same. Levene test is non-significant, p >.05, so we can say that the variances of groups are equal.

Table 5.19: ***ANOVA for the views of foreign exchange traders regarding central bank interventions achieve the desired goal.***

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	133.057	2	66.528	30.793	.000
Within Groups	529.330	245	2.161		
Total	662.387	247			

Table 5.19 depicts the ANOVA statistics for the views of foreign exchange traders regarding central bank interventions are conducted at an appropriate moment. F-ratio estimate of combined between-group effect is significant (two-tailed), $p < 0.001$. So, there is a significant difference in the views of foreign exchange traders regarding central bank interventions achieves the desired goal. To see which groups differ contrast tests were conducted on groups. The results of the contrasts are reported in table 6.20, table 6.21 and table 6.22.

Table 5.20: ***Robust Tests of Equality of Means for the views of foreign exchange traders regarding central bank interventions achieve the desired goal.***

	Statistic	df1	df2	Sig.
Welch	30.110	2	143.094	.000
Brown-Forsythe	30.342	2	209.688	.000

Table 5.20 indicates results of Welch and Brown-Forsythe which compares groups without assuming homogeneity of variance between them. The tests confirm ANOVA results of the table as $p < 0.001$.

Table 5.21: ***Contrast Coefficients for the views of foreign exchange traders regarding central bank interventions achieve the desired goal.***

Contrast	Current Position		
	Dealer (RBI registered)	Broker/Sub Broker (SEBI registered)	Investor
1	1	-1	0
2	1	0	-1
3	0	1	-1

Table 5.21 indicates the representation of contrasts. Contrast 1 compares dealer group with broker/sub-broker group, Contrast 2 compares dealer group with investor group and Contrast 3 compares broker/sub-broker group with an investor group. The results of these contrasts are displayed by table 5.22.

Table 5.22: ***Tukey HSD Tests for the views of foreign exchange traders regarding central bank interventions achieve the desired goal.***

Current Position	Mean Difference (I-J)	Std. Error	Sig.
Dealer - Broker/Sub Broker	1.832*	.245	.000
Dealer – Investor	.670*	.244	.018
Broker/Sub Broker - Dealer	-1.832*	.245	.000

Table 5.22 gives the statistics for each contrast. Only values reported assuming equal variances are reported because the Levene test result was not significant. All contrast results are significant (two-tailed). So, dealer group differs significantly from broker/sub-broker group ($p < 0.001$), dealer group differs significantly from investor group ($p < 0.001$) and broker/sub-broker group differs significantly from investor group ($p < 0.001$). Therefore, views of foreign exchange traders regarding central bank interventions achieve the desired goals differ significantly from each other.

There was a significant difference in the views of foreign exchange traders regarding central bank interventions achieve the desired goals, $F(2, 245) = 30.79$, $p < 0.001$. Contrast results revealed that dealer group differs significantly from broker/sub broker group, $p < 0.001$ (2-tailed), $r = 1.20$, dealer group differs significantly from investor group, $p < 0.001$ (2-tailed), $r = 0.41$ and broker/sub broker group differs significantly from investor group, $p < 0.001$ (2-tailed), $r = 0.78$.

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Interventions, Exchange Rate and Volatility

Liquidity is one of the essential elements of a stable financial market. The absence of such liquidity (supply-demand mismatch) makes the asset price volatile. The volatility of the exchange rate makes uncertainty in the foreign exchange market and influences the macroeconomic variables negatively (Acemoglu, Johnson, Robinson, & Thaicharoen, 2003; Gali & Monacelli, 2005). Ensuring liquidity in the market is the only solution for mitigating uncertainty in a thin market. Monetary authorities are responsible for reducing volatility by influencing the foreign exchange market either expansion or contraction of supply of domestic assets. Similarly, monetary authorities should restore the equilibrium exchange rate if it drifts away from the equilibrium without the support of Economic fundaments. As a regulatory, it is the duty of the central bank to correct the market misalignment for the growth and smooth operation of the foreign exchange market. So central banks intervene in the foreign exchange market to fulfil its specific objectives.

The effectiveness of the central bank's foreign exchange intervention has been widely analysed by academicians and policymakers after the popular intervention decision of Plaza Accord-1985 and Louvre Accord 1987 (Dominguez, 1990). But constraints on accessibility to the intervention data and other methodical issues challenged the reliability of results. Irrespective of weak findings of academicians central banks continued their intervention operation by neglecting these academic findings, believing that interventions are achieving its objective. Lack of transparency and information asymmetry might have created a conflicting result between academicians and policymakers. Central Banks are specific about their multiple policy objectives of intervention but the academicians are only aware of the communicated objectives and most of the time they concentrated on how the intervention influenced those communicated objectives. Availability of the high-frequency data and transparent communication leads to tremendous growth in the intervention literature especially from Emerging Market Economies (EMEs).

6.1 Motives for Intervention

Foreign exchange intervention is a process of purchase and sale of foreign assets by monetary authority (central bank or currency board) with an intention to influence the

exchange rate or exchange rate volatility. Official interventions are driven by the current and expected economic condition prevailing in the economy. It can be broadly divided into three categories including basic determinants, domestic economic determinants and foreign exchange market determinants. These determinants are driven from the broad economic objectives of internal economic stability, protect the economy from a possible crisis and protect economic competitiveness and growth, and (BIS 2005). These objectives can be attained through exchange rate targeting, exchange rate smoothing, curbing volatility and managing foreign exchange reserves. Central banks with floating regime manage sharp fluctuations in the nominal exchange rate if the main target is to maintain internal balance or inflation control. Central bank targeting external balance may be concerned with real exchange rate rather than a nominal one. An unfavourable Balance of Payment (BoP), Balance of Trade (BoT), and capital flow stimulate central bank to intervene to maintain their external balances. For preventing currency crisis central banks observe market behaviour such as turnover, the magnitude of exchange rate volatility, the speed of exchange rate changes, bid-ask spread and exposure of market participants. In addition to that other exchange rate determinants like forward market behaviour and development of the capital market also influence intervention decision. In addition to the cost and profitability of intervention, tactics like curbing excess volatility, leaning against the wind and leaning with the wind also affect intervention in the foreign exchange market. Uncertainty in the capital market and reserve accumulation is also influence intervention decision of EMEs central banks (Humala & Rodríguez, 2010; Tashu, 2014)

Objectives of intervention maintain internal balance, maintain external balance, protecting market competitiveness, controlling inflation, support economic growth, prevent currency crisis and prevent exchange rate misalignment. For achieving these objectives monetary authorities influence exchange rate level, curbing excessive volatility of exchange rate and achieve foreign exchange reserve.

6.2 Channels of Intervention

Theoretical literature pointed out that official sterilised interventions influence the exchange rate mainly through three major channels, which are not mutually independent. It

includes portfolio balancing channel, signalling and microstructure channel. All of these channels have an extensive theory of exchange rate determination.

6.2.1 Signalling Channel

As per this channel, central bank intervention provides signals to the market regarding its future monetary policy actions (Dominguez & Frankel, 1993; Kaminsky & Lewis, 1996). Under this approach, the exchange rate is considered as an asset price which is decided by the supply of money. When central bank intervenes, expectations of the market participants changes by perceiving the future monetary policy of the central bank. The effectiveness of this channel depends on the credibility of the central bank. So intervention by a less credible central bank may work counterproductive (increase speculation attack) and further worsen the situation (Sarno & Taylor, 2001). Hence, it is more effective in industrialised countries because of their transparency and credibility of the monetary authorities to correct the exchange rate misalignments. Secrecy of intervention and lack of credibility leads to the failure of this channel in EMEs. But the magnitude of the intervention (large frequent or infrequent interventions) has a role to pass signals to the market participants Mussa (1981)explained such phenomena as a type credibility purchase in case of EMEs.

6.2.2 Portfolio Balance Channel.

This channel is based on the portfolio balance approach of exchange rate determination. Under this approach, intervention increase (decrease) the supply of the domestic assets and influence the participants to balance their portfolio according to the new market condition (Sarno and Taylor, 2001). This model assumes imperfect substitutability of domestic and foreign assets and market participants are risk averse (Dominguez & Frankel, 1993; Edison, 1993). Altering the supply of foreign and domestic assets through intervention force investors to rebalance their portfolio, brings changes in exchange rate. For compensating the risk on increased assets, investors demand more return to equalise risk-adjusted return. This channel is more effective in EMEs because of imperfect substitutability of foreign and domestic assets even though the credibility of central banks from EMEs is weak. In addition to that EMEs central bank's interventions are high magnitude related to the market turnover (Canales-Kriljenko, Guimaraes, & Karacadag, 2003; Disyatat & Galati, 2007)

6.2.3 Microstructure channel

Microstructure channel is based on the structure of the foreign exchange market. The existence of information asymmetry is one of the key assumptions of this approach. Central banks have superior information access as compared to other market participants. It also includes order flow, liquidity, trading mechanism and price discovery in the market. As per this channel central bank intervention emit information to the market and which alter the expectation of the market participants by generating huge flow (Evans & Lyons, 2002). Alteration of order flow may enhance market volatility based on the participation of the liquidity traders related to informed traders. Here central bank intervention alters the order flow and changes the expectation of the participants especially chartists by exploiting the "herd" behaviour of the market. Most of the time volatility is a result of huge supply-demand mismatch. So, central bank examines the market heterogeneity and use its information advantage which gives benefit to informed traders over uninformed traders during the period of new information. This model is based on the Mixture of Distribution Hypothesis (MDH) proposed by Easley & O'Hara (1992).

MDH assumes a strong relationship between volume and exchange rate volatility because both are driven by of the dynamics of new information during the normal (liquid market) period (Frankel & Froot, 1990; Tauchen & Pitts, 1983). However, these relationships are negative during the market disturbance period because liquidity traders withdraw from the market (Galati, 2000). This entail that official intervention takes place in two regimes. (a).Highly volatile regime (informed trading regime), where the liquidity traders leave the market resulting in an increase the mean and variance of the exchange rate return. (b) Low volatile (liquidity trading regime), where the variance and mean of exchange rate return is low due to the active liquidity participation in the market. In the informed regime intervention reduces the volatility (the negative relationship between volatility and volume) but in the liquidity, regime intervention enhances it (positive relationship between volume and volatility).

Theoretical literature highlighted four specific reasons for central bank intervention. (1) Calm disorderly market or volatility smoothing, (2) restore equilibrium exchange rate (if the

exchange rate diverted from equilibrium level without the support of economic fundamentals), (3) Accumulating international reserve and (4) signalling future policies.

6.3 RBI Intervention

The prime objective of Reserve Bank of India (RBI) foreign exchange management is to ensure the credible and rational external value of rupee along with the optimum value of reserve to meet its liabilities. The former governor of the RBI *Raghuram Rajan* supported this idea. He stated that

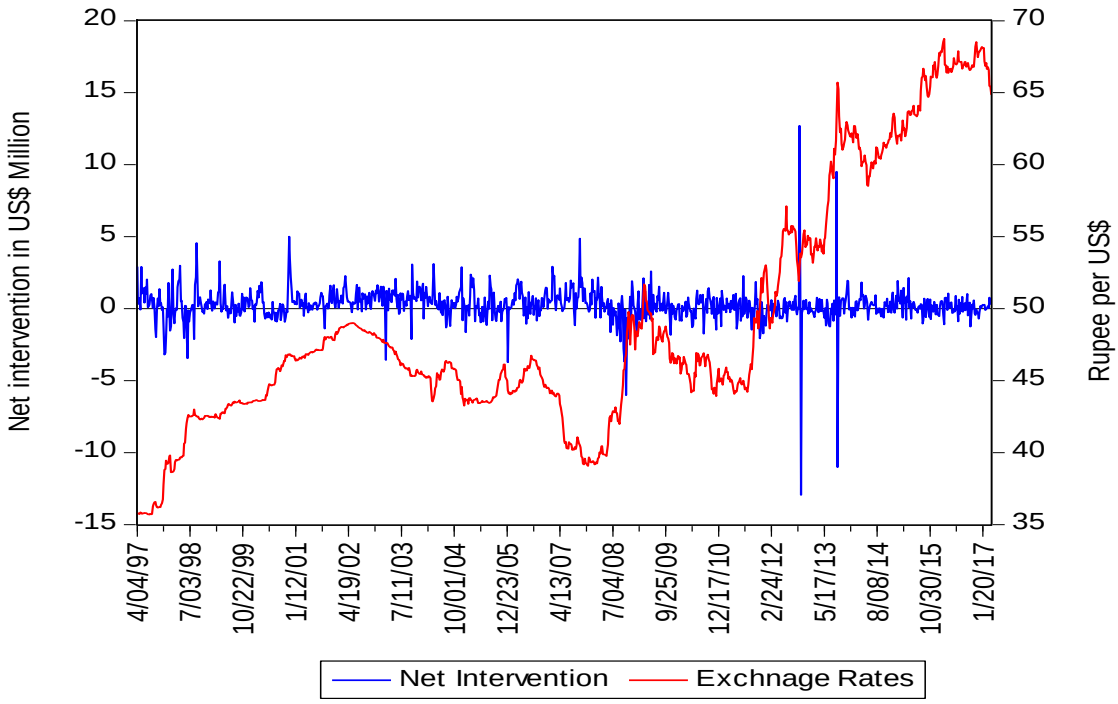
"*We really don't want the currency to move only as a result of capital flow, we would like it to be more focused on the underlying fundamentals of trade and services. There is a school of thought that says: Let the exchange rate move wherever it will. That's something we could do. But in emerging markets, with institutions not as strong as industrialized countries, you find there are collateral effects of both the capital moving in and going out. This would imply minimal management of the exchange rate by the RBI, except perhaps to smooth extreme volatility, including preventing significant departures from equilibrium. So we let the exchange rate move, we never stand in the way, but we pick up some as flows come in." Rajan (2016).*

These statements reflect the intervention policy of RBI which aims to curb excessive volatility without targeting any specific exchange rate level. It allows the market to determine the exchange rate level with a policy of leaning against the wind. Hence, this chapter deal with an important enquiry as to whether RBI intervention has influenced exchange rate and its volatility in consensus with policy objective. It is crucial to understand the impact of the intervention on exchange rate mainly because of the inconclusiveness among academic researchers regarding the same.

More specifically it can observe that RBI is concerned with both magnitude and speed of rupee exchange rate misalignment as it is necessary for the policy action. So RBI tries to influence both magnitude and speed of misalignment through intervention. The intervention aims to reduce the speed of misalignment is a part of 'leaning against wind' strategy. These types of interventions are implemented if the exchange rate is moving away from the equilibrium or the exchange rate is moving back to equilibrium 'too quickly'. As a circuit breaker, these types of interventions reduce the 'herd' behaviour in the market. On the other

hand, intervention accelerating speed of exchange rate changes called 'leaning with wind' policy. Such type of interventions aims to activate the market and to ensure the development of the financial market. But there is no evidence for such type of interventions in the Indian context.

Figure 6.1: RBI Intervention and Exchange Rate Movement.



Data Source: RBI

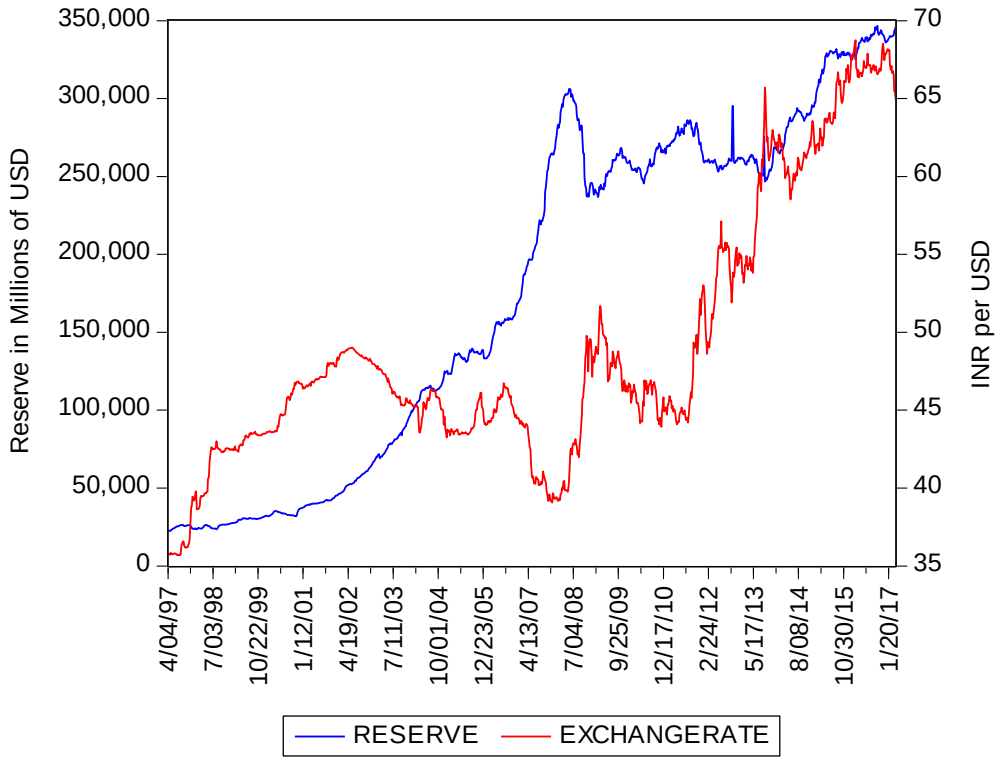
By accumulating foreign exchange reserve, RBI provides 'insurance' to international investors from the rapid exchange rate movement (Aizenman & Lee, 2008). India's reserve accumulation is the by-product of 'fear of floating'. Former RBI governor Raghuram Rajan stated that:

"*We really don't want the currency to move only as result of capital flow….. So we let the exchange rate move, we never stand in the way, but we pick up some as flows come in*" *Rajan (2016).*

This clearly indicates that RBI accumulated foreign exchange reserves while intervening to prevent the appreciation pressure on Indian Rupee. Details of RBI's foreign exchange

reserve and exchange rate movements can be observed from Figure 2. It shows a rapid accumulation reserve after the sub-prime crisis 2008 along with a rapid depreciation of rupee during this period.

Figure 6.2: Reserve Accumulation and Exchange Rate Movement.



Data Source: RBI

Why central banks are going for secret intervention? Empirical studies highlighted some of the key reason for keeping intervention information secret (de Haan, Eijffinger, & Rybiński, 2007; Dominguez, 1998; Horváth & Vaško, 2016; Kim & Sheen, 2002). These points can be observed in various policy statements and speeches of top officials of RBI. One argument is that secrecy intervention prevents market participants to differentiate the effect of the intervention and those of other determinants of exchange rate so that it cannot consider intervention as the renege on formerly declared policy objectives. According to Cukierman & Meltzer (1986) concealing information is one of the ways to protect the credibility of the central bank. Another motive behind the secrecy of intervention is to restrict

the participants from getting information on the central bank's asset position. Since the ability of the central bank intervention completely depends on the resources available with them. Giving detail information on intervention will give counterproductive results during the period of extreme disturbances (presence of destabilising technical or psychological phenomena in the market) and it makes a bandwagon effect which leads to one-way bets or threats to the resistance level. Sometimes secret intervention gives ambiguous signals to the market and accelerates disturbances rather than dampening it. And finally, intervention to replenish the reserve will also pressure central banks to keep intervention confidential to prevent losses from such replenishment.

Literature from the emerging market shows more positive results on the effectiveness of the intervention. This may be attributed to several reasons including information advantage of the central bank, market dominance of central bank, lack of depth in the market and less liquidity. Unlike industrialized economies, emerging market economies are more concerned with appreciation pressure than depreciation, which impacts their competitive position in the world market.

In the case of India, the concept of intervention goes attention after the implementation of a managed floating exchange rate regime in 1994. Shifting from pegged regime to managed floating created volatility of Indian rupee. In order to prevent the consequences of excess volatility, RBI intervened in the market with the objectives of curtailing excess volatility by permitting exchange rates to reflect fundamentals (Prakash, 2012). Even though RBI intervention started long back, an only limited amount of literature is available in this context. It is mainly owing to non-availability of high-frequency data.

These contradictory arguments in the literature on RBIs intervention calls for more academic attempts to bring clarity on the issue. The present study is a step in this direction. Moreover, the existing studies about RBI intervention and its effectiveness on exchange rate volatility were restricted in their scope to examine the problem at hand mainly owing to the limitations of the data used as well as the methodological constraints of the models employed. The present study tries to address these shortcomings by using weekly data on intervention. Moreover, it also seeks to explore the asymmetric impact of the intervention on depreciation and appreciation pressures.

This study used weekly average exchange rate expressed as Rupee per USD, so raise in the exchange rate is a depreciation of INR. Official intervention is defined as the variation of weekly foreign exchange reserve. A negative value of intervention defined as the official sale (sales intervention) and positive value indicate official purchase (purchase intervention) of foreign assets. For the modelling purpose, we calculated the exchange rate return by taking the log difference of exchange rate. Weekly data on the exchange rate and intervention cover a period from the first week of April 1997 to last week of March 2017. Both the data is sourced from the Reserve Bank of India (RBI) database.

Descriptive statistics of the variables in Table 6.1 shows that the Jarque-Bera test failed to accept the null hypothesis of normality for all variables at the 5% level. This non-normality might be partly the result of volatility clustering of the series. Non-normal distribution of the variables is one of the peculiar features of financial time series (Mills & Markellos, 2008). Negatively signed skewness of reserve and net intervention is the evidence of a long left tail in the distribution, which supports the idea that these series follow an asymmetric distribution. The kurtosis of the exchange rate (level) shows the value close to 3 but the foreign exchange reserve shows a platykurtic distribution due to the fact that the distribution follows less number of extreme values in tails. The kurtosis of exchange rate return and net purchase shows a leptokurtic pattern and it validates the heteroscedasticity of the series as it keeps more weight in the tails. The far excess of kurtosis of net intervention series shows the persistent volatility because of the excess distribution in tails. Moreover, these fat tail distribution mainly owing to the volatility of financial assets.

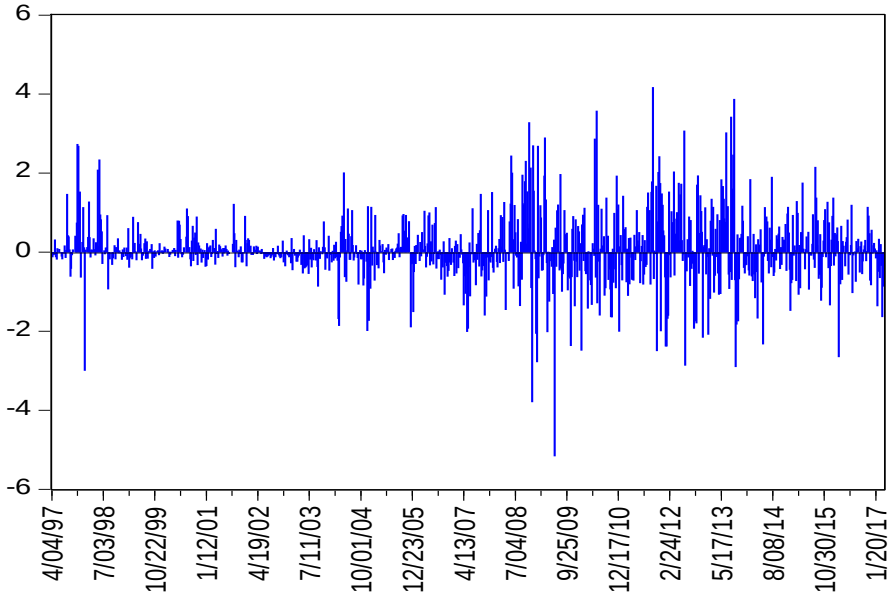
Table 6.1: ***Descriptive Statistics.***

	EXCHANGERATE	RESERVE	Net Purchase	Return
Mean	48.99668	176858.9	313.0222	0.028058
Median	46.305	196877	185	0
Maximum	68.737	346711	35208	2.5
Minimum	35.69	22341	-35832	-2.48
Std. Dev.	8.238136	111133.3	2585.604	0.429395
Skewness	0.96528	-0.11848	-1.01157	0.18413

Kurtosis	2.916295	1.431952	95.33365	8.387477
Jarque-Bera	161.0318	108.4561	367838.8	1257.548
Probability	0	0	0	0
Observations	1035	1035	1035	1035

Source: Authors Calculation

Figure 6.3: ***Exchange Rate Returns***



Data Source: RBI, Authors Calculation

Literature highlighted two methods for estimating exchange rate volatility. First one is Market determined option pricing and second is time series econometrics modelling (Bonser-Neal & Tanner, 1996). The market-determined option price is the best method for estimating volatility as it helps to estimate volatility accurately. The absence of option price data force researcher to opt for time series methodology. It has been monitored that exchange rate fluctuation shows fat tails i.e. leptokurtic. Additionally, the existence of volatility clustering (large changes are followed by further large changes and small fluctuations are followed by further small fluctuations) also motivated researcher to model the exchange rate volatility (Table 1.). Graphical presentation of the exchange rate return (figure3) clearly highlighted

volatility clustering evidently. For confirming the ARCH effect for running a GARCH family model, this study conducted ARCH LM test. The results failed to accept the null hypothesis of absence of ARCH effect (results are presented in table 6.2). Therefore the use of the GARCH model is justified.

Testing the presence of heteroscedasticity is one of the crucial part of volatility modelling in financial time series data. Heteroscedasticity of the residual series can be estimated by using the Lagrange Multiplier (LM) test proposed by Engle (1982) for examining the presence of ARCH effects. The LM test is performed after obtaining the residuals from the Ordinary Least Square Model (OLS) of a conditional mean equation following an Autoregressive (AR) process or Moving Average (MA) process or a mixture of AR and MA process.

An ARMA (1,1) model is described as:

$$X_t = \alpha X_{t-i} + \varepsilon_t + \beta \varepsilon_{t-i} \qquad (6.1)$$

After obtaining residuals from the equation (6.1) regress the squared error term with a constant and its q lags, described as:

$$\varepsilon_t^2 = \delta_0 + \sum_{i=1}^{q} \delta_i \, \varepsilon_{t-1}^2 + v_t \qquad (6.2)$$

Then it is checking the null hypothesis of absence of ARCH effect up to the q lag order against the alternative hypothesis of the presence of ARCH effect. The significance of test statistics for the joint squared residual measured as the number of observation multiplied by the R square of the model (TR^2) tested with a χ_q^2 test.

Table 6.2: ***ARCH Test***

Heteroskedasticity Test: ARCH			P Value
F-statistic	35.83304	Prob. F(1,1032)	0.0000
Obs*R-squared	34.69771	Prob. Chi-Square(1)	0.0000

Source: Authors calculation.

Following Baillie & Bollerslev (1989), Dominguez (1998) and Hoshikawa (2008), this study used a univariate GARCH model to capture the time-varying conditional variance character of the errors in the exchange rate return series. It examines the extent to which variation in the intervention variable influence the conditional mean and conditional variance of the rupee-dollar exchange rates. GARCH models help us to estimate the impact of the intervention on exchange rate volatility on both mean and conditional variance concurrently by modelling the heteroscedastic errors in our equations.

Following Dominguez (1998) and Hoshikawa (2008) GARCH model is developed in such a way that negative coefficient of official intervention point out the net purchase of foreign currency assets depreciate Indian rupee. Conditional variance equation includes the intervention variable in absolute form in order to protect the negativity constraint of the model. GARCH model is estimated using maximum likelihood estimation formula mentioned below:

$$I_t = -0.5\log(2\pi) - 0.5\, log\sigma_t^2 - 0.5(\mathrm{R_t} - \mathrm{x_t}\varphi)^2/\sigma_t^2 \qquad (6.3)$$

$\mathrm{x_t}$ Represent vector of the explanatory variable in the mean equation and φ is related parameter vector. The study used a maximum likelihood function for estimating the model.

Theoretical literature highlighted asymmetry of intervention operation in EMEs i.e. central bank purchase interventions are more effective than sale intervention. So we used to purchase and sale intervention separately for understanding such effects.

6.4 Unit Root Test.

Stationarity of the series is one of the necessary conditions for estimating the regression model. A non- stationary series may mislead the result. This study used both the Augmented Dickey-Fuller test and Philip- Perron test (Dickey & Fuller, 1979; Phillips & Perron, 1988) for stationarity analysis. Since the exchange rate and reserve are non-stationary at level. Taking the first difference of the variables ensured their stationarity at I(0).

6.4.1 Augmented Dickey-Fuller test

The basic ADF equation with constant and trend:

$$Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \, \Delta Y_{t-1} + \varepsilon_t \qquad (6.10)$$

$$\varepsilon_t \sim iid\ (0, \sigma^2)$$

Y_t is the data set, ε_t is the pure white noise error term, β_1 is the constant term, $\beta_2 t$ is the trend term and m represent the lag length of the dependent variables based on the information criteria. Inclusion of the lagged differences of the dependent variable ensures that error terms are serially uncorrelated. ADF estimates the null hypothesis δ=0 (presences of unit root) with an alternative hypothesis δ≠0.

After regressing the dependent variables on independent variables calculate tau statistics with the following equation

$$\tau = \frac{\delta\hat{}-1}{SE\hat{}\,(\delta\hat{})} \qquad (6.11)$$

The computed value of tau statistics (in absolute term | τ |) exceeds the table value, reject the null hypothesis of H_0: $\delta = 0$ against the alternative of H_1: $\delta \neq 0$. If the estimated tau statistics (in absolute term | τ |) are below the table value, accept the null hypothesis of presences of unit root. In such cases taking the first (second in exceptional cases) for making series stationary.

6.4.2 Phillips Perron Test

The basic equations of PP are as follows

With constant and trend

$$Y_t = \alpha + \beta t + \rho Y_{t-1} + \varepsilon_t \text{ , } \varepsilon_t \sim I(0)\ with\ 0\ mean \qquad (6.12)$$

PP test use "band-width" procedure of Newey-West 1987 or Andrews's heteroskedasticity and autocorrelation-consistent covariance matrix estimator for making the Dickey-Fuller (DF) statistics robust to serial correlation. Thus it transforms tau statistics to 'z' with DF distribution. If the adjusted tau statistics (in the absolute term) is greater than the critical value, reject the null hypothesis of the presence of unit root in the series.

H_0: $\rho = 0$ or $c = 0$

H_1: $\rho \neq 0$ or $c \neq 0$

$$z_t = \frac{\hat{\rho} n-1}{\hat{\sigma}} \qquad (6.13)$$

$$z_\rho = n(\hat{\rho} - 1) \quad (6.14)$$

$\hat{\sigma}$ is the OLS standard errors of $\hat{\rho}$

The computed value of z_ρ or z_t statistics (in absolute term exceeds the table value, reject the null hypothesis of H_0: $\rho = 0$ or $c = 0$ against the alternative of H_1: $\rho \neq 0$ or $c \neq 0$. If the estimated z_ρ or z_t statistics (in absolute the term) are below the table value, accept the null hypothesis of presences of unit root. In such cases taking the first (second in exceptional cases) for making series stationary. The results are presented in table 3.

Table 6.3: *Unit Root Test*

	R_t		INT_t	
Test	ADF	PP	ADF	PP
None	-19.42490***	-28.68936***	-14.45728***	-29.43805***
Intercept	-19.52558***	-28.73128***	-27.40119***	-28.87741***
Trend and Intercept	-19.51604***	-28.71819***	-27.67856***	-28.75066***

Notes: *** indicate variables are significant at 1% level.

6.5 Results of the GARCH model.

The result of the equation (6.3) shows the impact of RBI net intervention on exchange rate level. The coefficient of net intervention is expected to be positive, indicate that purchase intervention depreciates the domestic currency and vice versa. Our results are failed to get theoretically explained sign but it is statistically significant. It means RBI intervention failed to influence the exchange rate in the desired direction. Theoretically, it can be explained as 'leaning against wind' policy which aimed to reduce the speed of movement without correcting the trend.

6.5.1 Intervention and Volatility.

Considering the purchase and sale intervention separately gives an entirely different result from the model with net intervention. The estimated result of equation (6.8) shows that purchase and sale interventions influence the exchange rate in the desired direction. In other words purchase (sale) of US$ depreciate (appreciate) the rupee, indicate the trend correcting the behaviour of RBI intervention. Such a result may be because of the peculiar nature of the Indian foreign exchange market where RBI plays a significant role in managing the supply and demand of foreign currency assets with administrative measures on capital flow. Even in the expanded market RBI's purchase and sale intervention are able to influence the expectations of market participants to alter their position in the market. The magnitude of sale intervention is more compared to purchase intervention. This shows the demand-driven pressure can be removed through intervention. But it is difficult to manage supply driven pressure in the presence of high-interest rate differential.

Table 6.4: ***Empirical Results***

Conditional mean equation				
	Equation 6.3		***Equation 6.8***	
	Coefficient	***P Value***	***Coefficient***	***P Value***
C_0	0.014573	0.5030	0.019853	0.4026
C_1	-0.051850	0.0110		
δ_1			0.031106	0.1837

δ_2			-0.102709	0.0028
Conditional Variance equation				
	Equation 6.4		***Equation 6.9***	
α_0	0.014660	0.0000	0.038473	0.0000
α	0.116642	0.0000	0.198447	0.0000
β	0.882516	0.0000	0.769339	0.0000
φ_0	-0.012278	0.0001		
φ_1			-0.041226	0.0000
φ_2			0.021817	0.0000
Diagnostic Test				
$ARCH$	3.610258	0.0578	1.270361	0.260
Q	23.303	0.274	22.084	0.336

Source: Authors Calculation

Variance equation (6.4) shows the impact of net purchase intervention on exchange rate volatility. The statistically significant negative coefficient of net intervention (φ_0) indicates that RBI intervention reduces volatility instead of increasing it. Since the sum of α and β (coefficients of ARCH and GARCH) close to unity shows the high persistence of conditional variance.

The result of equation (6.9) shows the impact of purchase and sale intervention on volatility. Negatively significant purchase intervention reduces volatility whereas sale intervention enhances it. Speculators betting against central bank operation may be one of the key reason behind it. Similarly, with limited resources, RBI can't manage the demand-driven pressure on exchange rate but they can manage supply-driven pressure through purchase intervention. Figure (2) clearly shows such an asymmetric behaviour of RBI intervention. RBI's foreign exchange position itself explains the same.

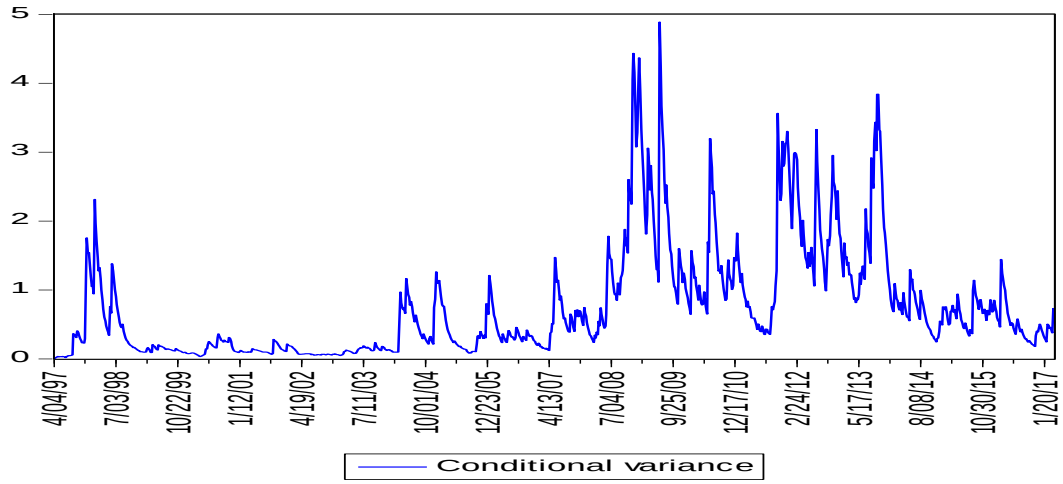
The negative coefficients of the intervention variable in the mean equation are the consensus with the theoretical argument, reveals that RBI intervention influences the exchange rate to move in the desired direction. It gives the idea that intervention was effective to moderate the exchange rate movement and intervention is able to reverse the

exchange rate trend (dampening the current exchange rate trend). Baillie & Osterberg (1997) point out such policies are 'leaning against the wind'.

Sale interventions send ambiguous signals to the market and it attracts more speculative attack as the market participants are aware of the constraint of foreign exchange reserves which can be used for intervention. But in case of purchase intervention there no limit for purchasing foreign exchange reserve if RBI is able to sterilise the same.

Since the mean and variance equation concurrently estimated by using the maximum likelihood approach, inspecting the absence of leftover ARCH effect in the errors of the mean equation gives more information about the significance of the model. Ineffectual assessment of parameters of the mean equation results in the existence of remaining ARCH effect in the model which in turn may generate a poor specification of the variance equation. With the help of ARCH- LM test the study has examined the remaining ARCH effect and failed to reject the null hypothesis of no ARCH effect at 5 percentage level of significance. A test was used to verify whether the GARCH (1, 1) model has effectively captured all of the persistence in the variance of the model. It was analysed by examining whether the correlogram standardized Squared residual is serially correlated (Engle & Patton, 2007). The result of Ljung- Box Q statistics at the 20^{th} lag signified the serially independent of the standardized squared residuals.

Figure 6.4: ***Conditional volatility***.



Source: Authors calculation.

The rupee was highly volatile after the implementation of the managed floating regime and it continued up to the mid of 1999. It may be because of the various economic crisis like Asian Financial crisis 1997, Russian financial crisis 1998 and USDot-com bubble 2000-2002 during this episode. later volatility reduced and the market was calm up to the mid of 2004. During this period rupee gradually depreciated and touched 49.010 per US$ and started appreciating again. This period experienced quite a high sale intervention compared to purchase intervention. the volatility of the exchange rate is increased after the mid of 2004 and it was moderate to April 2007. Expansion of the Indian economic activities enhanced demand for USD hence rupee started depreciating again. Impact of the sub-prime crisis 2008 magnified the volatility of rupee and continued up to 2011. This was one of the crucial periods for RBI, where the rupee was under strong appreciation pressure. But the failure of Lehman Brothers leads to depreciation of the rupee after strong appreciation pressure. 2011 to 2014 was the second episode of excessive volatility. high inflation, low productivity, political instability along with crisis recovery policies of the united states fueled the volatility. Performance of the was worse and in August 2013 touched a record low 68.3611 per USD. Last few years witnessed low-volatility with rapid depreciation of the Rupee. In February 2016 rupee touched its record low of 68.775 per US$ in February 2016. Along with the rapid depreciation, foreign exchange reserves were also growing very fast as a result of

high degree of asymmetric intervention against rupee appreciation driven from fear of floating as suggested by Calvo & Reinhart (2002).

This chapter empirically examined the impact of RBI intervention on exchange rate level and volatility with GARCH (1,1) model. Following Adler & Tovar (2011) valuation adjusted weekly reserve data (as a proxy for RBI intervention) for from the first week of April 1997 to the last week of April 2017 were used. The study found that purchase intervention depreciates the rupee against US$ and sale intervention appreciate the same. One noticeable point is that the coefficient of sale is much higher that of purchase. It shows the central banks concern on the rupee depreciation over appreciation. It may be because of the expectation on inflation derived from the depreciation of the rupee. In case of volatility it can be observed that purchase intervention reduces the volatility, which shows that RBI interventions are able to minimise the supply driven market uncertainty. Whereas the sale intervention amplify the market uncertainty, shows intervention failed to curb demand driven volatility. it may be because of the fact that market participants are aware about the limits of RBI sale intervention and they might be betting against the same. It can be concluded that RBI should continue its intervention practices whenever the foreign exchange market is in a directionless condition or diverting from the equilibrium level without the support of fundamentalists. Using microstructure channels of intervention also helps to increase the effectiveness of the intervention during such episodes.

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Forecasts and Appropriateness

This chapter examines the different forecasting models in case of US Dollar (USD), Great Britain Pound (GBP), Euro (EUR) and Japanese Yen (JPY). The daily data of the respective currencies have been considered 4th January 1999 to 31st March 2017. The variables to be examined in the study are USD, GBP, EUR and JPY. For forecasting the respective variables, we have applied Artificial Neural Network a nonlinear, nonparametric and data-driven modelling technique. Neural networks have a number of advantages over the other time series methods. First NN does not have any assumption about the nature of the distribution of data and requires less formal statistical training (Tu, J. V. 1996; Kuo & Reitsch, 1996 and Panda, 2011). Second, neural networks are best for nonlinear, ill-conditioning, robust, noisy and insufficient data *(*Hoptroff, 1993). Third, neural networks are better than the conventional methods (Regression Analysis, Moving Averages and Smoothing methods, the Box-Jenkins methodology etc.) in capturing the past relationships between the variables that might influence the result of the dependent variable (Kuo & Reitsch, 1996; Portugal, 1995 and Panda, 2011). Fourth, multilayer feedforward networks have mapping capability which is suitable in approximating the measurable function with accurate results (Hornik, et al. 1989; and Cybenko, 1989). Last, ANN is suitable for obtaining forecasts in the short period of time in comparison to the econometric techniques (Li, et al., 2004). We have reviewed some selected works on the performance of the neural network in chapter 2 (Nowrouz Kohzadi, et al. 1995; Henry C. Co, et al.2007; Aggarwal et al. 2008; Youngohc Yoon, et al. 1991; William Leigh, et al. 2002; Kumar, 2010; Kamruzzaman, et al. 2003; Weigend, et al. 1992). The overall outcome of these studies suggested that ANN is supreme over the other traditional techniques of forecasting (Gupta and Kashyap, 2015). So this motivates us to apply artificial neural network to forecast USD, GBP, EUR and JPY of the Indian foreign exchange market.

In order to get the final output, the weighted sum is passed through a filter called the transfer function or the activation function (Rajshekhran and Pai, 2012) which transforms the output from the input range so that the output may not be too large. In our study, we have first run the neural network model with the Linear, Logistic, Tanh, Exponential and Sine activation functions and compared the different forecasting models on the basis of

these activation functions and finally recommended the best forecasting model. There are many points which are to be taken into consideration before applying the ANN such as a number of inputs, hidden nodes; hidden layers and output(s). The hidden layer and its nodes play an important role in the effective implementation of ANN. In the network, the nodes in the hidden layer help in detecting the pattern of the data in such a way that the input and the output mapping can be performed proficiently (Gupta and Kashyap, 2015). Moreover, one hidden layer is adequate for most of the forecasting problems (Zhang, et al.1998). However increasing the size of the hidden layer will increase the processing power of the network, but it complicates the training process and the errors are difficult to be traced G B Hua (1996). If there are few neurons in the hidden layer, it can stop the network from mapping the inputs into outputs. Furthermore, too many neurons will lead to the risk of overloading the network (Hamid, 2004). There is no basis to determine the number of hidden units or layers in the network. Though too many hidden units will lead to the risk of overfitting of the data yet the forecasting accuracy can be achieved. Moreover, a number of weights will lengthen the estimating time of the model (Gonzalez, 2000). In our study, we have taken one hidden layer for finding out a suitable network because in literature one hidden layer is sufficient to capture all the information about the data. In NN architecture, we have considered only one output node and lagged values of the target variable is taken as inputs.

7.1 Results and Discussion

In the present study, the daily data of the respective currencies has been considered from 4th January 1999 to March 2017 from the RBI website. The variables to be examined in the study are US Dollar (USD), Great Britain Pound (GBP), Euro (EUR) and Japanese Yen (JPY) having 4567 observations. There is no basis how to split the data for training, testing and validation purpose. In the literature, most of the researchers have proposed to divide the data like 60:20:10, 70:20:10 or 80:10:10 (Haofei Zou et al. 2007). So we have divided 80 per cent data for training, 10 per cent for testing and 10 per cent for validation purpose respectively because it considers maximum data points for training the ANN model.

In practice, designing of the neural network is more an art, not the mathematics (Zhang et al. 1998). In our study, we have first run the neural network model with the Linear, Logistic, Tanh, Exponential and Sine activation functions and compared the

different forecasting models on the basis of these activation functions and finally recommended the best forecasting model. Through the trial and error approach, we have undertaken various combinations of one to ten neurones in the input layer and the hidden layer, one hidden layer and one output layer respectively. Out of the various models, we have finally chosen the best ten models on the basis of minimum SSE and RMSE. The results of best ten fitted models from the different activation functions as Identity, logistic, Tanh, Exponential and Sine are expressed in Table 1 for all the four currencies USD, GBP, EURO and JPY respectively.

Table 7.1 ***Sum of squared error and Root mean square error of different multilayered perceptron models of USD, GBP, EURO and JPY***

S. No.	**Currency**	**Architecture**	**SSE**	**RMSE**	**Activation Function**
1		MLP 1-7-1	0.0001731787	0.0001980084	Identity
2		MLP 2-5-1	0.0001413974	0.0001789192	Identity
3		MLP 3-10-1	0.0001413899	0.0001789145	Identity
4		MLP 4-5-1	0.0001414474	0.0001789509	Identity
5		MLP 5-2-1	0.0001413883	0.0001789134	**Identity**
6		MLP 6-2-1	0.0001423547	0.0001795239	Identity
7		MLP 7-8-1	0.0001413661	0.0001788995	Identity
8		MLP 8-8-1	0.0001413927	0.0001789163	Identity
9		MLP 9-2-1	0.0001498766	0.0001842057	Identity
10		MLP 10-8-1	0.0001413674	0.0001789002	Identity
1	**USD**	MLP 1-6-1	0.0001420650	0.0001793411	Logistic
2		MLP2-3-1	0.0001564738	0.0001882163	Logistic
3		MLP3-6-1	0.0001445670	0.0001809135	Logistic
4		MLP4-9-1	0.0001435468	0.0001802740	Logistic
5		MLP5-3-1	0.0001423674	0.0001795319	**Logistic**
6		MLP6-7-1	0.0001429877	0.0001799225	Logistic

7		MLP7-3-1	0.0001484560	0.0001833307	Logistic
8		MLP8-7-1	0.0001447650	0.0001810373	Logistic
9		MLP9-3-1	0.0001435540	0.0001802785	Logistic
10		MLP10-6-1	0.0001436560	0.0001803425	Logistic
1		MLP 1-1-1	0.0001414026	0.0001789225	Tanh
2		MLP2-7-1	0.0001418650	0.0001792148	Tanh
3		MLP3-8-1	0.0001423450	0.0001795178	**Tanh**
4	**USD**	MLP4-7-1	0.0001489877	0.0001836587	Tanh
5		MLP5-2-1	0.0001413550	0.0001788924	Tanh
6		MLP6-9-1	0.0001412658	0.0001788359	Tanh
7		MLP7-5-1	0.0001442970	0.0001807444	Tanh
8		MLP8-3-1	0.0001434530	0.0001802151	Tanh
9		MLP9-5-1	0.0001415466	0.0001790136	Tanh
10		MLP10-9-1	0.0001415679	0.0001790271	Tanh
1		MLP 1-3-1	0.0001413881	0.0001789133	Exponential
2		MLP2-4-1	0.0001427773	0.0001797901	Exponential
3		MLP3-9-1	0.0001428340	0.0001798258	Exponential
4		MLP4-2-1	0.0001428937	0.0001798634	Exponential
5		MLP5-7-1	0.0001659982	0.0001938599	Exponential
6		MLP6-3-1	0.0001748674	0.0001989714	**Exponential**
7		MLP 7-8-1	0.0001445230	0.0001808859	Exponential
8		MLP 8-3-1	0.0001423470	0.0001795190	Exponential
9		MLP 9-4-1	0.0001423450	0.0001795178	Exponential
10		MLP10-4-1	0.0001423450	0.0001795178	Exponential
1		MLP 1-8-1	0.0001428977	0.0001798659	Sine
2		MLP 2-6-1	0.0001423456	0.0001795181	Sine

3		MLP 3-6-1	0.0001833450	0.0002037374	Sine
4		MLP 4-8-1	0.0001631234	0.0001921739	Sine
5		MLP5-3-1	0.0001456780	0.0001816073	**Sine**
6		MLP 6-5-1	0.0001423456	0.0001795181	Sine
7		MLP 7-9-1	0.0001419898	0.0001792936	Sine
8		MLP 8-3-1-	0.0001425345	0.0001796372	Sine
9		MLP 9-5-1	0.0001444342	0.0001808303	Sine
10		MLP10-3-1	0.0001432123	0.0001800638	Sine
1	**GBP**	MLP 1-2-1	0.000132279	0.0001730538	Identity
2		MLP 2-4-1	0.000136282	0.0001756531	Identity
3		MLP 3-6-1	0.000132012	0.0001728795	Identity
4		MLP 4-3-1	0.000132961	0.0001734996	Identity
5		MLP 5-4-1	0.000139877	0.0001779545	**Identity**
6		MLP 6-9-1	0.000133089	0.0001735829	Identity
7		MLP 7-10-1	0.000136749	0.0001759534	Identity
8		MLP 8-3-1	0.000135248	0.0001749855	Identity
9		MLP 9-1-1	0.000134947	0.0001747908	Identity
10		MLP 10-8-1	0.000135593	0.0001752083	Identity
1		MLP 1-8-1	0.000133346	0.0001737503	Logistic
2		MLP 2-9-1	0.000133990	0.0001741695	Logistic
3		MLP 3-5-1	0.000138765	0.0001772462	Logistic
4		MLP 4-4-1	0.000136876	0.0001760354	Logistic
5		MLP 5-9-1	0.000134562	0.0001745410	**Logistic**
6		MLP 6-4-1	0.000135646	0.0001752424	Logistic
7		MLP 7-3-1	0.000139543	0.0001777421	Logistic
8		MLP 8-9-1	0.000135678	0.0001752633	Logistic

9		MLP 9-5-1	0.000136543	0.0001758211	Logistic
10		MLP 10-8-1	0.000136789	0.0001759794	Logistic
1	**GBP**	MLP 1-2-1	0.000133346	0.0001737503	Tanh
2		MLP 2-8-1	0.000132035	0.0001728940	Tanh
3		MLP 3-6-1	0.000134595	0.0001745624	**Tanh**
4		MLP 4-8-1	0.000132456	0.0001731698	Tanh
5		MLP 5-3-1	0.000131995	0.0001728684	Tanh
6		MLP 6-10-1	0.000133984	0.0001741660	Tanh
7		MLP 7-6-1	0.000132323	0.0001730831	Tanh
8		MLP 8-5-1	0.000138546	0.0001771060	Tanh
9		MLP 9-6-1	0.000136543	0.0001758212	Tanh
10		MLP 10-9-1	0.000137654	0.0001765350	Tanh
1		MLP 1-7-1	0.000136474	0.0001757766	Exponential
2		MLP 2-7-1	0.000135432	0.0001751044	Exponential
3		MLP 3-8-1	0.000146543	0.0001821457	Exponential
4		MLP 4-5-1	0.000156843	0.0001884382	Exponential
5	**GBP**	MLP 5-4-1	0.000136543	0.0001758211	Exponential
6		MLP 6-3-1	0.000226954	0.0002266758	**Exponential**
7		MLP 7-2-1	0.000178765	0.0002011766	Exponential
8		MLP 8-4-1	0.000133457	0.0001738227	Exponential
9		MLP 9-10-1	0.000136543	0.0001758212	Exponential
10		MLP 10-10-1	0.000133658	0.0001739537	Exponential
1		MLP 1-3-1	0.000137655	0.0001765353	Sine
2		MLP 2-2-1	0.000188764	0.0002067264	Sine
3		MLP 3-9-1	0.000198453	0.0002119657	Sine
4		MLP 4-9-1	0.000237654	0.0002319577	Sine

5		MLP 5-8-1	0.000137453	0.0001764063	**Sine**
6		MLP 6-10-1	0.000138456	0.0001770485	Sine
7		MLP 7-7-1	0.000137355	0.0001763429	Sine
8		MLP 8-3-1	0.000137485	0.0001764268	Sine
9		MLP 9-2-1	0.000138645	0.0001771695	Sine
10		MLP 10-6-1	0.000138675	0.0001771881	Sine
1		MLP 1-6-1	0.000141445	0.000178949	Identity
2		MLP 2-3-1	0.000141446	0.000178950	Identity
3		MLP 3-6-1	0.000143546	0.000180274	Identity
4		MLP 4-1-1	0.000141396	0.000178918	Identity
5		MLP 5-4-1	0.000142877	0.000179853	Identity
6		MLP 6-1-1	0.000141384	0.000178911	Identity
7		MLP 7-1-1	0.000147654	0.000182835	**Identity**
8		MLP 8-6-1	0.000150988	0.000184887	Identity
9		MLP 9-3-1	0.000141391	0.000178915	Identity
10		MLP 10-10-1	0.000141480	0.000178971	Identity
1	**EURO**	MLP1-4-1	0.000142637	0.000179702	Logistic
2		MLP2-4-1	0.000142865	0.000179846	Logistic
3		MLP3-9-1	0.000142544	0.000179643	Logistic
4		MLP4-4-1	0.000143266	0.000180098	**Logistic**
5		MLP5-8-1	0.000142536	0.000179638	Logistic
6		MLP6-6-1	0.000143679	0.000180357	Logistic
7	**EURO**	MLP7-7-1	0.000144455	0.000180843	Logistic
8		MLP8-3-1	0.000143465	0.000180222	Logistic
9		MLP9-3-1	0.000143648	0.000180337	Logistic
10		MLP 10-4-1	0.000145466	0.000181475	Logistic

1		MLP 1-1-1	0.000143335	0.000180141	Tanh
2		MLP2-6-1	0.000142536	0.000179638	Tanh
3		MLP3-8-1	0.000141097	0.000178729	Tanh
4		MLP 4-7-1	0.000141988	0.000179292	Tanh
5		MLP 5-8-1	0.000141244	0.000178822	Tanh
6		MLP 6-4-1	0.000141999	0.000179300	Tanh
7		MLP 7-2-1	0.000142355	0.000179524	Tanh
8		MLP 8-6-1	0.000142347	0.000179519	Tanh
9		MLP 9-3-1	0.000141238	0.000178818	Tanh
10		MLP 10-3-1	0.000142637	0.000179702	**Tanh**
1		MLP 1-8-1	0.000143547	0.000180274	Exponential
2		MLP 2-3-1	0.000143550	0.000180276	Exponential
3	**EURO**	MLP 3-2-1	0.000142365	0.000179530	Exponential
4		MLP 4-1-1	0.000143988	0.000180551	Exponential
5		MLP 5-2-1	0.000177654	0.000200551	Exponential
6		MLP 6-10-1	0.000176543	0.000199923	Exponential
7		MLP 7-2-1	0.000143695	0.000180367	Exponential
8		MLP 8-7-1	0.000293778	0.000257897	**Exponential**
9		MLP 9-3-1	0.000154658	0.000187121	Exponential
10		MLP 10-3-1	0.000143334	0.000180140	Exponential
1		MLP 1-6-1-	0.000145363	0.000181411	Sine
2		MLP 2-6-1	0.000143988	0.000180551	Sine
3		MLP 3-3-1	0.000143545	0.000180273	Sine
4		MLP 4-4-1	0.000146546	0.000182147	Sine
5		MLP5-2-1	0.000143765	0.000180411	Sine
6		MLP 6-9-1	0.000246575	0.000236271	Sine

7		MLP 7-5-1	0.000143877	0.000180481	**Sine**
8		MLP 8-3-1	0.000154536	0.000187047	Sine
9		MLP 9-5-1	0.000143977	0.000180581	Sine
10		MLP 10-9-1	0.000198765	0.000212132	Sine
1		MLP 1-8-1	0.000141386	0.000178912	Identity
2	**JPY**	MLP 2-10-1	0.000141386	0.000178912	Identity
3		MLP 3-4-1	0.000143848	0.000180463	Identity
4		MLP 4-6-1	0.000151275	0.000185063	Identity
5		MLP 5-2-1	0.000141380	0.000178908	Identity
6		MLP 6-8-1	0.000143526	0.000180261	Identity
7		MLP 7-8-1	0.000148765	0.000183522	Identity
8	**JPY**	MLP 8-4-1	0.000141454	0.000178955	Identity
9		MLP 9-6-1	0.000144457	0.000180844	**Identity**
10		MLP 10-1-1	0.000141466	0.000178962	Identity
1		MLP 1-3-1	0.000145346	0.000181400	Logistic
2		MLP 2-4-1	0.000144355	0.000180781	Logistic
3		MLP 3-9-1	0.000148746	0.000183510	Logistic
4		MLP 4-4-1	0.000144536	0.000180894	**Logistic**
5		MLP 5-3-1	0.000145884	0.000181735	Logistic
6		MLP 6-9-1	0.000144325	0.000180762	Logistic
7		MLP 7-3-1	0.000144759	0.000181033	Logistic
8		MLP 8-3-1	0.000149574	0.000184020	Logistic
9		MLP 9-5-1	0.000143547	0.000180274	Logistic
10		MLP 10-9-1	0.000145648	0.000181588	Logistic
1		MLP 1-3-1	0.000141874	0.000179220	Tanh
2		MLP 2-6-1	0.000142355	0.000179524	Tanh

3		MLP 3-7-1	0.000142746	0.000179770	Tanh
4		MLP 4-7-1	0.000142735	0.000179764	Tanh
5		MLP 5-7-1	0.000146583	0.000182171	Tanh
6		MLP 6-1-1	0.000147486	0.000182731	**Tanh**
7		MLP 7-4-1	0.000142375	0.000179536	Tanh
8		MLP 8-3-1	0.000141987	0.000179292	Tanh
9	**JPY**	MLP 9-4-1	0.000141988	0.000179292	Tanh
10		MLP 10-5-1	0.000142387	0.000179545	Tanh
1		MLP 1-5-1	0.000143756	0.000180406	Exponential
2		MLP 2-8-1	0.000145365	0.000181412	Exponential
3		MLP 3-7-1	0.000148765	0.000183522	Exponential
4		MLP 4-7-1	0.000147654	0.000182835	Exponential
5		MLP5-4-1	0.000145367	0.000181414	Exponential
6		MLP 6-8-1	0.000245423	0.000235719	**Exponential**
7		MLP 7-7-1	0.000388387	0.000296530	Exponential
8		MLP 8-4-1	0.000145436	0.000181457	Exponential
9		MLP 9-7-1	0.000145877	0.000181731	Exponential
10		MLP 10-4-1	0.000142636	0.000179701	Exponential
1		MLP 1-3-1	0.000141425	0.000178937	Sine
2		MLP 2-4-1	0.000142655	0.000179713	Sine
3		MLP 3-8-1	0.000145788	0.000181676	Sine
4		MLP 4-3-1	0.000146355	0.000182029	Sine
5		MLP 5-4-1	0.000248385	0.000237137	Sine
6		MLP 6-6-1	0.000147686	0.000182855	Sine
7		MLP 7-4-1	0.000144859	0.000181096	Sine
8		MLP 8-8-1	0.000144877	0.000181107	**Sine**

9		MLP 9-5-1	0.000344888	0.000279431	Sine
10		MLP 10-8-1	0.000144836	0.000181082	Sine

USD- In the case of Identity activation function, the optimum forecasting model is 7-8-1 because the SSE and RMSE were 0.0001413661 and 0.0001788995 respectively which was least in comparison to other competitive models. Similarly, for logistic activation function, the ultimate forecasting model is 1-6-1 because the SSE was 0.0001420650 and RMSE was 0.0001793411 respectively which was least than the other models. The best forecasting model for Tanh activation function is 6-9-1 because the SSE and RMSE were least up to the value of 0.0001412658 and 0.0001788359 respectively in comparison to its counterparts. For Exponential activation function, the dominant forecasting model in comparison to other models is 1-3-1 because the SSE was 0.0001413881 and RMSE was 0.0001789133 respectively. Finally, the best forecasting model for Sine activation function is 7-9-1 because the SSE and RMSE were lowest up to the value of 0.0001419898 and 0.0001792936 respectively.

GBP- In the case of Identity activation function, the optimum forecasting model is 3-6-1 because the SSE and RMSE were 0.000132012 and 0.0001728795 respectively which was least in comparison to other competitive models. Similarly, for logistic activation function, the ultimate forecasting model is 1-8-1 because the SSE was 0.000133346 and RMSE was 0.0001737503 respectively which was least than the other models. The best forecasting model for Tanh activation function is 5-3-1 because the SSE and RMSE were least up to the value of 0.000131995 and 0.0001728684 respectively in comparison to its counterparts. For Exponential activation function, the dominant forecasting model in comparison to other models is 8-4-1 because the SSE was 0.000133457 and RMSE was 0.0001738227 respectively. Finally, the best forecasting model for Sine activation function is 7-7-1 because the SSE and RMSE were lowest up to the value of 0.000137355 and 0.0001763429 respectively.

EURO- In the case of Identity activation function, the optimum forecasting model is 6-1-1 because the SSE and RMSE were 0.000141384 and 0.000178911 respectively which was least in comparison to other competitive models. Similarly, for logistic activation function, the ultimate forecasting model is 5-8-1 because the SSE was 0.000142536 and

RMSE was 0.000179638 respectively which was least than the other models. The best forecasting model for Tanh activation function is 3-8-1 because the SSE and RMSE were least up to the value of 0.000141097 and 0.000178729 respectively in comparison to its counterparts. For Exponential activation function, the dominant forecasting model in comparison to other models is 3-2-1 because the SSE was 0.000142365 and RMSE was 0.000179530 respectively. Finally, the best forecasting model for Sine activation function is 3-3-1 because the SSE and RMSE were lowest up to the value of 0.000143545 and 0.000180273 respectively.

JPY- In the case of Identity activation function, the optimum forecasting model is 5-2-1 because the SSE and RMSE were 0.000141380 and 0.000178908 respectively which was least in comparison to other competitive models. Similarly, for logistic activation function, the ultimate forecasting model is 9-5-1 because the SSE was 0.000143547 and RMSE was0.000180274 respectively which was least than the other models. The best forecasting model for Tanh activation function is 1-3-1 because the SSE and RMSE were least up to the value of 0.000141874 and 0.000179220 respectively in comparison to its counterparts. For Exponential activation function, the dominant forecasting model in comparison to other models is 10-4-1 because the SSE was 0.000142636 and RMSE was 0.000179701 respectively. Finally, the best forecasting model for Sine activation function is 1-3-1 because the SSE and RMSE were lowest up to the value 0.000141425 and 0.000178937 respectively.

Table 7.2 ***Best model amongst the different multi-layered perceptron models of USD, GBP, EURO and JPY***

	USD	**SSE**	**RMSE**	**Activation Function**		**GBP**	**SSE**	**RMSE**	**Activation Function**
1	MLP 7-8-1	0.0001413	0.0001788	Identity	1	MLP 3-6-1	0.0001320	0.000172	Identity
2	MLP 1-6-1	0.0001420	0.0001793	Logistic	2	MLP 1-8-1	0.0001333	0.000173	Logistic
3	MLP6-9-1	0.0001412	0.0001788	Tanh	3	MLP 5-3-1	0.0001319	0.000172	Tanh
4	MLP 1-3-1	0.0001413	0.0001789	Exponential	4	MLP 8-4-1	0.0001334	0.000173	Exponential

5	MLP 7-9-1	0.0001419	0.0001792	Sine	5	MLP 7-7-1	0.000137	0.0001763	Sine
	EURO	**SSE**	**RMSE**	**Activation Function**		**JPY**	**SSE**	**RMSE**	**Activation Function**
1	MLP 6-1-1	0.0001413	0.0001789	Identity	1	MLP 5-2-1	0.0001413	0.0001789	Identity
2	MLP5-8-1	0.0001425	0.0001796	Logistic	2	MLP 9-5-1	0.0001435	0.0001802	Logistic
3	MLP3-8-1	0.0001410	0.0001787	Tanh	3	MLP 1-3-1	0.0001418	0.0001792	Tanh
4	MLP 3-2-1	0.0001423	0.0001795	Exponential	4	MLP 10-4-1	0.0001426	0.000179701	Exponential
5	MLP 3-3-1	0.0001435	0.0001802	Sine	5	MLP 1-3-1	0.0001414	0.000178937	Sine

Table 7.2 ***Ranking of the best-multilayered perceptron models of USD, GBP, EURO and JPY.***

Currency	**S. No.**	**Neural Architecture**	**Activation function**	**Ranking**	**Currency**	**S. No.**	**Neural Architecture**	**Activation function**	**Ranking**
USD	1	MLP 7-8-1	Identity	2	**GBP**	1	MLP 3-6-1	Identity	2
	2	MLP 1-6-1	Logistic	5		2	MLP 1-8-1	Logistic	3
	3	**MLP6-9-1**	**Tanh**	**1**		3	**MLP 5-3-1**	**Tanh**	**1**
	4	MLP 1-3-1	Exponential	3		4	MLP 8-4-1	Exponential	4
	5	MLP 7-9-1	**Sine**	4		5	MLP 7-7-1	Sine	5
	1	MLP 6-1-1	Identity	2		1	**MLP 5-2-1**	**Identity**	**1**
	2	MLP5-8-1	Logistic	4		2	MLP 9-5-1	Logistic	5

EURO	3	**MLP3-8-1**	**Tanh**	**1**	**JPY**	3	MLP 1-3-1	Tanh	3
	4	MLP 3-2-1	Exponential	3		4	MLP 10-4-1	Exponential	4
	5	MLP 3-3-1	Sine	5		5	MLP 1-3-1	Sine	2

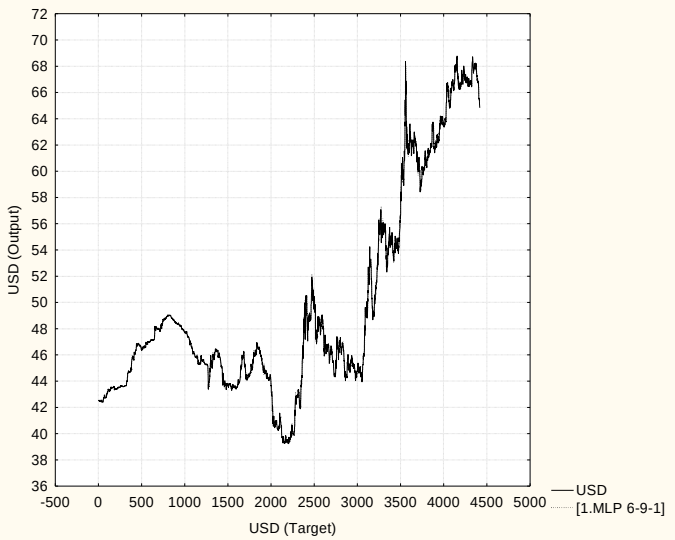
Table 7.2 and 7.3 clearly depicts the best model and ranking of various models amongst the different multilayered perceptron models on the basis of the activation functions as Identity, logistic, Tanh, Exponential and Sine in the case of USD, GBP, EURO and JPY respectively. The best forecasting model of USD is 6-9-1 of Tanh activation function because the SSE was 0.0001412658 and RMSE was 0.0001788359 respectively which was least than its competitors. Similarly, the best forecasting model of Pound is 5-3-1 of Tanh activation function because the SSE and RMSE were 0.000131995 and 0.0001728684 respectively which was least in comparison to its counterparts. Similarly, in case of EURO, the best forecasting model is 3-8-1 of Tanh activation function again because the SSE and RMSE were 0.000141097 and 0.000178729 respectively which was least to its competitors. Finally the best forecasting model of Yen is 5-2-1 of Identity activation function because the SSE was 0.000141380 and RMSE was 0.000178908 respectively.

7.1.1 Comparison between the Actual and Predicted Values

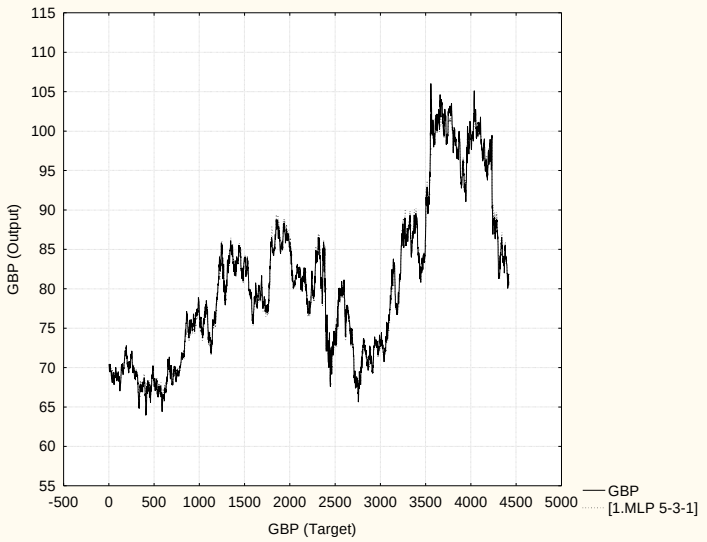
From the best-fitted models of USD, GBP, EURO and JPY, the comparison between the actual and the predicted values of the exchange rate have been plotted; graphical uniformity is depicted in figure 6.1. In the figure, the continuous line and the dotted line indicate the actual and the predicted values respectively from 4th January 1999 to 31st March 2017. From the close inspection of the figure, it is obvious to conclude that the respective ANN models are appropriate for the present data and can be employed for producing the out of sample predictions.

Figure 7.1 ***Comparison between the actual and predicted values in the case of USD, GBP, EURO and JPY***

a) USD (MLP- 6-9-1)

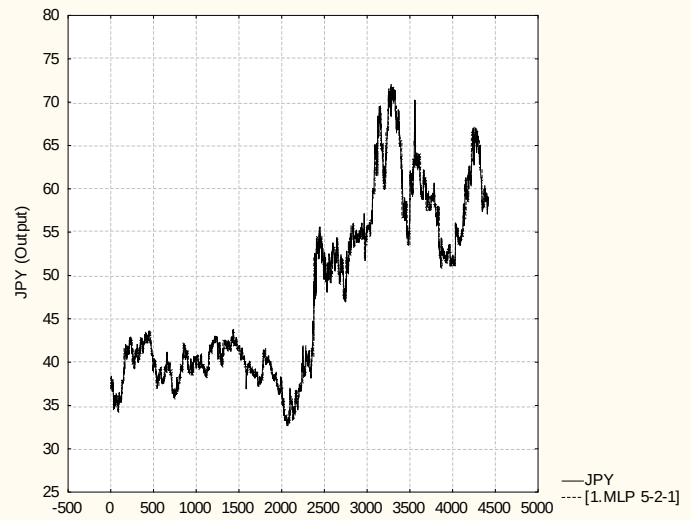


b) GBP (MLP- 5-3-1)



c) EURO (MLP- 3-8-1)

d) JPY (MLP- 5-2-1)



7.1.2 Forecasts based on fitted Neural Models

Table 7.4 clearly shows the out of sample forecasts of the exchange rate from April 1, 2017, to April 28, 2017. The examination of the Table revealed that in the case of USD/INR, on April 1, 2017, the predicted value of USD will be 65.03, will continuously be depreciating to 65.48 and 65.58 on April 11, 2017 and April 12, 2017, respectively and

it will finally settle to 66.78 on April 28, 2017. In the case of GBP/INR, on April 1, 2017, the predicted value of GBP will be 81.07, will continuously be depreciating to 81.48 and 81.56 on April 11, 2017, and April 12, 2017, respectively and it will finally settle to 82.23 on April 28, 2017.

Table 7.4: ***Out of sample forecasts of USD, GBP, EURO and JPY on the basis of best neural models***

Date	USD Predicted	GBP Predicted	EURO Predicted	JPY Predicted
April 3, 2017	65.03418	81.01712	69.85018	58.42853
April 4, 2017	65.07786	81.05182	69.84497	58.45402
April 5, 2017	65.14549	81.15294	69.84149	58.42821
April 6, 2017	65.22965	81.23546	69.83819	58.42428
April 7, 2017	65.31061	81.32775	69.83493	58.41984
April 10, 2017	65.39578	81.40644	69.83171	58.41725
April 11, 2017	65.48820	81.48580	69.82853	58.41243
April 12,2017	65.58617	81.56028	69.82538	58.40828
April 13,2017	65.68650	81.63276	69.82227	58.40411
April 14,2017	65.78940	81.70137	69.81919	58.40005
April 17,2017	65.89503	81.76717	69.81614	58.39591
April 18,2017	66.00240	81.82982	69.81313	58.39179
April 19,2017	66.11011	81.88964	69.81014	58.38766
April 20,2017	66.21712	81.94658	69.80719	58.38355
April 21,2017	66.32238	82.00081	69.80428	58.37944
April 24,2017	66.42463	82.05239	69.80139	58.37533
April 25,2017	66.52254	82.10144	69.79854	58.37122
April 26,2017	66.61492	82.14804	69.79571	58.36712
April 27,2017	66.70080	82.19231	69.79292	58.36302

April 28,2017	66.77936	82.23432	69.79015	58.35892

Similarly, the predicted value of EURO will be 69.85, will continuously be appreciating to 69.82 on April 11, 2017 and it will finally settle to 69.79 on April 28, 2017. Finally, in the case of YEN/INR the predicted value will be 58.41 on April 11, 2017, has been experiencing appreciation marginally and will settle to 58.35 on April 28, 2017. Analysis of the predicted exchange rates of USD, GBP, EURO and JPY shows that USD, GBP will depreciate and EURO, JPY will appreciate during the coming days.

7.2 CONCLUSIONS

In this chapter we have compared the different forecasting models on the basis of Linear, Logistic, Tanh, Exponential and Sine activation functions and finally recommended the best forecasting model for out of sample prediction of the exchange rates of USD, GBP, EURO and JPY in terms of Indian rupee on daily data from 4th January 1999 to 31st March 2017. We have recommended neural network models on the basis of two loss functions as SSE and RMSE and on the basis of the proposed model the in-sample forecasts have been compared with the actual values.

It has been observed that the Tanh function happened to be the best fit for USD, GBP, EURO and Identity function is suitable April 28, 2017, on the basis of the best models has also been calculated. The outcome of the study depicts that USD, GBP, EURO and JPY shows that USD, GBP will depreciate and EURO, JPY will appreciate in April 2017 onwards. So these recommended models are the benchmark for the policy makers, practitioners and researchers to forecast the exchange rate for the coming time period.

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Summary and Conclusion

The foreign exchange market is the largest highly and liquid financial market in the world with worldwide average daily turnover around $5.3 trillion, which makes foreign exchange highly global trading asset (Rime & Schrimpf, 2013). Foreign exchange forms the basis of dealings for trade and other monetary transactions between economies of the world. Trading participants in this market include central banks, commercial banks, companies, brokers, fund managers, speculators and individuals. Every participant aims to achieve its objectives with the best possible management of risks to which one is exposed. High liquidity comes with high volatility which makes management of risk difficult. Since the global capital is highly volatile and forms its basis from country fundamentals and investor sentiments. This volatility influences exchange rate and in turn the trade balance and cost of goods and services of import-dependent countries like India.

Impact of several factors such as economic forces, market psychology, political influences and availability of several technical trading rules etc. makes the prediction of the exchange rate a highly volatile and intricate phenomenon. Even forex traders, academicians and economists who study the forex market every day find it difficult to accurately predict exchange rate movements (Hill, 2012). All market participants whether central banks, commercial banks, multinational corporations or brokers, speculators and individuals etc. make attempts to accurately predicting future exchange rate movements in order to satisfy their respective objectives.

In forex market technical analysis is considered to be the most successful and most utilized means of making decisions and analyzing FOREX markets (Archer & Bickford, 2015). Technical analysis attempts to forecast prices by analyzing market data. Technical analyses aim at generating buy and sell signals by predicting the direction in which the market moves through the use of various technical techniques such as price charts, moving averages momentum, oscillators, etc. Technical analysis is an important and widely used method of analysis in the foreign exchange market and that applying certain technical trading rules over a sustained period may lead to significant positive excess returns (Menkhoff & Taylor, 2006). For taking trading decisions traders in many banks, hedge funds, and another potential market-moving institutions will often use certain techniques of technical analysis.

Fundamentals focus on estimating exchange rate movements based on economic and political forces affecting supply and demand of a currency. Fundamental analysis studies political considerations and economic factors also known as macroeconomic indicators, such as interest rates, inflation, Gross Domestic Product, unemployment, Balance of Payment position, foreign exchange reserves, government policies, industrial and commercial production.

Behavioural finance research has contributed significantly in the field of foreign exchange trading by exploring through different methods factors that affect trader's psychology. Behavioural factors comprise variables that affect a trader's psychology such as bandwagon effects, overreaction to the news, market judgment, peers & social influences and rumours etc. Overreaction to news followed by bandwagon, effects are the most important driving factors that cause movements in the exchange rate (Cheung, Chinn, & Marsh, 2004). Successful forex trading requires a total approach that integrates fundamentals, technical analysis, and psychology (Cofnas, 2012).

The issue of central bank intervention in the foreign exchange market is crucial and highly relevant in order to know how the intervention affects the exchange rate. Intervention is required to smooth out excessive fluctuations in exchange rates in order to avoid the adverse effects of these fluctuations on economic activity. Whether or not official exchange rate intervention is effective in influencing exchange rates, and the means, by which it does so, are issues of crucial policy importance, and they have been the subject of a vast academic and policy-related literature (Sarno and Taylor 2001).

Foreign exchange market is characterised by unpredictability, high volatile, complex and chaotic in behaviour. The present study is an attempt to study the ability of fundamental and non-fundamental factors to determine exchange rates, empirical verification of impact of Central Bank Interventions on Exchange rate and Volatility and to recommend an appropriate model for forecasting in the Indian Foreign Exchange rate market.

OBJECTIVES OF THE STUDY

The specific objectives of the study are:

1. To examine the relative importance of fundamental as well non-fundamental that influence foreign exchange rate predictions and the role of their specific constituents over different time horizons.
2. To know the level of importance assigned by foreign exchange traders to fundamental and non-fundamental factors, while trading in the foreign exchange market.
3. To assess the impact of central bank interventions in the foreign exchange market in India.
4. To assess and quantify the extent of the volatility of the Indian foreign exchange market due to Central Bank interventions.
5. To recommend the appropriate model to forecast the exchange rate movements of INR-USD; INR-GBP, INR-JPY and INR-EUR.
6. To recommend measures for policy makers, investors and corporate on the basis of conclusions from the present study.

8.2 Review of Literature

Copious studies have been conducted to investigate the different facets of the exchange rate. The available literature on foreign exchange market has been thoroughly reviewed (refer to chapter 2 for details) but in the present section is discussed in four sub-sections as follows:

8.2.1 Studies Associated to Survey of Traders: Very few studies have been conducted on the theme of Survey of Traders. The prominent studies are of Bhanumurthy, 2006; Cheung & Chinn, 2001; Cheung et al., 2004; Cheung & Wong, 2000; Fischer, Isakova, & Termechikov, 2009; Gehrig & Menkhoff, 2006; Lui & Mole, 1998; Oberlechner, 2001. Review of the entire cited studies highlight that there is a need to conduct primary database study in the Indian context.

8.2.2 Studies Related to Fundamental and Technical Analysis: The review of literature on fundamental and technical analysis reveals that there is dearth of studies in this area, Some of the studies that were reviewed are: Cialenco & Protopapadakis, 2011; Lee, Gleason, & Mathur, 2001; Martin, 2001; Menkhoff & Taylor, 2007; Neely & Weller, 2011.

The literature on this theme is inconclusive. This justifies the need for a comprehensive study.

8.2.3 Studies Related to Central Bank Interventions and its Impact on Volatility: Central Bank intervenes in the foreign exchange market to stabilise the fluctuation in foreign exchange rate. Many empirical studies have been conducted to know the impact of Central Bank interventions. In this regard the studies by Baillie & Osterberg, 1997; Barnett & Ozerturk, 2007; Bayoumi & Eichengreen, 1998; Beattie & Fillion, 1999; Beine, 2001; Beine, Laurent, & Lecourt, 2003; Berganza & Broto, 2012; Bleaney & Francisco, 2008; Brissimis & Chionis, 2004; Catalán-Herrera, 2016; Cheng, Das, & Shimatani, 2013; Dominguez, 1993; Dominguez, 2003; Dominguez, 1998; Dominguez & Frankel, 1993; Doroodian & Caporale, 2001; Égert & Lang, 2007; Fischer & Zurlinden, 1999; Frenkel, Pierdzioch, & Stadtmann, 2004; Hoshikawa, 2008; HUNG, 1997; Ito, 2002, 2007; Kaminsky & Lewis, 1996; Kearns & Manners, 2006; Kihangire, 2010; Kim, Kortian, & Sheen, 2000; Kim & Sheen, 2006; Kim & Sheen, 2002; Miyajima & Montoro, 2005; Moreno, 2005; Mundell, 2000; Neely, 2000; Saacke, 2002; Sahadevan, 2002; Sarno & Taylor, 2001; Seerattan & Spagnolo, 2009; Watanabe & Harada, 2006 are noteworthy. Review of these studies highlights the necessity to conduct a study on the basis of survey and secondary data.

8.2.4 Studies related to Forecasting- Various studies have been conducted relating to forecasting. The relevant studies are of Andreou & Zombanakis, 2006; Canova, 1993; Chen, Peng, & Abraham, 2006; Dua & Ranjan, 2011; Engel, Mark, & West, 2015; Eva & Maria, 2011; Ince, 2014; Jiang, Ahmed, & Liu, 2017; Kamruzzaman & Sarker, 2003; Lam, Fung, & Yu, 2009; Rout, Majhi, Majhi, & Panda, 2014 etc. The outcome of all the studies shows the superiority of non-linear models over linear models.

8.3 Data Base and Methodology

The Present study is based on primary as well as secondary data. The primary data was collected through a non-disguised structured questionnaire. The questionnaire was administered to 250 respondents selected on the basis of purposive sampling. The survey instrument was pretested and examined for validity and reliability. To ensure content validity of questionnaire items, discussions were held with 2 expert's having more than 20 years of experience in the foreign exchange market and 2 professors from the academic field. After

two revisions consensus was formed among the suggestions of experts from two fields and questionnaires were administered on 60 brokers from Ludhiana for assessing reliability. After a gap of 20 days questionnaire was again administered to the same 60 brokers. Reliability for unidimensional measures was assessed through Cronbach alpha (α) and for other questions, where internal consistency between items/statements was not desired, reliability was assessed through test-retest reliability coefficients.

The target respondents for the survey were 58 dealers registered with RBI (Reserve Bank of India), 94 brokers/sub-brokers registered with SEBI (Securities and Exchange Board of India) and 96 investors from Delhi, Ludhiana, Amritsar, Jalandhar and Chandigarh. List of registered brokers and sub-brokers traders were obtained from the handbook of statistics on Indian securities market 2014, published by SEBI. Selection of cities was made on the basis of the highest number of registered brokers. From each city, major trading locations were identified and respondents were targeted accordingly. One investor from each broker office was selected on the basis of highest trading experience. Out of total 250 questionnaires, 248 completed questionnaires were received from respondents. Finally, 248 completed questionnaires were used for analysis.

In order to examine the extent of volatility due to Central Bank interventions weekly data on the exchange rate and intervention cover a period from the first week of April 1997 to last week of March 2017. The study also generated forecasts of the Indian foreign exchange market covering United States Dollar (USD), Great Britain Pound (GBP), Euro (EUR) and Japanese Yen (JPY) in terms of Indian rupee (INR) on daily basis from 4th January 1999 to 31st March 2017. Secondary data has been culled from the websites of RBI, State and Central Governments, FEDAI, NSE & BSE etc.

Primary as well as secondary data in the present study has been analyzed with bar charts, pie charts and tables. Descriptive analysis of data was undertaken using various tools like averages, variance, kurtosis and skewness for normality test and outlier detection. Correlation, t-test and ANOVA have been used for inferential analysis. GARCH (1, 1) was used to detect the effect of Central Bank interventions on volatility. Artificial Neural Network modelling was used to generate forecasts (for details refer to Chapter 3).

8.4 Findings of the Study

The major findings of the study are as follows:

8.4.1 Fundamental and Non-Fundamental Factors Impact on Foreign Exchange Market: The present study compared the ability of fundamental factors with non-fundamental factors (Technical, behavioral and speculation) to determine the exchange rate. Based on the literature, hypotheses $H_0$1 to $H_0$4 were developed and tested. The results show that:

- Determination of foreign exchange rate through fundamental factors was significantly higher than technical factors. However, the relevance of fundamental factors was found to be significant in long-period (6 months and more). It expresses that traders rely more on fundamentals than technical factors in the long run. As the length of time period decreases, the ability of technical factors to determine foreign exchange increases. Therefore, in the medium run (1 week to 3 months) traders give more importance to technical factors. This is consistent with the findings of (Bhanumurthy, 2006; Cheung & Chinn, 2001; Fischer et al., 2009; Gehrig & Menkhoff, 2006; Lui & Mole, 1998; Oberlechner, 2001; Saacke, 2002b; Taylor & Allen, 1992)
- Fundamental factors ability to determine foreign exchange rate was significantly higher than behavioural factors. However, the relevance of fundamental factors was found to be significant in long-period (6 months and more). It expresses that traders rely more on fundamentals than behavioural factors in the long run. In intraday and medium period (1 week to 3 months), the dependence of traders on behavioural factors for determination of foreign exchange found to be higher than fundamentals. Comparable results were obtained in some other studies such as, (Cheung & Chinn, 2001; Cheung et al., 2004; Cheung & Wong, 2000; Frankel & Froot, 1990).
- Fundamental factors ability to determine foreign exchange rate was significantly higher than speculation. However, the relevance of fundamental factors was found to be significant in long-period (6 months and more). It expresses that traders rely more on fundamentals than speculation in the long run. Dependence of traders on speculation for determination of foreign exchange found to be higher than

fundamentals in a very short period (intraday). The findings support the arguments of (Bhanumurthy, 2006; Cheung & Chinn, 2001; Cheung et al., 2004).

8.4.2 Success rate achieved through Fundamental and Non-Fundamental Factors While Trading in the Foreign Exchange Market: The present study seeks to analyze, whether the success rate achieved by foreign exchange traders through fundamental factors differ significantly from the success rate achieved through non-fundamental factors. The results show that:

- Success rate achieved through fundamental factors found to be significantly higher than technical factors. However, the usefulness of a factor may vary for prediction of trends and turning points. To compare the prediction of a trend with turning pints following hypotheses were developed and tested. The results revealed that fundamental factors were considered somewhat more useful in predicting trends than predicting turning points in the foreign exchange market). The findings are consistent with results of Lui & Mole (1998). Technical factors were considered somewhat more superior in predicting turning points than predicting the trend in the foreign exchange market. Comparable results were obtained by Lui & Mole (1998). Fundamental factors were considered somewhat more useful in predicting trends in the foreign exchange market than technical factors. This is contrary to the findings of Lui & Mole (1998). Technical factors were considered somewhat more useful in predicting turning points in the foreign exchange market than fundamental factors. Similar results were obtained by Lui & Mole (1998).
- Success rate achieved through fundamental factors found to be significantly higher than behavioural factors.
- Foreign exchange traders viewed success through fundamental factors significantly higher than behavioural factors.
- Overall comparison of non-fundamental factors with fundamental factors revealed that the success rate achieved by foreign exchange traders in the foreign exchange market, through fundamental factors was significantly higher than non-fundamental factors.

8.4.3 Within Factor Comparison of Factor Constituents (Intra-Factor Comparison)

To know the relative importance of factor constituents in predicting foreign exchange rate, all the constituents within a particular were compared with each other. The results revealed that:

- Foreign exchange traders viewed the prediction ability of various constituents of fundamental factors significantly different from each other. Interest rates were found to be a relatively important fundamental factor in exchange rate prediction. This is consistent with the findings of Lui & Mole (1998) Interest rate was followed by monetary policy, inflation, central bank interventions, GDP, rating by major credit rating agencies and budget deficit. Unemployment was ranked last followed by balance of payment position, stock market operations and political stability. All the constituents of fundamental factors were further investigated to know the importance of each over different time horizons. Fundamental factors that have influence over the long run are GDP and budget deficit. BOP position, unemployment, political stability and stock market operations have influenced both in medium and long run primarily from 3 months to a year. Inflation, interest rates, credit rating, monetary policy and central bank interventions found to have relatively important in the medium period (1 week to 3 months).
- Foreign exchange traders viewed turning points prediction ability of various constituents of technical factors significantly different from each other. The rate of change indicator and moving average convergence divergence were regarded as relatively most important factors in predicting turning points followed by stochastic, William % R, Bollinger bands and relative strength indicator. Filters and channel rule received lowest scores followed by Fibonacci retracement, neural networks, candlesticks, average directional movement index and moving averages. For moving averages results show consistency with the study results of Lee, Pan, & Liu (2001)
- Foreign exchange traders viewed the trend prediction ability of various constituents of technical factors significantly different from each other. Average directional movement index and moving averages were regarded as most relatively important factors in predicting trends followed by neural networks, Bollinger bands, stochastic, relative strength indicator and William % R. Filters and channel rule received lowest

scores followed by Fibonacci retracement, candlesticks, the rate of change indicator and moving average convergence divergence.

- The ability of various constituents of behavioural factors to influence trading decisions of foreign exchange traders differ significantly from each other. Overreaction to the news was reported to be a factor with the highest ability followed by rumours, market judgments, bandwagon effects and peer & social influences.

8.4.4 Effect of Speculation on Foreign Exchange Rate: Based on the literature, hypotheses related to the effect of speculation on foreign exchange rate were developed and tested. The results show that:

- It appeared that broker/sub-broker views regarding the effect of speculation on increase in exchange rate volatility were significantly higher than dealer group and investor group. Investor views regarding the effect of speculation on increase in exchange rate volatility were significantly higher than dealer group. However, no significant difference was found in the views of broker/sub-broker group and investor group. This is consistent with the findings of Cheung & Wong (2000).
- It was found that investor's views regarding speculation move exchange rate away from fundamental levels were significantly higher than dealer group and brokers/sub-brokers group. The views of the dealer group do not differ significantly from the investor group. Similar results were obtained by (Cheung & Chinn, 2001; Fischer et al., 2009).
- It appeared that broker/sub-broker views regarding the effect of speculation on increase in liquidity in the foreign exchange market were significantly higher than the dealer. Broker/sub-broker group views regarding the effect of speculation on increase in liquidity in the foreign exchange market were higher but not significantly different from the investor group. No significant difference was found in the views of dealer group and investor group. The results are consistent with the findings of Fischer et al., 2009).
- Therefore, all foreign exchange traders believe that speculation improves market efficiency. Similar results were obtained by Fischer et al., 2009).

8.4.5 Impact of Central Bank Interventions on Foreign Exchange Market: To study the impact of central bank interventions on the foreign exchange market we have used both views of foreign exchange traders and secondary data. The results show that:

- All foreign exchange traders highly believe that central bank interventions affect the foreign exchange rate.
- All foreign exchange traders believe that central bank interventions have little effect on the foreign exchange rate as the average score of each trader group was below the median (4) of a 7-point scale. Broker/sub-broker group differs significantly from dealer group and investor group regarding the effect of central bank interventions on exchange rate volatility. There was no significant difference in the views of dealer group and investor group regarding the effect of central bank interventions on exchange rate volatility. This is consistent with the findings of (Cheung & Wong, 2000; Fischer et al., 2009; Miyajima & Montoro, 2005). This is contrary to the findings of (Baillie & Osterberg, 1997; Beine, Laurent, & Lecourt, 2003; Dominguez, 2003; Dominguez, 1998; Edison, Cashin, & Liang, 2006) who found that central bank interventions are associated with higher exchange rate volatility.
- All foreign exchange traders believe that central bank interventions have a trivial effect on foreign exchange rate fundamental levels as the average score of each trader group was below the median (4) of a 7-point scale. Broker/sub-broker group differs significantly from dealer group and investor group regarding the effect of central bank interventions on exchange rate volatility. Broker/sub-broker group was the only groups which had mean close to the median of the scale. No significant difference was found in the views of dealer group and investor group regarding the effect of central bank interventions on exchange rate volatility. Comparable results were obtained in some other studies such as (Cheung & Chinn, 2001; Fischer et al., 2009; Menkhoff & Taylor, 2007).
- All foreign exchange traders believe that central bank interventions are conducted at appropriate as the average score of each trader group was above the median (4) of a 7-point scale. Dealer group differs significantly from the broker/sub-broker group and investor group. Broker/sub-broker group differs significantly from the investor group.

- Dealer and investor group believe that central bank interventions are conducted at appropriate as the average score of each trader group was above the median (4) of a 7-point scale. Dealer group differs significantly from the broker/sub-broker group, dealer group differs significantly from the investor group and broker/sub-broker group differs significantly from the investor group.
- For examining the impact of the intervention on volatility, weekly data on the exchange rate and intervention was used from the first week of April 1997 to last week of March 2017. The results revealed the evidence for the presence of 'leaning against the wind' policy which aims to minimise the speed of exchange rate movement rather than correcting the existing trend. Nevertheless, RBI purchase intervention curbs the exchange rate volatility whereas sale intervention amplifies it. It suggests that the central bank is likely to react asymmetrically to exchange rate shocks through direct foreign exchange market interventions subjected to the nature of price shocks influencing the exchange rate of policy concern. Similarly, the forward market intervention also curbs exchange rate volatility. It can be concluded that RBI intervention to prevent the appreciation pressure (supply driven volatility) was successful as compared to the prevention of rupee depreciation (demand driven volatility).

8.4.6 Impact of Central Bank Interventions on Technical Rules Profitability. One of the objectives of the present study was to assess the impact of central bank interventions on technical rules profitability. In this context, results of hypothesis revealed that:

- All traders disagree with the statement that central bank interventions have an influence on profits for chartists in short term. Dealer and investor group disagreed and broker/sub-broker slightly disagreed to the statement. Therefore, it appeared that broker/sub-broker views regarding the effect of central bank interventions on profits for chartists in short term were significantly different from dealer group and investor group. However, no significant difference was found in the views of dealer group and investor group. This is consistent with the findings of (Menkhoff & Taylor, 2007)

8.4.7 Forecasting of the Foreign Exchange Market- For forecasting the USD, EURO, GBP and JPY, we have applied artificial neural network a nonlinear, nonparametric and data-driven modelling technique with Linear, Logistic, Tanh, Exponential, Sine activation functions. We compared the different forecasting models on the basis of these activation functions and finally recommended the best forecasting model based on loss functions for out of sample prediction.

- The best forecasting model of USD is 6-9-1 of Tanh activation function because the SSE was 0.0001412658 and RMSE was 0.0001788359 respectively which was least than its competitors. Similarly, the best forecasting model of Pound is 5-3-1 of Tanh activation function because the SSE and RMSE were 0.000131995 and 0.0001728684 respectively which was least in comparison to its counterparts. Similarly, in the case of EURO, the best forecasting model is 3-8-1 of Tanh activation function again because the SSE and RMSE were 0.000141097 and 0.000178729 respectively which was least to its competitors. Finally, the best forecasting model of Yen is 5-2-1 of Identity activation function because the SSE was 0.000141380 and RMSE was 0.000178908 respectively.
- The recommended models i.e. 6-9-1, 5-3-1, 3-8-1 of Tanh activation function in case of USD, GBP, EURO and 5-2-1 of Identity activation function in case of JPY respectively have been considered for out of sample prediction. From the predicted exchange rate of USD, GBP, EURO and JPY it is depicted that USD/INR and GBP/INR will appreciate during the period of forecast, EURO/INR and JPY/INR will depreciate during the period of prediction.

8.5 Recommendations of the Study

The research has the following key implications and recommendations:

I. In long run (6 months-more than 1 year), fundamental factors found to be more significant than technical factors in both, its ability to influence foreign exchange market and success rate. Technical factors dominate medium run (1 week-3 month) trading as the majority of foreign exchange traders relied on technical factors in the

long run. Therefore, applications of these techniques differ in terms of time period. For long term trading, foreign exchange traders should give more weight to fundamentals and for medium period trading due consideration on technical factors should be placed.

II. A comparison of various constituents of fundamental factors with each other revealed that interest rate is the most important fundamental constituent followed by monetary policy, inflation, central bank interventions (CBI), gross domestic product (GDP), rating by major credit rating agencies (CRA) and budget deficit. Unemployment was regarded as the least important fundamental constituent followed by balance of payment (BOP) position, stock market operations and political stability. However, foreign exchange traders should consider these fundamental constituents on the basis of their time-period. GDP and budget deficit are important in long run. Inflation, interest rates, credit rating, monetary policy and CBI are relatively important in the medium period. The constituents of a fundamental factor that are important in both medium and long run are BOP position, unemployment, political stability and stock market operations.

III. For trading in long run (6 months), foreign exchange traders should apply the rate of change indicator followed, bollinger bands, stochastic and neural networks. Fibonacci retracement, channel rule, and candlesticks should be utilised for generating trading signals for a period of 1 week. The filter was the only technical rule found to be significant for intraday trading. Moving averages holds significance over a period from 3 months to 6 months. Relative strength indicator dominates other trading techniques for a trading period of 3 months followed by stochastic.

IV. Fundamental factors found to be more effective in predicting trends than turning points. Whereas technical factors are more useful in the prediction of turning points. Based on these findings it is suggested that foreign exchange traders should utilise technical trading techniques for identifying turning points in the foreign exchange market and trend prediction should be followed with fundamental factors.

V. Comparison of fundamental factors with technical factors revealed that fundamental factors are more useful than technical for predicting trends in the foreign exchange market. Whereas, technical factors dominate fundamental factors in predicting

turning points. It is therefore recommended that for forecasting turning points in foreign exchange market high confidence should be laid on technical factors, whereas, fundamental factors gain an advantage over technical for trend prediction.

VI. The rate of change (ROC) indicator and moving average convergence divergence (MACD) were reported to be the most important technical factors in predicting turning points followed by stochastic, William % R, Bollinger bands and rate of strength indicator (RSI). For predicting trends through technical factors foreign exchange traders should consider the average directional movement index (ADI) and moving averages (MA) followed by neural networks.

VII. In long run (6 months-more than 1 year), fundamental factors found to be more significant than behavioural factors in both, its ability to influence foreign exchange market and success rate. However, as the length of time period contracts reliance on behavioural factors gain an advantage. Behavioural factors have the least impact in influencing foreign exchange market and success rate achieved through it was also ranked lowest amongst other factors. Therefore, high caution is required for taking trading decisions processed through behavioural factors.

VIII. Within factor evaluation of behavioural factors indicates that over-reaction to the news was the major constituent of behavioural factors that have the ability to influence decisions of foreign exchange traders. Rumours were the next important constituent followed by market judgments, bandwagon effects and peer and social influences. Therefore, careful interpretation of news is necessary for proper judgments of its impact on the foreign exchange market. The authenticity of news should be established for differentiating it from rumours.

IX. Fundamental factors found to be superior to speculation in influencing the foreign exchange rate. Success rate achieved through following fundamentals found to be significantly higher than speculation. However, speculation believed to have importance in a very short period (intraday). Impact of speculation should be duly considered, as all foreign exchange traders viewed that speculation significantly increase volatility in the foreign exchange market in a very short period. In long run, speculation revealed no significant impact in moving the exchange rate away from

their fundamental levels. All traders believe that speculation increase liquidity but do not improve market efficiency in the foreign exchange market.

X. In long run and over very short period central bank interventions found to have a trivial effect on foreign exchange volatility and movement of exchange rate away from their fundamental levels. However, over a medium period, due consideration on intervention effect is required. All foreign exchange dealers and investors believed that central bank interventions are conducted at an appropriate moment and achieve the desired goal. Broker/sub-broker reported to be neutral in their perspective.

XI. All traders disagreed that central bank interventions result in profits for chartists in short period. Hence, gaining advantage from the intervention effect reported to be difficult in a short period. This may be because different types of the interventions root cause of different effect on exchange rate fluctuations as the significance of a particular type of intervention vary according to the time period involved. Thus, it becomes difficult for traders to forecast intervention moves of central banks and so, unable to take advantage of it.

XII. Jawboning is the only type of intervention that has intraday effects on the foreign exchange rate. Jawboning revealed the highest influence on exchange rate followed by spot market intervention, forward market intervention and operational intervention. Monthly influences on exchange rates were dominated by scheduled interventions followed by operational intervention, forward market intervention, currency swaps, concerted and sterilized intervention. Foreign exchange rates over more than a month were dominated by sterilized intervention followed by concerted intervention, currency swaps and scheduled interventions.

XIII. Appreciation or Depreciation impact of the rupee varies from firm to firm such as export and import-dependent concerns thereby benefitting tremendously or hitting adversely. The export-oriented firms such as software suffer heavily if there is an appreciation of rupee thereby making local goods and services costlier in the foreign market. So the solution to this problem is the appropriate derivative tool to hedge the risk due to the currency fluctuations. Measures should be taken to bring the transparency in the currency derivative segment which may affect mainly the small firms. The client positions of the open interest must be relaxed and paperwork should

be made lessened so that more Indian companies can go for hedging their increasing amount of inflows or outflows. The cost of hedging should be reduced so that more small companies can go for the risk management tools. Moreover, Volatility forecasting should be used for managing the currency risk. More sophisticated techniques like hybrid models, decision trees models, non-linear GARCH model etc. can be applied for desirable results.

XIV. The financial institutions such as banks are the authorised dealers, who deal with the purchase and sale of foreign currencies in India, should be given the freedom to initiate long and short term trading position in the overseas market. They should be free to borrow or invest funds within specified limits in the overseas market. The banks may use the derivative products for the management of asset and liability mismatch.

XV. The banks play an important role in making the link between forex and domestic markets. For the internal control of foreign exchange, the banks should be given the freedom to frame their own risk management guideline. Banks should be free to lend the currencies to the corporate without linking it to export and import financing for any productive purpose.

XVI. The corporate has to deal with economic exposure such as accounting exposure while preparing their consolidated balance sheet. They have to manage the currency risk by hedging through derivative contracts such as forward, futures and options. They should be given freedom to cancel and rebook forward contracts.

XVII. Forex market is deregulated in nature being ruled by brokers, so a layman has to do trading with the professionals. A trader has less control on the exact status of his trade-order being executed, may not find a good bargain or may receive incomplete information of the trading quotes as given by the selected broker. It means that the foreign exchange market is not fully transparent. A simple solution for this problem is to deal only with those brokers who are authorised to do.

XVIII. Since the state-run oil companies are the major cause for the demand of millions of dollars on daily basis, so they should be permitted to raise extra funds in case of need through external commercial borrowings (ECBs). It will reduce the pressure on the rupee in case volatility arises.

XIX. Foreign companies are less active in the currency market and as per information, their share is even less than 1 per cent in the rupee-dollar derivative contracts of exchange. The reason for restricted participation is inadequate liquidity, limited flexibility and inadequate margin requirements duration of contracts. So the need of the hour is to develop a suitable derivative product that may receive more genuine customers.

XX. The companies are applying these days the instruments like Global Depository Receipts (GDRs), American Depository Receipt (ADRs) and Indian Depository Receipts (IDRs) for raising the funds from the international markets. To closely screen these investments, a review and assessment relating to the source of funds, purpose and term of such investment need to be carefully handled. The audit of the firms, who make use of this route, should be done. In this concern, RBI and SEBI should work with great synchronisation. The funds with the suspicious source need to be watched closely.

XXI. A finding of the study shows that sterilized intervention is not able to create a permanent impact on Rupee exchange rate. RBI intervention may be able to deal with undesirable exchange rate movements driven from the temporary market shocks and helps to hold back the magnitude and pace of exchange rate movements; otherwise, it would have enlarged the market vulnerability. Therefore RBI intervention can be used as a short-term independent market instrument to manage the exchange rate (directly) as a substitute for capital control (administered measure). In addition to that using the conventional volatility estimators like moving standard deviation or coefficient of variation may not yield an accurate result; hence, policy decision should be designed after analysing the exchange rate volatility with appropriate volatility models.

XXII. Post-subprime intervention accumulated a huge amount of foreign exchange reserve and its level is crossed beyond the conventional optimum reserve measurement. The necessity and objective of reserve accumulation should be communicated with the market otherwise it may create counterproductive results. In addition to that, the cost and benefit of the accumulated reserve should be analysed because the cost of reserve accumulation is one of a key determining factor for a sustainable intervention operation. The high cost of intervention due to the low yield from foreign assets

negatively influence the profitability of RBI and it may be harmful to the sustainability of monetary authority. Hence, RBI should consider all these factors before absorbing the excess supply of foreign exchange from the market.

XXIII. Foreign intervention is the best instrument for monetary expansion in a growth-oriented economy like India. Using intervention after ensuring a stable money demand will help country acquire foreign exchange reserve and to maintain external competitiveness. But RBI should consider existing domestic as well as foreign economic environment before implementing its policies, otherwise, intervention to prevent appreciation pressure may consider as currency manipulation and hamper the credibility of the central bank.

XXIV. Increasing volatility during the uncertainty episodes is mainly owing to the fact that intervention operation brings ambiguity in the market. One possible reason may the communication gap between the monetary authority and heterogeneous market participants. So intervention policies should design in such a way that it should act as a coordinating channel among the market participants.

XXV. Central bank intervention is a short-term policy to manage the unwanted movements of exchange rate without the support of economic fundamentals. It should not be used as a substitute for monetary policy or to compensate for the failure in economic fundamentals. If there are some issues in fundamentals, RBI should not interfere in the free movements of the exchange rate and should allow the rupee to appreciate (depreciate), otherwise it may give counterproductive result and cause depletion of the foreign exchange reserve. Similarly, intervention should not be used for creating an artificial exchange rate for maintaining external competitiveness.

XXVI. According to Blinder (2000) credibility of the central bank is one of the determinants of policy success. A low credible central bank may not be able to influence the intervention even if it designed and implemented properly. The ineffectiveness of jawboning intervention indicates low credibility of RBI in the foreign exchange market. There should be more attention to the development of institutional and instrumental level which will improve the credibility and autonomy of the RBI and help to give leverage effect on policy actions.

XXVII. During the period of global market uncertainty and heavy capital inflow, the RBI intervention operations are not completely able to manage the undesirable movements of the exchange rate. There should be special arrangements for the absorption these types of heavy shocks without much impact on domestic money supply. During the periods of capital inflow, RBI can accumulate the reserves after considering the future requirements of the reserve, but the cost of reserve accumulation should be considered as one of the criteria before doing such interventions. In addition to that, it is better to have an automatic sterilisation facility to reduce the impact of intervention due to lumpy capital inflow.

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XXX. Instead of targeting nominal exchange rate, it is better to target the Real Effective Exchange Rate (REER) because it gives a clear idea on the overvaluation and undervaluation of the domestic currency in relation to the trading (transacting) partners. Because of the sentiment and speculative oriented determination, using nominal exchange rate may lead to wrong conclusion depreciation (appreciation) of the domestic currency and ultimately makes the intervention counterproductive.

The present study has executable implications for policy makers, investors and corporate. On the basis of conclusions from the present study the policies should be designed to make forex market on resilient.

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An Empirical Study on Dynamics of Foreign Exchange Market in India

Kindly help me to gather the information by sparing your 10-15 minutes for filling the questionnaire. The information will be kept confidential and used for academic purpose only. We will be very thankful.

SECTION – A

Q1: Your current position is….. *(Mark only one oval)*

- ◯ Dealer (RBI Registered)
- ◯ Broker/Sub Broker (SEBI Registered)
- ◯ Investor
- ◯ Others (Specify.....)

Q2: What is your experience in Foreign Exchange Trading *(number of years)*……..

Q3: Which factor(s) in your opinion determines exchange rates? *(Mark only one oval per row)*

7 means most important and 1 means least important

	(7)	(6)	(5)	(4)	(3)	(2)	(1)
Fundamental factors	◯	◯	◯	◯	◯	◯	◯
Technical factors	◯	◯	◯	◯	◯	◯	◯
Behavioural factors	◯	◯	◯	◯	◯	◯	◯
Speculation	◯	◯	◯	◯	◯	◯	◯

Q4: Please mark your opinion on following factors as per their importance in determining foreign exchange rate over different forecast horizons: *(Mark only one oval per row)*

	Intraday	1 Week	1 Month	3 Months	6 Months	1 Year	> 1 Year
Fundamental factors	◯	◯	◯	◯	◯	◯	◯
Technical factors	◯	◯	◯	◯	◯	◯	◯
Behavioural Factors	◯	◯	◯	◯	◯	◯	◯
Speculation	◯	◯	◯	◯	◯	◯	◯

Q5: Rate your opinion on the following constituents of fundamental factor as per their ability to influence foreign exchange rates. *(Mark only one oval per row),* **7 means highly ability to influence and 1 means least ability to influence.**

	7	6	5	4	3	2	1
Inflation							
Interest Rates							
Balance of Payment Position							
Unemployment							
Political Stability							
GDP							
Budget Deficit							
Rating by major Global Credit Rating Agencies							
Monetary Policy							
Government (Central Bank) Intervention							
Stock market operations							

Q6: As per your opinion, how quickly information of fundamental factors is reflected in foreign exchange rates:
(Mark only one oval per row)

	Intraday	1 Week	1 Month	3 Months	6 Months	1 Year	> 1 Year
Inflation							
Interest Rates							
Balance of Payment Position							
Unemployment							
Political Stability							
GDP							
Budget Deficit							
Rating by major Global Credit Rating Agencies							
Monetary Policy							
Government (Central Bank) Intervention							
Stock market operations							

Q7: Rate the following constituents of behavioural factors as per their ability to influence your foreign exchange trading decisions. *(Mark only one oval per row).*
7 means highly influenced and 1 means least influenced

	7	6	5	4	3	2	1
Bandwagon effects (I follow trading actions of others)							
Over reaction to news							
Market Judgments							
Peers/Social influence(s)							
Rumors							

Q 8: Rate your degree of agreement on statements where **7 means strongly agree and 1 means strongly disagree**. *(Mark only one oval per row).*

	7	6	5	4	3	2	1
Speculation increases exchange rate volatility							
Speculation move exchange rates away from their fundamental levels							
Speculation increases market liquidity							
Speculation improves market efficiency							

Q9: Rate the predictability of market trend as per your opinion over different time horizon.
*(Mark only one oval per row).***7 means high Predictability and 1 means least Predictability.**

	7	6	5	4	3	2	1
Intraday							
1 Week							
1 Month							
3 Months							
6 Months							
1 Year							
> 1 Year							

Q10: Rate the importance of data in predicting trends. *(Mark only one oval per row)*
7 means most important and 1 means least important

	7	6	5	4	3	2	1
Daily data							
Weekly data							
Monthly data							
Quarterly data							
Semi-annually data							
Yearly data							

Q11: For predicting both trends length of the time period used by you is:
(Mark only one oval)

- ☐ Less than 1 year
- ☐ 1 year – less than 2 year
- ☐ 2 year – less than 5 year
- ☐ 5 year – less than 10 year
- ☐ More than 10 year

Q12: Mark your opinion on following technical trading techniques as per their importance over different time horizons:
(Mark only one oval per row)

	Intraday	1 Week	1 Month	3 Months	6 Months	1 Year	> 1 Year
Filters							
Moving averages							
Channel rule							
Fibonacci retracement							
Candlesticks							
Relative Strength Indicator (RSI)							
Stochastic.							
Rate of change.							
William %R.							
Moving Average Convergence/Divergence (MACD).							
Bollinger Bands.							
Average Directional Movement Index.							
Neural Networks							

Q13: Rate your opinion on the following techniques in terms of their effectiveness in predicting turning points. (Mark only one oval per row). **7 means highly effective and 1 means least effective**

	7	6	5	4	3	2	1
Filters							
Moving averages							
Channel rule							
Fibonacci retracement							
Candlesticks							
Relative Strength Indicator (RSI)							
Stochastic.							
Rate of change.							
William %R.							
Moving Average Convergence/Divergence (MACD).							
Bollinger Bands.							
Average Directional Movement Index.							
Neural Networks							

Q14: Rate your opinion on the following techniques in terms of their effectiveness in predicting the trend. (Mark only one oval per row). **7 means highly effective and 1 means least effective.**

	7	6	5	4	3	2	1
Filters							
Moving averages							
Channel rule							
Fibonacci retracement							
Candlesticks							
Relative Strength Indicator (RSI)							
Stochastic.							
Rate of change.							
William %R.							
Moving Average Convergence/Divergence (MACD).							
Bollinger Bands.							
Average Directional Movement Index.							
Neural Networks							

Q15: Rate your perceived usefulness of fundamental analysis and technical analysis in predicting trends and turning points. (Mark only one oval per row). **7 means highly useful and 1 means least useful.**

	7	6	5	4	3	2	1
Usefulness of fundamental analysis in predicting Trends							
Usefulness of fundamental analysis in predictingTurning Points							
Usefulness of technical analysis in predictingTrends							
Usefulness of technical analysis in predicting Turning Points							

Q16: Following your trading strategies how you would rate your success rate in foreign exchange trading:
(Mark only one oval per row). **7 means highly successful and 1 means least successful.**

	7	6	5	4	3	2	1
Based on Fundamental factors							
Based on Technical factors							
Based on Behavioural Factors							
Based on Speculation							

Q17: Rate the degree of predictability of foreign exchange in the presence of central bank interventions:

(Mark only one oval per row). **7 means highly predictability and 1 means least predictability.**

	7	6	5	4	3	2	1
Intraday	⬭	⬭	⬭	⬭	⬭	⬭	⬭
1 Week	⬭	⬭	⬭	⬭	⬭	⬭	⬭
1 Month	⬭	⬭	⬭	⬭	⬭	⬭	⬭
3 Months	⬭	⬭	⬭	⬭	⬭	⬭	⬭
6 Months	⬭	⬭	⬭	⬭	⬭	⬭	⬭
1 Year	⬭	⬭	⬭	⬭	⬭	⬭	⬭
> 1 Year	⬭	⬭	⬭	⬭	⬭	⬭	⬭

Q18: Rate the statements where 7 means strongly agree and 1 means strongly disagree.

(Mark only one oval per row).

	7	6	5	4	3	2	1
Do you agree that central bank intervention has effect on exchange rate	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Do you believe that Central Bank interventions results in profit for chartists in short term?	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Central Bank interventions increase exchange rate volatility	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Central Bank interventions move exchange rates away from their fundamental levels	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Central Bank interventions are usually conducted at the appropriate moment	⬭	⬭	⬭	⬭	⬭	⬭	⬭
Central Bank interventions achieve the desired goal	⬭	⬭	⬭	⬭	⬭	⬭	⬭

Q19: Mark the following interventions on the basis of their influence on exchange rate over time period:

	Intraday	Week	Month	> Month
Reserve Bank's Jawboning (moral suasion)	◯	◯	◯	◯
Operational Intervention (concrete buying and selling of currency)	◯	◯	◯	◯
Concerted Intervention (simultaneous buying or selling by several central banks)	◯	◯	◯	◯
Sterilized Intervention (purchase or sale of currency without changing the monetary base)	◯	◯	◯	◯
Scheduled Interventions (depends on the structure of the market of a nation)	◯	◯	◯	◯
Spot Market Intervention (agreement to buy or sell currency at the current exchange rate)	◯	◯	◯	◯
Forward Market Intervention (agreement to buy or sell in future at predetermined rates)	◯	◯	◯	◯
Currency Swap (both the spot and forward markets may be used simultaneously)	◯	◯	◯	◯

SECTION -B

Demographic Profile

1. Name: ……...

2. Age (Optional): ……

3. Gender: Female ☐ Male ☐

4. Educational Qualification:

a) Matriculate ☐ b) Intermediate ☐ c) Graduate ☐ d) Post graduate ☐

Any Certified Course(s) (Optional): ……

Contact no. (Optional): .....

Email ID. (Optional): ……