

# **A STUDY OF VOLATILITY IN INDIAN STOCK AND COMMODITY MARKETS**

**Dissertation**

**Submitted to the Punjab Agricultural University  
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**DOCTOR OF PHILOSOPHY  
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BUSINESS ADMINISTRATION  
(Minor Subject: Economics)**

**By**

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## **CERTIFICATE I**

This is to certify that the dissertation entitled “**A Study of Volatility in Indian Stock and Commodity Markets**” submitted for the degree of **Ph.D.**, in the Subject of **Business Administration** (Minor subject: **Economics**) of the Punjab Agricultural University, Ludhiana, is a bonafide research work carried out by **Nisha Rani** (Admission No: **L-2015-BS-72-D**) under my supervision and that no part of this dissertation has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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### **ABSTRACT**

The aim of present study is to assess the nature of volatility, relationship between return and volatility, impact of selected macroeconomic variables on volatility, identification of suitable model for forecasting volatility and perception of market participants regarding volatility in Indian stock and commodity market. The study analyzed both primary and secondary data. In most of the stock market indices significant day of the week effect was found on Tuesday and in case of commodity market indices day of the week effect was found to be different in all the selected indices. Further, significant month of the year effect was found for both stock and commodity market indices. The relationship between return and volatility was assessed through GARCH in Mean model and it was found to be significant only in case of Nifty Smallcap 50. The impact of various macroeconomic variables in explaining the volatility of stock and commodity market indices was studied. It was found that FII net flows, DII net flows are significant determinants for stock market indices and GDP, CPI and yield on 10 year government bonds were found to be significant determinant of volatility for commodity market indices. The suitable model for forecasting volatility was identified. It was found that GARCH (1, 1) is the most suitable symmetric model and EGARCH model is the most suitable asymmetric model in case of stock market indices and commodity market indices. The perception of different market participants regarding volatility has been found to be varied and significantly different from one group to another.

**Keywords:** Volatility, GARCH Models, Calendar anomalies, Market participants, Risk-return

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ਮੌਜੂਦਾ ਅਧਿਐਨ ਦਾ ਉਦੇਸ਼ ਅਸਥਿਰਤਾ ਦੀ ਪ੍ਰਕਿਰਤੀ ਦਾ ਮੁਲਾਂਕਣ ਕਰਨਾ, ਵਾਪਸੀ ਅਤੇ ਅਸਥਿਰਤਾ ਦੇ ਵਿਚਕਾਰ ਸਬੰਧ, ਅਸਥਿਰਤਾ 'ਤੇ ਚੁਣੇ ਹੋਏ ਮੈਕਰੋ-ਆਰਥਿਕ ਪਰਿਵਰਤਨ ਦਾ ਪ੍ਰਭਾਵ, ਅਸਥਿਰਤਾ ਦੀ ਭਵਿੱਖਬਾਣੀ ਕਰਨ ਲਈ ਢੁਕਵੇਂ ਮਾਡਲਾਂ ਦੀ ਪਛਾਣ ਅਤੇ ਭਾਰਤੀ ਸਟਾਕ ਅਤੇ ਵਸਤੂ ਮਾਰਕੀਟ ਵਿੱਚ ਅਸਥਿਰਤਾ ਸੰਬੰਧੀ ਮਾਰਕੀਟ ਭਾਗੀਦਾਰ ਦੀ ਧਾਰਨਾ ਹੈ ਅਧਿਐਨ ਨੇ ਦੋਵਾਂ ਪ੍ਰਾਇਮਰੀ ਅਤੇ ਸੈਕੰਡਰੀ ਅੰਕੜਿਆਂ ਦਾ ਵਿਸ਼ਲੇਸ਼ਣ ਕੀਤਾ। ਜ਼ਿਆਦਾਤਰ ਸਟਾਕ ਮਾਰਕੀਟ ਦੇ ਸੂਚਕਾਂਕ ਵਿੱਚ ਹਫ਼ਤੇ ਦਾ ਪ੍ਰਭਾਵਸ਼ਾਲੀ ਦਿਨ ਮੰਗਲਵਾਰ ਨੂੰ ਪਾਇਆ ਗਿਆ ਅਤੇ ਵਸਤੂ ਬਾਜ਼ਾਰ ਦੇ ਸੂਚਕਾਂਕ ਦੇ ਹਫ਼ਤੇ ਵਿੱਚ ਪ੍ਰਭਾਵ ਸਾਰੇ ਚੁਣੇ ਹੋਏ ਸੂਚਕਾਂਕਾਂ ਵਿੱਚ ਵੱਖਰਾ ਪਾਇਆ ਗਿਆ ਇਸ ਤੋਂ ਇਲਾਵਾ, ਸਾਲ ਦੇ ਪ੍ਰਭਾਵ ਦਾ ਮਹੱਤਵਪੂਰਣ ਮਹੀਨਾ ਸਟਾਕ ਅਤੇ ਵਸਤੂ ਬਾਜ਼ਾਰ ਸੂਚਕਾਂਕ ਦੋਵਾਂ ਲਈ ਪਾਇਆ ਗਿਆ ਸੀ। ਰਿਟਰਨ ਅਤੇ ਅਸਥਿਰਤਾ ਦੇ ਵਿਚਕਾਰ ਸਬੰਧਾਂ ਦਾ ਮੁਲਾਂਕਣ GARCH ਮੀਨ ਮਾਡਲ ਦੁਆਰਾ ਕੀਤਾ ਗਿਆ ਸੀ ਅਤੇ ਇਹ ਸਿਰਫ ਨਿਫਟੀ ਸਮਾਲਕੈਪ 50 ਦੇ ਮਾਮਲੇ ਵਿੱਚ ਮਹੱਤਵਪੂਰਣ ਪਾਇਆ ਗਿਆ ਸੀ। ਸਟਾਕ ਅਤੇ ਵਸਤੂ ਬਾਜ਼ਾਰ ਸੂਚਕਾਂਕ ਦੀ ਅਸਥਿਰਤਾ ਦੀ ਵਿਆਖਿਆ ਕਰਨ ਲਈ ਵੱਖ-ਵੱਖ ਸਮੁੰਦਰੀ ਆਰਥਿਕ ਪਰਿਵਰਤਨ ਦੇ ਪ੍ਰਭਾਵਾਂ ਦਾ ਅਧਿਐਨ ਕੀਤਾ ਗਿਆ। ਇਹ ਪਾਇਆ ਗਿਆ ਕਿ ਐਫਆਈਆਈ ਸ਼ੁੱਧ ਪ੍ਰਵਾਹ, ਡੀਆਈਆਈ ਸ਼ੁੱਧ ਵਹਾਅ ਸਟਾਕ ਮਾਰਕੀਟ ਸੂਚਕਾਂਕ ਲਈ ਮਹੱਤਵਪੂਰਨ ਨਿਰਧਾਰਕ ਹਨ ਅਤੇ GDP, CPI ਅਤੇ 10 ਸਾਲਾ ਸਰਕਾਰੀ ਬੋਂਡਸ ਦੀ ਯੀਲਡ ਐਗਰੀ ਕੋਮੋਡਿਟੀ ਮਾਰਕੀਟ ਸੂਚਕਾਂਕਾਂ ਲਈ ਅਸਥਿਰਤਾ ਦਾ ਮਹੱਤਵਪੂਰਣ ਨਿਰਧਾਰਕ ਪਾਇਆ ਗਿਆ। ਅਸਥਿਰਤਾ ਦੀ ਭਵਿੱਖਬਾਣੀ ਕਰਨ ਲਈ ਢੁਕਵੇਂ ਮਾਡਲ ਦੀ ਪਛਾਣ ਕੀਤੀ ਗਈ। ਇਹ ਪਾਇਆ ਗਿਆ ਕਿ GARCH (1, 1) ਸਭ ਤੋਂ ਢੁਕਵੇਂ ਸਮਮਿਤੀ ਮਾਡਲ ਹੈ ਅਤੇ EGARCH ਮਾਡਲ ਸਟਾਕ ਮਾਰਕੀਟ ਸੂਚਕਾਂਕ ਅਤੇ ਵਸਤੂ ਮਾਰਕੀਟ ਸੂਚਕਾਂਕ ਦੇ ਮਾਮਲੇ ਵਿੱਚ ਸਭ ਤੋਂ ਢੁਕਵੇਂ ਅਸਮੈਟ੍ਰਿਕ ਮਾਡਲ ਹੈ। ਉਤਰਾਅ-ਚੜ੍ਹਾਅ ਦੇ ਬਾਰੇ ਵਿੱਚ ਵੱਖ ਵੱਖ ਮਾਰਕੀਟ ਭਾਗੀਦਾਰਾਂ ਦੀ ਧਾਰਨਾ ਵੱਖੋ ਵੱਖਰੀ ਅਤੇ ਇੱਕ ਸਮੂਹ ਤੋਂ ਦੂਜੇ ਸਮੂਹ ਵਿੱਚ ਕਾਫ਼ੀ ਵੱਖਰੀ ਪਾਈ ਗਈ ਹੈ।

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## **CHAPTER I**

### **INTRODUCTION**

This chapter contains introduction to stock and commodity markets, volatility in stock and commodity markets, definitions, concepts, and classification of volatility, calendar anomalies, theories of volatility, and reasons of the same. This chapter also includes introduction to various forecasting models of ARCH family, uses of the ARCH and GARCH models, risk and return relationship, and impact of various macroeconomic variables on volatility. Finally, the chapter concludes with the objectives of the present study. Accordingly, the chapter is divided into the following sections.

#### **1.1 Introduction to volatility**

#### **1.2 Definition and concept of volatility**

#### **1.3 Types of volatility**

#### **1.4 The theories of volatility**

##### 1.4.1 The Efficient Market Hypothesis

##### 1.4.2 Market Anomalies

#### **1.5 Reasons of volatility**

#### **1.6 Volatility clustering**

#### **1.7 Volatility and Macroeconomic variables**

#### **1.8 Stock markets and Stock Market Indices**

##### 1.8.1 Nifty 50

##### 1.8.2 Nifty Midcap 50

##### 1.8.3 Nifty 500

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#### **1.9 Commodity markets and Commodity Market Indices**

##### 1.9.1 Leading commodity markets of India

##### 1.9.2 Commodity markets Indices

#### **1.10 Introduction to ARCH GARCH models for estimating volatility**

##### 1.10.1 Testing of ARCH effect

##### 1.10.2 Symmetric GARCH Models

##### 1.10.3 Asymmetric GARCH Models

#### **1.11 Uses of GARCH and ARCH**

#### **1.12 Objectives**

## 1.1. Introduction to Volatility

The financial market is considered as a growth component of any economy. These have been examined by many researchers from different facets. The major aspect of the stock and commodity market that has been discussed by many researchers is the analysis of returns and of volatility. Volatility is as old as the financial market itself.

Volatility is mainly the dispersion of the probable result of the variable. In financial markets, it is a measure of the spread of returns related to a particular asset. Volatility is different from risk. Risk is basically related to unsuitable outcome whereas volatility helps in measuring the uncertainty of favorable and unfavorable results (Poon 2005). Volatility is the change in the price of the trading asset over a period of time. Volatility is the basic statistical risk measurement tool used to measure the market risk of a single instrument or portfolio of instruments. Volatility can be expressed in many ways, but the volatility of a random variable is expressed as its standard deviation (Kaur 2004). Volatility also evaluates the riskiness of the asset. Standard deviation is a measure of variability and if there are more deviations in returns it means that there is more volatility. Many studies have been conducted by various researchers regarding volatility in stock and commodity markets around the globe. It has been put forward by many pieces of research that with the emergence of the new economy, financial markets have become more volatile. This increased volatility in 'New Economy' stocks is because of the higher return expectations of investors than traditional stocks. Such higher expectations by investors have resulted in more fluctuations in the markets which have made the market more disruptive and volatile (Bond 2000).

Volatility of stock returns has been primarily studied in developed countries and is being currently studied in developing countries like India. After the introduction of the Autoregressive Conditional Heteroscedasticity (ARCH) model by Engle (1982) and its generalized form (GARCH) by Bollerslev (1986), many researchers have done empirical work using these models and their extensions (for example, French *et al* 1987, Gokcan 2000, Frimpong & Oteng-Abayie 2006, Wennström, 2014, Vasudevan *et al* 2016). The volatility is nothing but the variability in the price over time. It is measured as the variance or the standard deviation of the asset returns. The higher the variation more volatile is the asset. This also measures the riskiness of the asset since the more variation it has, higher is the unpredictability associated with its returns. There are many market models that measure the residual variances to measure volatility. Various empirical studies have been conducted by researchers to test volatility in the stock markets globally. Financial markets demonstrate striking movements, and it cannot be said that these changes in stock prices change solely because of changes in fundamentals and stock prices may seem too volatile to be justified by

changes in fundamentals. Such facts have been under surveillance over the years -and are still being studied (LeRoy and Porter 1981, Shiller 1981, Darrat *et al* 2003).

## **1.2. Definition and concept of Volatility**

According to the business dictionary, volatility means “size and frequency of rapid changes in the price of a security. If the causes of volatility are peculiar to security, it is measured by alpha, if the causes are related to the securities market as a whole, it is measured by beta.”

Volatility is defined as the amount of indefiniteness about the extent of changes in the value of security. Volatility is used as a measure of the variability of dispersion about central tendency. The volatility of an asset is measured by the variability in the price over time. It is measured as the variance or the standard deviation of the returns of an asset. With the increasing value of variance, the asset is considered to be more volatile. This is also used as a measure of the riskiness of the asset since with increasing variance the uncertainty related to the returns from assets will also increase. Many ARCH and GARCH Models have been developed that measures the volatility by measuring the residual variances.

## **1.3. Types of Volatility**

Historical volatility is the trend the price of the asset has shown in the last one year. An asset is considered more volatile if its price has shown more variation in the past year. So such stocks from an investors' point of view becomes less attractive. If an investor has invested in such an asset he will have to wait for the price to return at a price where he wants to sell. Unfortunately, in a highly volatile market, stock prices are very much unpredictable. Implied volatility means the volatility that the investors and traders opine a particular asset will have in the future, when all other things being equal. One can estimate the implied volatility by looking at the charts and trends of price changes. When there is a rise in the prices it means implied volatility is increasing. One can guess what the implied volatility of an asset is by looking at how much the prices of the future and options of an asset vary. Market volatility means the pace at which the prices of particular market change. The different markets may be the foreign exchange market, the commodities market, the stock market, etc. When the volatility of the stock market is increased it means a market top or market bottom is near. It is because of the indefiniteness of the market.

## **1.4 The Theories of volatility**

Volatility is caused by many reasons. Some experts believe that the information provided to the market is the major reason for the ups and downs in the market. This phenomenon has been explained by researchers with the help of theories. Many researchers are of the view that with the presence of the Efficient Market Hypothesis (EMH), new

information may lead to immediate price action. While other researchers believe that greater influence is exerted by the investor's belief which is both psychological and social. As per the Popular Models Theory (Popular models are a qualitative explanation of price) investors do not act appropriately according to the information they receive. So the information that is freely available in the market is not always incorporated in market prices as hypothesized by the EMH model. Hence on the basis of theory, it cannot be said what actually causes variations, economic or psychological factors, in the market.

#### **1.4.1 The Efficient Market Hypothesis (EMH) :**

The Efficient Market Hypothesis (EMH) (Malkiel *et al* 1970). Efficient capital markets: A review of theory and empirical work. *The journal of Finance*, 25(2), 383-417. 1970) states that shares prices in the market reflect all the available information. No investor can earn excess profits without bearing high risk. As per this theory, the market behaves normally so it is impossible to generate consistent alpha. In addition, the efficiency with respect to any information set depicts that it is not possible to make economic profits by trading on the basis of such information. So, assuming this is true, no amount of analysis can give an investor an edge over other investors. Burton *et al*(2003) observed that securities markets used to be very efficient in reflecting information regarding stocks and the whole stock market. It is believed that whenever new information arises and spreads in the economy, it quickly gets incorporated into the stock prices. In such a situation both technical and fundamental analysis fails to help investors in achieving more returns than a randomly selected portfolio. However, there are some violations to the theory of Efficient Market theory called anomalies.

#### **1.4.2 Market Anomalies**

A stock market anomaly means an unusual behavior of stock markets. The stock market sometimes behaves differently than its usual behavior. Dranev (2014) observed that anomalies refer to situations when security performs inversely to the concept of efficient markets, as per which prices of the securities are said to reflect all available information. Some anomalies are there for a shorter period and others show continuity. These are the patterns in the market that do seem to lead to abnormal returns. These patterns are based on financial information which shows the importance of fundamental analysis, causing a challenge to the semi-strong form of the EMH. Other anomalies are in the market for a comparatively longer period that causes a problem for rational investors. An investor should understand that these market anomalies can appear, disappear, and reappear. The following are different types of major market anomalies.

January effect is when the securities in the markets show a cyclic increase in the prices of the stocks during the month of January. This anomaly is perhaps one of the most

popular anomalies. As per this anomaly, the stocks that did not perform well in the last quarter of the previous year tend to and outperform the market in the first month of the year. This may take place because many investors prioritize selling their losses before the end of the year so that they can write the loss off their taxes. On the other hand, buyers who don't follow such a trend prefer to wait until January to buy the stocks. This pushes the price up again. In the Day of the week effect, some stocks are inclined to show positive results on a particular day of the week say Fridays rather than Mondays. Statistically, this anomaly is true to some extent, but it cannot be used to make profits by predicting prices. There may be losses on Friday when the stock goes down and there may be good profits on the following day. As per the different researches, stocks tend to move more on Fridays than Mondays.

As per the low book value anomaly, the stocks having prices less than average price-to-book ratios tend to perform better in the market. It has been proved by many researchers that a group of stocks having a low price/book ratio always performs better. But this anomaly is considered to be relatively weak. This anomaly is applicable only in the case of a group of stocks but not in the case of individual performance of stock having a low price/book ratio.

There is another anomaly called neglected stocks anomaly, in this, the stocks that are disregarded by investors sometimes outperform the market averages. This applies to the stocks with less liquidity and having minimal analyst support. But researchers deny the acceptance of this anomaly with an assertion that without considering market capitalization there is nothing like outperformance. So as a result small and neglected companies tend to outperform, on the other hand, companies with larger and neglected stocks do not perform better than otherwise. The benefit of this anomaly comes out to be the lower volatility of neglected stocks.

Under the reversals anomaly, some time stocks show different behavior. Some stocks that were performing good will reverse their performance and stock which were performing not well starts outperforming for more than a year. There may be different reasons for this. One reason is the expectations of the investors. They expect outperform stocks to come down and disregarded stocks to get discovered and go up. Some research evidence also suggests that stocks do tend to reverse course in the following period – yesterday's top performers become tomorrow's underperformers, and vice versa.

### **1.5. Reasons of volatility**

There are different perceptions and views regarding reasons for volatility in stock and commodity markets. There are two schools of thought that have divergent views on the reasons for volatility. As per the fundamentalist approach, the ups and downs in the market can be explained wholly by the information given in the market (Chowhan 2000). Many

economists have tried to bring forward different theories to predict future changes in prices. Most of the economist believes that the information changes do affect the prices as the efficient market hypothesis holds true. The inflow of new information in the market causes changes in the volatility of the market. With the flow of new information, the volatility in the market starts changing. There are some economists (Bakar 2016, Sarwar 2016,) who believe that volatility is not related to external factors. They believe that the major factors that have an influence on market prices are psychological or social beliefs. Basically, how the investors react to any news affect the prices in the market. Aggarwal *et al* (1999) examined the events associated with the sudden shift in the volatility of stock market returns. The authors found that most country-specific events caused a large shift in volatility rather than global events or changes in exchange rate regimes. Further, the study concluded that the only global event that affected most of the emerging markets was the October 1987 crash. Pal (2005) studied the impact of change in the trading behavior of Foreign Institutional Investors (FIIs) on the Indian stock market (BSE Sensex) and its volatility. He identified the herd instinct of investors due to the FIIs movement responsible for increased volatility in the stock market.

Schwert (1989) related stock market volatility to the time-varying volatility of a variety of economic variables. The study found high volatility in the period of 1929-1939 than from 1857-1987 for many economic factors like industrial production, inflation, money growth, and other measures of economic activity. Jain *et al* (2012) believed that the Sensex movement is influenced by FII to a greater extent. The study found that with positive inflow in FIIs there was an increase in Sensex which also go down with the fall in FII inflows. The study found a positive correlation between Foreign Institutional Investments and the movement of Sensex using Pearson's correlation. Singh (2010) explored the causal relationship between stock market indices i.e., BSE Sensex and three key macroeconomic variables namely wholesale price index (WPI), Index of Industrial Production (IIP), and the exchange rate of the Indian economy. The study depicts that IIP is the only variable having a bilateral causal relationship with BSE Sensex. He observed unilateral causality between WPI and BSE Sensex and a high correlation between WPI and Sensex. Jalota (2017) observed that FII took the money out under the conditions of volatility in the Indian stock market. She found in her research that the FII movement affects stock market indices. Singh (2014) studied the relationship between macroeconomic variables and the Indian stock market. The study includes the average monthly closing price of BSE 100 as explained variable and Index of Industrial Production (IIP), Wholesale Price Index (WPI), Money Supply, Interest Rates, Trade Deficit, Foreign Institutional Investment, the Exchange rate, Crude Oil Price and Gold Price (GP) as the explanatory variables. The author found that the Indian stock market is significantly influenced by gold prices, inflation, money supply, exchange rates, and foreign institutional investments.

## **1.6 Volatility Clustering**

Time series of financial asset returns often exhibit volatility clustering. Generally, in time series data it is seen that the variance of returns follows a particular pattern. It is firstly high for extended periods and then low for extended periods or vice versa. In this way, returns show high and low volatility trends in different periods which makes an iid model (independent and identically distributed model) of log-prices or asset returns unconvincing. This feature of the time series of prices is called volatility clustering. In volatility clustering, price changes show the tendency of clustering together causing the persistence of these magnitudes of price changes. Under volatility clustering when it comes to markets large changes tend to be followed by large changes and small changes tend to be followed by small changes. This phenomenon is observed when there are extended periods of high market volatility, followed by a period of "calm" or low volatility. In market terms, whenever there is sudden shock in the market, more volatility is expected. This is known as the persistence of volatility shocks, which is the basis of the concept of volatility clustering. Volatility clustering is highly researched topic. On the basis of volatility clustering many stochastic models has been developed in the field of finance. The Autoregressive Conditional Heteroskedasticity (ARCH) model of Engle (1982) and its various extensions are used for modeling volatility.

## **1.7 Volatility and Macroeconomic variables**

The financial theory asserts that the movement in stock prices is related to macroeconomic variables. It is believed that stock market prices respond quickly to new information in the market. So it can be stated that for measuring the economic condition of any country, stock price volatility can be used, as it reflects great information about the market condition. The stock prices and various macroeconomic variables are closely related to each other. This relationship is explained in theoretical stock valuation models also. As per this model the current prices of an equity share is affected by macroeconomic variable. As the current price of a share is equal to the present value of all cash inflows of the future, which are influenced by macroeconomic variables. So any changes in future cash flows due to macroeconomic variables will ultimately influence the stock prices and hence volatility. Although stock return volatility is used as a measure of risk, its extreme case is taken as noise in econometrics. The users of the information believe that noise undermines the usefulness of the stock prices which is an indicator of the true intrinsic value of the firm (Karolyi 2001). There are many economic variables like fluctuations in exchange rates, growing inflation, interest rate, Real Gross Domestic Product (GDP) growth, etc. which increases the volatility of stock returns. In such a situation the investors prefer to switch their investment to less risky portfolios like bonds. There are many macroeconomic variables that affect volatility. Fama

explained the weak-form efficiency of a market as a condition under which all the information contained in the past stock prices is fully reflected in current prices (Fama 1970, 1991). This implies that past security prices cannot be used to predict future price changes and hence, technical analysis tools have no value. On the contrary, the technical analysts believe that information contained in past stock prices is not fully reflected in current security prices so future security prices can be predicted by observing the past security prices. Technical analysts agree on the point that volume is one of the reasons for price movement (Kapoff 1987). Many studies on volume-price relation found positive relations between the absolute value of daily price changes and daily volume for market indices and the same holds true for individual stocks (Ying 1966, Westerfield 1977, Rutledge 1984, Chandrapala 2011). On the other hand, some studies on volume-price relations examined contemporaneous relationships between trading volume and absolute price changes.

Some early studies have analyzed the relation between market efficiency and information flow in the market using return volume dynamics. The studies have found the presence of asymmetry of trading volume in the market which is depicted from the contemporaneous relationship between volume and returns. Further, the studies suggest the presence of a positive relationship between volume and return but this relation can be seen in bond and stock markets only but not in future markets (Kocagail 1999 and Chen *et al* 2004).

Foreign investment was allowed in the Indian economy in 1991 when liquidity, privatization, and globalization policy were introduced in India. Foreign investments were allowed under the Foreign Exchange Management Act (FEMA). This step was a part of the government's policy to attract foreign sources of capital formation in India as other developing economies were already attracting foreign capital. Presently, the investment by Foreign Institutional Investors (FIIs) has become a dynamic force in the development of the Indian stock market. It is considered one of the important causes of volatility in stock and commodity markets. This state of affairs has propelled researchers to study the relationship between FIIs capital flows and stock market volatility. So, FII inflow has become an important measure of economic development in both developed and developing countries. Also, FDI & FII are becoming important sources of finance in developing countries including India.

### **1.8 Stock market and stock market Indices**

The capital market includes many exchanges where activities like buying, selling, and issuance of shares of publicly-held companies take place. Such financial activities are conducted through institutionalized formal exchanges or over-the-counter (OTC) marketplaces that operate under a defined set of regulations. Every stock exchange has its

own set of stock market indices which represent the shares of various companies listed on the stock exchange. A stock market index is derived from the prices of selected stocks. Stock market indices are used by various investors, managers, and other different parties to have an understanding of the market. They use it as a reference for making financial investment decisions. Some of the important indices used in the present study are:

### **1.8.1 NIFTY 50**

The Nifty 50 is the major index on the National Stock Exchange of India Ltd. (NSE). It came into existence in April 1996. As the name indicates the Nifty 50 is an index of 50 stocks. These stocks represent 12 different sectors of the Indian economy, namely financial services, media and entertainment, information technology, telecommunications, pharmaceuticals, metals, consumer goods, automobiles, energy, construction, cement and cement products, fertilizers and pesticides, and services. This Index covers a portfolio of blue-chip, leading, and most liquid Indian securities. There are 50 companies of approximately 1600 companies. These are listed on the NSE and as per the records till October 2019 it covers around 65% of its free float-adjusted market capitalization. The Nifty 50 traces the movement of stocks of major sectors of the Indian economy. It is used as a portfolio that provides complete exposure of the Indian market to varied users. It is used by investment managers for benchmarking, index funds, and index-based derivatives. For calculation of Nifty 50 free-float market capitalization weighted method is used. In this, the level of the index reflects the total market value of all the stocks in the index relative to a particular base period. The base period selected for the Nifty 50 index is the close of prices on November 3, 1995.

### **1.8.2 NIFTY MIDCAP 50**

Nifty Midcap 50 index is based on full market capitalization. It includes the top 50 companies that are taken from Nifty Midcap 150 index. The base period selected for Nifty 50 index is the close of prices on January 01, 2004 with base value of 1000. NIFTY Midcap 50 Index is computed using free float market capitalization method, wherein the level of the index reflects the total free float market value of all the stocks in the index relative to particular base market capitalization value. The main objective of the Nifty Midcap 50 Index is to track the movement of the midcap segment of the market. It can also have less than 50 stocks if the required data is missing. This index exhibit around 6% of the free-float market capitalization of the stocks listed on NSE as on March 29, 2019.

### **1.8.3 Nifty 500**

It covers the top 500 companies based on full market capitalization from the eligible universe. The base date for Nifty 500 is January 01, 1995 with 1000 as base value. As per the

data till March 2017, about 95.2% of the free-float market capitalization of the NSE listed stocks is covered by the Nifty 500 Index. The total traded value for the last six months ending March 2017, of all index constituents, is approximately 91.7% of the traded value of all stocks on NSE (Anonymous 2017 a)

#### **1.8.4 Nifty Smallcap 50**

The primary objective of the Nifty Smallcap 50 Index is to capture the movement of the small-cap segment of the market. The base date for Nifty Smallcap 50 is April 01, 2005 with 1000 as base value. The Nifty Smallcap 50 Index represents about 2% of the free-float market capitalization of the stocks listed on NSE as on March 31, 2017. (Anonymous 2017b).

### **1.9 Commodity markets and Commodity Market Indices**

Commodities are considered as an important asset for trading. For many decades commodity trading has played an important role in the economy. With its changing methods from the barter system to futures and options, commodity markets are perceived as volatile. The volatility results in increased demand for commodity markets as a hedging tool. It is probably one of the most ancient economic activities and, therefore, it would not be incorrect to state that commodity trading is as old as human civilization. However, from the past few decades many government restrictions have been imposed in commodity futures. This has resulted in the underdevelopment of commodity futures markets in India. The government took many steps for developing the commodity market in India. One of them was in terms of the commodity futures market. However, in April 2003 these restrictions on trading of a large number of commodities were withdrawn by the Indian government (Anonymous 2017c). Further in May 2003 the Indian government also revoked the prohibitions on non-transferable specific delivery forward contracts.

From the last few decades, the commodity futures market not only in India but in abroad also, have grown significantly in terms of both network and volume. The trading in commodity markets can be done through over the counter market (OTC) or through the exchange-traded market. Like equity markets there are spot and the derivatives segments in commodity markets also. Spot markets are where commodities are traded over the counter with an expectation of delivery at settlement. The various participants are farmer, wholesaler, processor, etc. The exchange-traded markets are fundamentally derivative markets and they act like equity derivatives. As in equity markets, in the commodity market also one can enter into a standardized contract by paying a percentage of contract.

In commodity markets also there is provision for physical delivery, but many contracts are squared-off before expiry and are settled in cash. In India, around 146 commodities are traded in 23 different exchanges all over India. In India many exchanges has

been nationalized by the government of India as per the recommendation of the FMC namely, the National Multi Commodity Exchange (NMCE), Ahmedabad, Multi Commodity Exchange (MCX) Mumbai and National Commodity and Derivative Exchange (NCDEX), Mumbai, as nationwide multi-commodity exchanges. The commodity exchanges namely MCX and NCDEX commenced trading in November 2003 and NMCE 2002. In commodity markets volatility is described as the change in the price an asset over time. The volatility increases with the increase in the gap in the price range on a daily, weekly, monthly, or longer-term basis. The interest of market participants in particular stock is determined by the volatility of the market. Commodities are considered as most volatile asset class.

Volatility as a statistical measure is used for determining risk-return profile of an asset. Many investors like to invest in commodities when they have expectation of bull market conditions. In such a situation the investors compare the risk and return profile of the asset on the basis of volatility. But as commodity markets are considered as more volatile, predicting the prices of commodities is more difficult task. The prices in the commodity markets are determined by supply and demand conditions. When the supply in the market decreases the prices tend to rise and with increase in the supplies the prices go down. There are other factors also that determine the prices of commodity markets. In such an environment predicting commodity price movements becomes difficult.

The prices of the commodities have shown considerable volatility over the past decade because of many reasons. The price boom between 2002 and 2008 was the most pronounced in several decades – in magnitude, duration and breadth. Commodities are considered to be more volatile than other assets because of the following reasons namely liquidity, mother nature, supply and demand, geopolitics and leverage. The three major reasons for commodity price volatility are: first is the basic law of demand and supply where with increase in the supply the prices tends go down. But if the demand is greater than supplies, the inventory deficit tends to push prices higher. The second reason is the technical condition of the market. Besides, the behavior of the investors, traders and other market participants is driven by the price charts. As same data is available to all, it leads to a herd mentality of massive group buying or selling consequently that influence the prices. Besides, fluctuations in commodity prices are also due to the changes in the global macroeconomic and geopolitical landscape.

### **1.9.1 Leading commodity markets of India**

Commodity trading in India is considered to be as old as the civilization. The organized commodity trading started in India in 1875. It was further discontinued due to many reasons like natural calamities, war and resultant shortage of commodities. Besides,

years of foreign rule, droughts and periods of scarcity and Government policies also caused the commodity trading in India to diminish. Commodity trading was restarted in India in 2003. Multi Commodity Exchange (MCX), National Commodity and Derivatives Exchange (NCDEX), National Multi-Commodity Exchange (NMCE) and Indian Commodity Exchange (ICEX) are the predominant commodity exchanges in India. The regulatory body is Stock Exchange Board of India (SEBI). The current commodities traded on the market include Agri commodities like black pepper, cardamom, castor seeds, cotton, crude palm oil, rubber etc, Soft products such as coffee, cocoa, sugar, etc, Energy products like crude oil, natural gas, gasoline and other energy sources, base metals such as nickel, aluminum, copper, brass, lead etc, besides precious metals such as gold, silver, platinum, etc. are also included in commodities.

### **1.9.2 Commodity Market Indices**

Nkrishi index of NCDEX is the Agri commodity Index. Nkrishi index acts as a benchmark to the Indian Agricultural futures sector. Nkrishi value weighted index which is computed using the prices of the 10 most liquid agricultural commodity futures traded on the NCDEX platform that accounts for over 75% of the Agri-trading activity. For commodity market indices the choice of commodities is made on the basis of their economic significance and liquidity. The main objective of Nkrishi is to provide a reliable benchmark for the traded Agri-commodities in India. Nkrishi is a rolling index, in which the as the current month contracts approaches expiration, the futures contract held in the index are rolled over onto next month contracts. Nkrishi covers several agricultural commodities namely Oil seeds like Soybean, Rape seeds, Mustard Seeds, Cotton seed cake, Castor seed, spices like coriander, Jeera, and other commodities like Barley, Chana, Guar seed etc.

The Multi Commodity Exchange of India Limited (MCX), is the first listed exchange of India. It is a commodity derivatives exchange where commodity derivatives are traded online. It provides a platform to the investors where they can do the price discovery and risk management. The MCX was established in the year 2003. It is regulated by Securities and Exchange Board of India (SEBI). It has its 12 branches in all over India. It provides many facilities to the investors like online futures trading, clearing and settlement in commodities futures. It covers variety of commodities in four major sectors namely Agriculture, Energy, Precious and Non Precious metals. The sectoral division of its indices is as for Agriculture it is MCX Agriculture, for metal it is MCX Metal and for Energy it is MCX Energy. The year 2001 is used as a base year for MCX Indices. The Comdex Futures are computed on the near month's active contract prices.

## 1.10 Introduction to ARCH GARCH models for estimating volatility

Uncertainty is a key to, much of modern finance theory. Financial markets respond nervously to disorder in political systems, the crisis in the economy, wars, or any natural calamities. There are huge fluctuations in the prices of financial assets. Put in statistical terms, it means that the conditional variance for the given past is not constant over time and the process  $X_t$  is conditionally heteroscedastic

$$Var = (X_t/X_{t-1}, X_{t-2}, \dots)$$

Econometricians usually say that volatility changes over time. In most of the asset pricing theories for determining the risk premium of an asset the covariance between the future return on the asset and one or more benchmark portfolios are used. ARCH and GARCH models are the tools that are widely used in time series analysis in financial applications. These models are specially used for forecasting volatility in financial markets.

The least-square model is the model that is used by most of the econometricians to determine the change in one variable in response to a change in some other variable. The econometricians are also interested in forecasting and finding and analyzing the size of the errors of the model. For forecasting any model the level of volatility in particular asset is ascertained. There are many models to model and forecast the volatility. The ARCH and GARCH models are standard tools to forecast volatility. The classical least square model is based on the assumption that the expected value of all the error terms remains same when squared at a given point of time. This assumption of the classical model is called homoscedasticity. In the ARCH/GARCH models assumption of homoscedasticity is the main focus. The other term opposite to homoscedasticity is heteroscedasticity which refers to the data in which the variances of the error terms are varying. In other words the data in which the error terms may be expected to be larger for some points than for others. It is however considered to be warning that in the presence of heteroskedasticity, there will be a false sense of precision given the unbiased regression coefficients, but the standard errors and confidence intervals estimated by conventional procedures will be too narrow. In the ARCH or GARCH model this is not taken as a problem but as a variance to be modeled. Therefore, not only are the deficiencies of least squares corrected, but a prediction is computed for the variance of each error term.

An ARCH (Autoregressive Conditionally Heteroscedastic) model is a model for the variance of a time series that was introduced by Engle (1982). It is a measure that takes into account past history (time-varying volatility) and their GARCH (Generalized ARCH) extension is due to Bollerslev (1986). ARCH and GARCH models are based on conditional

variance, that is, the variance is conditional on the past. Under the classical GARCH models, the conditional variance is expressed as a linear function of the squared past values of the series. In the GARCH model the conditional variance at a time 't' depends on the past values of the squared error terms and the past conditional variances. This particular specification is able to capture the main stylized facts characterizing financial series. Under GARCH model the simplest form of the GARCH (p, q) model the GARCH (1, 1) model becomes ARCH (q) when p=0. The GARCH model is easy to estimate and specifically performs very well because it has only three unknown parameters:  $\omega$ ,  $\alpha$  and  $\beta$  where  $\omega$  is the constant term,  $\alpha$  denotes the past values of returns and  $\beta$  denotes the shocks captured by the lagged squared error term. Understanding the nature of such time dependence is very important for many macroeconomic and financial applications, e.g. irreversible investments, option pricing, asset pricing etc. Models of conditional heteroskedasticity for time series have a very important role in today's financial risk management.

The (1, 1) in the GARCH (1, 1) model refers to the presence of a first-order autoregressive GARCH term (the first term in parentheses) and a first-order moving average ARCH term (the second term in parentheses). The GARCH model is often interpreted in a financial context, where an agent or trader predicts this period's variance by forming a weighted average of long-term average (the constant), the forecasted variance from the GARCH term and information about volatility observed in the ARCH term. If there comes out to be any upward or downward variations in the asset return then the trader will make changes in the estimate of variance for upcoming period.

### 1.10.1 Testing of ARCH-effect

In the financial time-series for modeling volatility, data series is assumed to show some clustering of volatility. In other terms the variance of the time series is not constant but is heteroscedastic. For testing the level of heteroscedasticity a test for it is conducted. The test is ARCH effect test. A time series in which ARCH effect is there can be used for forecasting and modeling volatility. Some author argue for the use of a non-linear model when financial theory states that the data at hand requires a non-linear model, while, from a statistical point of view, some argue that the use of a model should depend on description of the important features of the most appropriate data (Brooks, 2008). The first step in the test is to regress a linear equation as follows

$$y_t = \beta_1 + \beta_2 x_{2t} + \beta_3 x_3 + \beta_4 x_4 + \mu_t$$

To test for ARCH-effects, the residuals are squared and regressed on q own lags

$$\hat{\mu}_t^2 = \gamma_0 + \gamma_1 \hat{\mu}_{t-1}^2 + \gamma_2 \hat{\mu}_{t-2}^2 + \dots + \gamma_q \hat{\mu}_{t-q}^2$$

## 1.10.2 Symmetric GARCH Models

### ARCH model

The first and simplest model is an ARCH model. The return on an asset is assumed to be

$$Y_t | I_{t-1} = \alpha + \beta X_t + \mu_t$$

where  $Y_t$  is a random variable and  $X_t$  is one variable or vector variable conditional on the information available up to time (t-1), the value of time variable  $Y_t$  is the function of the variable  $X_t$  and  $\mu_t$

$$\mu_t | I_{t-1} \sim iid N(0, \sigma_t^2)$$

In the classical linear regression model it is assumed that  $\sigma_t^2 = \sigma^2$  means the variance is homoscedastic but to take into account ARCH effect following equation is used.

$$\sigma_t^2 = \lambda_0 + \lambda_1 \mu_{t-1}^2$$

Here it is assumed that the error variance at the time t is equal to some constant plus a constant multiplied by the squared error term in the previous time period. In this equation if  $\lambda_1 = 0$ , in such a case the error variance will turn out to be homoscedastic and the framework of classical least square model will be applicable.

$$Y_t | I_{t-1} = \alpha + \beta X_t + \mu_t$$

After taking mathematical expectations on both the sides  $\alpha + \beta X_t$

Conditional mean equation

$$\alpha + \beta X_t$$

Conditional variance equation

$$\sigma_t^2 = \lambda_0 + \lambda_1 \mu_{t-1}^2$$

Both are conditional on the information set  $I_{t-1}$ . This equation is known as ARCH (1) model. It includes only one lagged squared value of the error term. This model can be extended to ARCH (p) model, where there can be p lagged squared error terms.

$$\sigma_t^2 = \lambda_0 + \lambda_1 \mu_{t-1}^2 + \lambda_2 \mu_{t-2}^2 + \dots + \lambda_p \mu_{t-p}^2$$

In the above equation the presence of ARCH effect can be tested by checking the statistical significance of the estimated  $\lambda$  coefficients. If the value of  $\lambda$  comes out to be significantly different from zero then it can be inferred that there is an ARCH effect.

### GARCH model

In generalized autoregressive conditional heteroscedastic model the variance equation is modified to get GARCH (1, 1) model as follows:

$$\sigma^2_t = \lambda_0 + \lambda_1 \mu^2_{t-1} + \lambda_2 \sigma^2_{t-2}$$

In above equation conditional variance at time t depends on the lagged squared error term at time t-1 the lagged variance error term at time t-1. It can be seen that ARCH (p) model is equivalent to GARCH (1, 1) model as p increases in ARCH (p) one have to estimate (p+1) coefficients, whereas in GARCH (1, 1) model, only 3 coefficients are estimated. GARCH (1, 1) can be converted into GARCH (p q) model. Robert F. Engle developed the term the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) process in 1982. There are several forms of GARCH modeling which are used by different experts and professional for predicting the prices and rates of various financial instruments. The GARCH model is applied by estimating a best-fitting autoregressive model. Then the autocorrelations of the error term is computed and is tested for significance.

The basic GARCH (1,1) model is a symmetric model. It does not take into account the asymmetry effect or leverage effect, of the stock markets return data. The leverage effect in financial context refers to the tendency of an asset to be more volatile because of bad news than good news. There are different GARCH models to capture the asymmetric effect to the conditional variance of the time series. These models are the Exponential GARCH (EGARCH) model and the Threshold GARCH (TGARCH).

**GARCH-M:** In capital market an investor is generally interested in risk premium for bearing extra risk on any particular asset. That premium is clearly expected for the extra risk. If the risk is captured by the volatility or by the conditional variance, then the conditional variance may enter the conditional mean function of  $Y_t$ . Under the GARCH-M model the conditional mean depend on its own conditional variance. It models a time varying risk premium to explain asset returns. Under this model a new variable, the risk factor as a conditional variance is introduced in the mean equation to take into account the risk. The equation can be expressed as under:

$$Y_t = \alpha + \beta X_t + \gamma \sigma^2_t + \mu_t$$

### 1.10.3 Asymmetric GARCH models

**EGARCH:** In the EGARCH model the natural logarithm of the conditional variance is allowed to vary over time as a function of the lagged error terms rather than lagged squared errors. The EGARCH (1,1) model can be written as:

$$\log(h_t) = \alpha + \sum_{i=1}^q \beta_i \left| \frac{\mu_{t-i}}{\sqrt{h_{t-i}}} \right| + \sum_{i=1}^q \gamma \frac{\mu_{t-i}}{\sqrt{h_{t-i}}} + \sum_{k=1}^p \theta_k \log(h_{t-k})$$

In the above equation on the LHS is the log of the variance series ( $h_t$ ), which makes the leverage effect exponential rather than quadratic. This ensures that the estimates are non

negative. In the equation  $\alpha$  is constant,  $\beta_i$  is the ARCH effect,  $\gamma$  is asymmetric effect and  $\theta_k$  is GARCH effects. So  $\gamma$  captures the asymmetric effect.

**TGARCH:** The threshold GARCH model was introduced by the works of Zakoian (1990) and Glosten *et al* (1993). The main target of the TGARCH model is to capture asymmetries in terms of negative and positive shocks. Under the TGARCH model the original GARCH specification are modified by using a dummy variable. This model assumes that unexpected changes in the market returns have different effects on the conditional variance of the returns. The conditional variance for TGARCH model is stated as:

$$h_t = \varphi + \theta_1 h_{t-1} + b_1 \mu_{t-1}^2 + \gamma_1 \mu_{t-1}^2 D_{t-1}$$

Where  $D_t$  takes the value of 1 (bad news) for  $\mu_t < 0$ , and 0 otherwise. So ‘good news’ and ‘bad news’ have different impact. Good news (positive shock) has an impact of  $b_1$ , bad news (negative shock) has an impact of  $b_1 + \gamma_1$  is known as asymmetry or leverage term. If  $\gamma_1$  is significant and positive, negative shocks will have larger effect on  $h_t$  than positive shocks.

### 1.11 Uses of GARCH and ARCH

Since the introduction of the GARCH models these have been used by varied researchers, professional, policy makers and many others for different purposes. GARCH models can be used for examining the impact of particular index trading on volatility. Rahman (2001) used GARCH models to study the impact of index futures trading on the volatility of component stocks for the Dow Jones Industrial Average. The author used the simple GARCH (1, 1) model to calculate the conditional volatility of intra-day returns. It was found that there has been no change in conditional volatility from pre- to post-futures periods.

Bologna and Cavallo (2002) examined the effect of the introduction of stock index futures for the Italian Market. They found that the introduction of stock index futures affects the volatility of the spot market. Further, they found that volatility is reduced by the index future markets. They also used GARCH model to examine the effects that Indian spot market have on volatility and to see that to what extent the change (if any) could be attributed to the introduction of index futures. They concluded that the GARCH models are good for forecasting volatility and are useful for portfolio allocation, performance measurement, option valuation, etc. In view of this, present study was conducted with focused objectives as mentioned in section 1.12.

### 1.12. Objectives

1. To study the nature of volatility in Indian stock and commodity markets.
2. To study the relationship between return and volatility in selected indices of Indian stock and commodity markets.

3. To examine the impact of selected variables on volatility in Indian stock and commodity markets.
4. To identify suitable model for forecasting volatility in Indian stock and commodity markets.
5. To analyze perception of market participants regarding volatility in Indian stock and commodity markets.

## **CHAPTER II**

### **REVIEW OF LITERATURE**

Stock market volatility has been studied from different perspectives. In some studies, return-volatility dynamics are focused (Mahajan and Singh 2009) and in others the nature of volatility, pattern of volatility has been studied using day of week effect and other calendar anomalies. In some other studies the impact of macro-economic variables on volatility has been studied (Loomba 2012). In many studies ARCH and GARCH models have been used for modeling volatility. Accordingly the review for the present study is divided into following sections.

#### **2.1 Nature of volatility in Stock and Commodity markets**

#### **2.2 Impact of macroeconomic variables on volatility of stock and commodity Indices**

#### **2.3 Risk return relationship in stock markets**

#### **2.4 Risk return relationship in commodity markets**

#### **2.5 Volatility modeling**

#### **2.6 Perception of market participants about volatility**

#### **2.1 Nature of volatility in Stock and Commodity markets**

Ariel *et al* (1987) determined that the mean return depicts positive behavior only immediately before and during the first half of calendar months, and identical to zero for the last half of the month of the year. The study suggests that this ‘monthly effect’ is different from other known calendar anomalies such as the January effect which is caused by a shift in the mean of the distribution of returns from days in the first half of the month relative to days in the last half.

Glosten (1993) found negative relation between conditional expected monthly return and conditional variance of monthly return, using a GARCH-M model modified by allowing seasonal patterns in volatility, positive and negative innovations to returns having different impacts on conditional volatility, and nominal interest rates to predict conditional variance. The study used the modified GARCH-M model, to show that monthly conditional volatility may not be as persistent as was previously thought. Positive unanticipated returns appear to result in a downward revision of the conditional volatility whereas negative unanticipated returns result in an upward revision of the conditional volatility.

Anshuman (2000) analyzed day-of-the-week effects on the Bombay Stock Exchange (BSE) covering the period from 1991 through 1996. The study found the proofs of excess positive returns on Friday and excess negative returns on Tuesday. It was also found that excess (negative) returns on Tuesdays were mainly observed in post-March 1994 period and the excess (positive) Friday returns were related to firm size.

Taufiq (2000) analyzed the presence of the day of the week effect on seven emerging Asian stock market returns and volatility. The study was conducted using the GARCH model. In the study, the daily returns of seven Asian countries namely India, Indonesia, Malaysia, Philippines, South Korea, Taiwan, and Thailand from January 1990 to June 1995 were used. The study found the presence of the day of the week effect on both stock returns and volatility.

Berument *et al* (2001) examined the presence of the day of the week effect in stock market volatility. For the study purpose, the S&P 500 market index from January 1973 to October 1997 was used. It was found that the day of the week effect was present in both volatilities and return equations. In the study, it was found that highest and lowest return occurred on Wednesday and Monday and the highest and the lowest volatility was there on Friday and Wednesday, respectively. All of the findings were found to be statistically significant. The study concluded that the highest volatility on Friday may be the result of various macroeconomic news releases taking place on Thursday and Friday.

Bhattacharya *et al* (2003) examined the stability of the day of the week effect in returns and volatility in the Indian capital market. The study covered the time period from January 1991 – September 2000. It was found that there are significant positive returns on Thursday and Friday. The study covered a separate sub period analyses as per which changes in daily seasonality in returns and volatility were found. These findings related to the day of the week effects and its variation within a fortnight suggests that day of the week effect is due to the regulations imposed by stock exchange and interaction between stock market and the particular industry. Further it was concluded that the seasonality in volatility may also be due to the arbitrage opportunities in the market.

Kiyamaz *et al* (2003) investigated the day of the week effect on the volatility of stock market indexes. The study covered the period from 1988 to 2002. In the study, the conditional variance framework was used. The evidence of presence of the day of the week effect in both return and volatility equations were found. It was found that the highest volatility occurred on Mondays, on Fridays, and on Thursdays for different countries. It was further found that in most of the markets, whenever there was the lowest trading volume there were resultant highest volatility days.

Batra (2004) examined the time variation in volatility in the Indian stock market during 1979-2003. The study used the BSE Sensex and the International Finance Corporation (and S&P) published IFC Global (IFCG) index monthly data. The asymmetric GARCH methodology augmented by structural change analysis was used. The study identified the sudden shifts in stock price volatility. It was found that the period around the BOP crisis and

the subsequent initiation of economic reforms in India is the most volatile period in the stock market. Further the major cause of such sudden shifts was found to be major policy changes. It was concluded that the stock return volatility in India seems to be influenced more by domestic political and economic events rather than by global events. Further it was found that the stock market cycles in India have not intensified after financial liberalization.

Kaur (2004) investigated the nature and characteristics of stock market volatility in India. It was found that the volatility in the Indian stock market exhibits characteristics similar to those found earlier in many of the major developed and emerging stock markets. Various volatility estimators and diagnostic tests have been used and it was found the volatility clustering is present and it persists in Sensex and Nifty returns. It was also found that good and bad news does not have the same impact. Further the 'day-of-the-week effect' or the 'weekend effect' and the 'January effect' were found to be absent in Nifty and Sensex returns. It was also found that for both the indices, the month of February exhibits highest volatility and corresponding highest return. The month of March also exhibits significantly higher volatility but the magnitude is lesser as compared to February.

Sarma (2004) conducted a study on stock market seasonality in emerging markets. The study analyzed the returns of various indices to identify the presence or absence of seasonality in Indian stock market. The study used the Kruskal-Wallis test and 'H' statistics which is a non parametric test. The study tested the seasonality in Indian capital market and found the establishment of presence of seasonality across the days of the week. The study concluded as to the leptokurtic distribution of equity returns having presence of highest variance on Mondays and weekend effect.

Raj *et al* (2006) examined the presence of seasonal effects in the stock market of India. The study tests the efficiency of the Indian stock market through a number of hypotheses. The various statistical techniques to examine different effects like Weekday effects, weekend effect, day-of-the-week effect, and January and April effects were used. The negative Monday effect and the positive January effects were found to be absent in this piece of research. It was also found that there exist positive Monday returns and negative Tuesday returns. It was concluded that in India the stock market does not exhibit the usual seasonal anomalies like Monday and January effect.

Elango *et al* (2008) focused on the anomalies 'Monday effect' in many developed and developing markets around the world including India. For the study, the secondary data of three of the major indices of the National Stock Exchange of India (NSE) for 1999-2007 periods were used. For analysis, a set of descriptive and inferential statistics were used. The evidence of negative Monday returns was found in case of two out of three indices found. The

Kruskal Wallis non-parametric test was used to see whether the ranks of mean returns for each day of the week are equal. The study found evidence of a statistically significant difference in the case of one sample index, CNX S&P Nifty Junior. The study concluded that the weekend effect is present in small stocks. The dummy variable regression was also used with which it was found that Monday returns are negative in one of the benchmark indices, the NSE S&P Nifty. The study further suggested that the Indian Market is inefficient and investors can exploit it to maximize returns.

Mittal *et al* (2009) determined whether the stock market of India follows the weak form of efficiency and the efficient market hypothesis. For the study purpose, the closing prices and daily returns of three indices namely S&P CNX 500, CNX 100, and BSE 200 data from the time period 2007–2008 were used. The three types of anomalies namely Day of the Week effect, Friday Effect, and Monday Effect were studied. The study found the evidence against the presence of these anomalies in the Indian stock market and therefore concluded markets as informationally efficient.

Singhal *et al* (2009) carried out the testing of the existence of this 'weekend effect' in BSE Sensex, BSE 200, and the S&P Nifty from April 2003 to April 2008. The study is based on the argument that the measured daily returns should depend on the day of the week. More specifically, the expected returns on Monday should be lower and returns on Friday should be higher than on other days. The study found the results in accordance with the efficient market hypothesis which states that stock prices are random and that investors cannot make abnormal profits using historical prices. Further, it was found that there were lower returns on Mondays and maximum returns on Fridays across different indices. The study suggested that the investor should prefer to buy the scrips on Mondays and sell them on Fridays. The study further suggests that investors could experiment with the above strategy, to start with, on small stocks, and extend the same on blue-chips based on the risks and rewards.

Garg *et al* (2010) made an attempt to investigate the persistence of seasonal anomalies in the developed and developing markets by studying the Indian and US markets as the representative of emerging and developed markets, respectively from the period spanning from January 1998 to December 2007, further broken into two sub-periods: (i) January 1998 to December 2001, and (ii) January 2002 to December 2007. The study was conducted to examine the five different types of anomalies namely, monthly effect, turn of the month effect, semi-monthly effect, Monday effect, and Friday effect. It was found that the Monday effect is present only in India and the semi-monthly and turn of the month effect is found in both the markets. It was concluded that in spite of the developed information system, technology, and regulatory system, the stock markets are not yet free from seasonal

anomalies. The study found varying nature of volatility in different periods. From 1998-2001 fewer stock returns on Friday and on Monday were found, also the returns were significantly lesser than other days. On the other hand from 2002-2007 significantly higher returns on Monday as compared to other days were found. Further, it was found that the Monday effect disappears during the recent period in the stock market of India.

Patel *et al* (2011) studied the presence of the day-of-the-week effect along with the returns volatility and the annual returns of the Bombay Stock Exchange. The study used a set of parametric and nonparametric tests to test the equality of mean returns and standard deviations of the returns across the-days-of-the-week. The study found contradicting results of the presence of the-day-of-the- week effect but the results indicated insignificant daily returns volatility in most of the Markets. The study concluded that the daily return seasonality is not accompanied by any volatility seasonality and investing on low (high) return weekday does not necessarily mean that risk is also low or high.

Sharma (2011) conducted a study to analyze the existence of anomalies in India. For the study data for Sensex and Nifty indices for the period from January 2008 to December 2009 was used. For the study, the nonparametric tests like Run test, Kolmogorov-Smirnov (K-S) test, T-test, and ANOVA tests were used. It was found that the day of the week effect does not exist in the Indian Stock Market and this market can be considered as informationally efficient. Further, the Monday Effect and Friday Effect came out to be insignificant while comparing returns on these days with other day's returns. The findings of the study suggest that the absence of anomalies may not provide opportunities to formulate profitable trading strategies so as to earn the abnormal return.

Musunuru *et al* (2013) empirically examined the presence of calendar anomalies in agricultural commodity markets. The GARCH model for examining the time-varying volatility of commodities was used. The study found evidence of monthly seasonality in agricultural commodities. Further, it was also found that the volatility of corn, coffee, rough rice, soybeans, and soybean meal is caused by positive shocks and negative news has an impact on lean hogs. The significance of calendar effects for agricultural commodities was studied by using a non-linear symmetric GARCH (1, 1) model, a traditional OLS model, and two non-linear asymmetric models namely TGARCH (1, 1), and EGARCH (1, 1). From OLS results the study found evidence of the presence of the month-of-the-year effect for some commodities. Under GARCH models, the results indicated that the shocks to the conditional variance are highly persistent. The study also concluded that calendar anomalies exist for agricultural commodities and market participants, whether they are farmers or investors, can take advantage of this volatility in managing their trading decisions.

Srinivasan (2013) studied the day-of-the-week effect on stock returns and volatility of stock markets in India. To examine the presence of daily anomalies the study employed the GARCH (1, 1), EGARCH (1, 1), and TGARCH (1, 1) models. The study covered the period from 1st July 1997 to 29th June 2012. Their study confirmed the presence of positive Monday and Wednesday effects in the NSE-Nifty and BSE-SENSEX market returns. The results of the GARCH models confirmed the presence of day-of-the-week effects on stock returns and volatility of stock markets in India.

Mitra (2014) focused on evaluating the significant day of the week effect in the Indian stock market covering the period from January 2001 to December 2012. For the study 5 models were estimated. The risk factor was defined differently in each model that leads to different results. It was found that the NSE Nifty 50 did not exhibit the presence of the day of the week effects on the intraday and inter-day stock returns. On the other side, the Midcap index depicted Wednesday effect on the inter-day return of the index. In some cases, Friday depicted the lowest return indicating the presence of reverse weekend effect in the Indian stock market.

Safeer *et al* (2014) investigated the presence of the market anomalies in the Indian Capital market. The study used the average of mean of Index values of BSE index from Jan 2008 to Dec 2012. The study analyzed weekend effect by comparing averages of the mean of the index values. It was found that the weekend effect exists in Indian market in terms of price and volume. Further it was also found that the month effect and month of the year effect were minimally visible but could not be proved statistically. The study also proved the presence of negative stock split effect.

Borowski (2015) tested the hypothesis of daily, the day-of-the-week, the first and the second half of monthly effects on the commodity markets. For the study futures contract of barley, canola, rough rice, soybean oil and soybean meal, from the period of 2006-2015 (barely) and 1998-2015 (the other commodities) was used. The study found the presence of monthly effect in some of the selected commodities. The seasonal effects were also observed for daily averaged rates of return for different days of the month.

Sudarvel (2015) examined the presence of the day of the week effect specifically in IT sector of India. The study used the daily return data of IT index from September 2005 to March 2015. The study specified descriptive statistics and Ordinary Least Square (OLS) Regression model to find the existence of day of the week effect in stock returns in India. The study concluded that there exists the seasonality in stock returns and week effect was also observed. The results also confirmed the existence of day of the week effect in Indian BSE IT index.

## **2.2 Impact of macroeconomic variables on volatility of stock and commodity indices**

Gompers *et al* (2001) studied the impact that demand of institutional investors has on prices of the stocks and on returns. It was found that there has been a great increase in the demand of shares from large institutional investors which has resulted in increase in demand of stocks of large companies and resultant decrease in stocks of small companies. It was also found that with this there was approximately 50% increase in the prices of large company stocks.

Jiang *et al* (2004) studied the relation between level of foreign ownership in a firm and information asymmetry between firm (managers) and market (outside investors). They studied the financial statement data and stock market data of non financial firms from July 1975 to September 1995. They found that foreign investors usually avoid the stocks having high cross corporate holdings. The study suggested that FII are likely to be effective processors of public information and are attracted to Japanese firms with low information asymmetry.

Rai *et al* (2004) studied the bi-directional relationship between FII flows and returns from equity. The various factors determining the FIIs investment in India during 1994-2002 were studied and it was found that equity returns is the major factor that attracts FII investments. Further the study found that FIIs are more reactive to bad news as compared to good news.

Rajput *et al* (2008) found the positive relationship between the FIIs flows and stock market in India. The study tried to measure the relationship and predictive power among exchange rate, FII flows and stock index in India. The study covered the period from January 2000 to December 2005. Simple correlation and regression analysis tools were used. It was concluded that FIIs do have impact on the volatility but fails to predict the future value.

Alam *et al* (2009) focused on the relationship between interest rates and stock market. The sample includes fifteen countries' monthly observations from January 1988 to March 2003. This study examined the market efficiency of fifteen countries and also looked at the effect of interest rate on share price and changes of interest rate on changes of share price. The study found that the theoretical argument of negative relationship between stock price and prevailing interest rate is not to be rejected. The study found that four countries namely Bangladesh, Colombia, Italy, and South Africa which depicted negative relationship for both interest rates with share price and changes of interest rate with changes of share price. Eight countries namely, Australia, Canada, Chile, Germany, Jamaica, Mexico, Spain, and Venezuela were found to have significant negative relationship between interest rates and share price but no relationship between change of interest rate and change of share price. So,

except Philippine all other countries depicted significant negative relationship of interest rates with share price or changes of interest rate with changes of share price or both.

Kaur and Dhillon (2010) studied the determinants of FIIs investment in India using monthly data from April 1995 to December 2006. It was found that Indian stock market returns and inflation in US market have positive impact on FII flows whereas US stock market returns and inflation in India have no significant influence of FII flows to India. Further they found market capitalization and stock market turnover of India have significant positive influence only in short-run. Among macroeconomic determinants, they found economic growth of India to have positive impact on FIIs investment both in long-run and short run. They concluded that stock market characteristics and macroeconomic factors are major determinants of FIIs inflows in India.

Singh (2010) studied the relation between stock market index and macroeconomic variables. For this purpose the BSE Sensex and three variables namely wholesale price index, index of industrial production (IIP) and exchange rate(Rs/\$) were taken into account from the period from April, 1995 to March, 2009. The results of Granger causality test depicted the bilateral causal relationship between IIP and BSE Sensex, strong correlation between WPI and Sensex but a unilateral causality with BSE Sensex. Authors concluded that stock market of India is moving towards informational efficiency with respect to exchange rate and inflation (WPI).

Du *et al* (2011) tried to assess the factors that potentially influence the volatility of crude oil prices. For the study stochastic volatility models were applied to weekly crude oil, corn, and wheat futures prices from November 1998 to January 2009. The study found that the speculation, scalping, and petroleum inventories are important in explaining the volatility of crude oil prices. The study found the evidence of volatility spillover among crude oil, corn, and wheat markets after the fall of 2006.

Karthikeyan *et al* (2012) studied the FII flows in India and the impact it has on Indian equity market viz. BSE, NSE and S&P CNX 500. The secondary data for a period of 10 years spanning from 2001 to 2010 was used for the study. The study found a positive relationship between the FII flows and Indian equity market performance but the impact was found to be insignificant. It was further found that besides FII there are other factors like inflation, interest rate, domestic investors fund flow, government policy etc that influence the performance of Indian equity market.

Ahuja *et al* (2012) examined the impact of macroeconomic variables on volatility using monthly data from April 2005 – March 2012. They used the macroeconomic variables namely the industrial production index, consumer price index, interest rate (call rate),

exchange rate, gold price, oil price, foreign institutional investment and includes sectoral analysis of five sectors (metal, auto, capital goods, FMCG, consumer durables). The study used Sensex and Nifty data. The study found the three variables namely exchange rate, foreign institutional investment and call rate to have more significant effect on FII. It was found that FIIs affects the stock market and results in volatility in the market. This study concluded that in long term the Indian stock market is more driven by domestic macroeconomic factors rather than global factors.

Jain *et al* (2012) examined the effect of foreign institutional investment on sensitivity index (Sensex). The study tried to understand the behavioral pattern of FII. The volatility of BSE Sensex due to FII was studied from the period 2001 to 2010. The study tried to explain the impact of foreign institutional investment on stock market and Indian economy. The study found that the FIIs influenced the sensex movement to a greater extent. Further it was found that the sensex has increased when there were positive inflows of FIIs and vice versa. The study concluded that there exists positive correlation between the foreign institutional investments and the movement of sensex.

Loomba (2012) studied the dynamics of trading behavior of FIIs along with its effect on equity market of India. The study used the daily data on BSE Sensex and FII activity for a period of 10 years from 01st Jan 2001 to 31st Dec 2011. The study found the evidence of positive correlation between FII activity and its effects on Indian stock Market. The study further explained that the ups and downs in the Indian stock market are fairly explained by the inflows from FII. The study concluded that the Indian stock market is mainly driven by FIIs.

Shrivastav (2013) conducted the study and found that investments by FIIs and the movements of Sensex are closely correlated in India. The study also found that FIIs have significant influence on the movement of Sensex. FIIs have positive impact on BSE Sensex and Nifty. The study further elaborated that there are many other major factors that affects stock market but FII is definitely one of the factors.

Joshi (2014) tried to identify the relationship between macroeconomic variables and stock market of India. For the study monthly frequency data was used from January 2011 to December 2012. For the study multivariate stepwise regression, the Pearson's correlation and Granger's causality test were used. The results of the study depicted that macroeconomic variables have significant impact on stock market of India. The study further observed that there is improvement in the performance of Indian Stock market with increased inflow of foreign investment. It was found through the Granger causality test that there exists causal relationship from FII to stock market but no causal relationship was found among the variables.

Kanojia (2015) studied the relationship between net investments by FIIs and return on BSE 100 Index from the period spanning from 1st April 2000 to 31st March, 2012. The study used the Granger Causality test to find relationship between net investment by FIIs and return on BSE 100 Index. It was found that the net investments by FIIs granger cause the return on BSE 100 Index. The study concluded that the BSE Index 100 got positively affected by net investments by FIIs. It was also concluded that the net investments by FIIs granger cause the return on BSE 100 Index. The study also found a uni-directional causality of net investments by FIIs over return on BSE 100 Index along with the association between the net investments by FIIs and return on BSE 100 Index.

Srinivas (2015) conducted the statistical analysis of FII (Foreign Institutional investor) flows and the impact it has on the index from 2008 to 2013. The empirical analysis was done using statistical tools like t-test, regression analysis, and correlation. The study found that there is significant relationship between the FII flows and the index.

Budu (2017) studied the impact of FIIs on Sensex movement. He concluded using simple correlation that the FIIs largely influence the Sensex movement. This is supported by observed direct relation between Sensex and FII inflow. As per the study the Sensex increased with the positive inflows of FIIs and vice versa. The study found positive correlation between the two.

### **2.3 Risk returns relationship in Stock Markets**

In Financial theory, it is generally accepted that the expected return of the stock is positively and proportionally related to the conditional volatility meaning that if there are expectations of higher levels of risk associated with a particular investment then greater returns are required as compensation for that higher expected risk. Alternatively, if an investment has relatively lower levels of expected risk then investors are satisfied with relatively lower returns.

The risk-return relationship is very essential part of the modern finance and economics. On the basis of the outcomes from the analysis of the risk-return relationship the practitioners can make appropriate decision in case of investment. If the risk-return relationship is positive the investors will be rewarded of taking additional risk by reaping a higher return. If it is negative the investors will lose their money for taking additional risk. The negative sign of risk-return coefficient is not consistent with portfolio theory.

The volatility and the risk-return trade off of stocks or stock markets play essential role in investment decision making and financial stability among others. Accordingly, there are various empirical studies that have been conducted to investigate the risk-return relation by using data from different countries or different stock markets. However, the results about

the risk and return relation are mixed. Guo *et al* (2006) found a positive risk-return tradeoff, whereas Goyal *et al* (2003) Chan *et al* (2005) found insignificantly positive relationship. Further Fama *et al* (1977), Campbell (1987), Breen *et al* (1989), Nelson (1991), Glosten *et al* (1993), and Bekaert *et al* (2000), found a significantly negative relationship between risk and return. On the other hand Glosten *et al* (1993) Pettengill *et al* (1995) and Harvey (2001) found positive relation between beta and returns when market excess returns are positive and a negative relation when market excess returns are negative. They also revealed that the positive or negative relation depends on the method used. Some of the studies that highlight the relation between risk and return are described as under.

French *et al* (1987) examined the relation between stock returns and stock market volatility using returns of NYSE from the period 1928-1984. The study found evidence of a positive relation between expected risk premiums and predicted level of volatility. Further they found that unpredictable stock market returns are negatively related to the unexpected change in the volatility of stock returns. They also observed substantial variation in the estimates of volatility and expected risk premiums. They found ambiguous results because the measures of risk and other factors that might affect expected risk premiums are less precise than the 23 volatility measures reported in the paper.

Mougoué *et al* (1996) examined the relationship between stock returns and volatility in the German and French equity markets. The empirical analysis of the paper was carried out by using GARCH(1,1)-M specification and the study found a positive and statistically significant risk aversion component in mean equation which implies the presence of a positive relationship.

Huang (1997) examined the risk and return relationship for stocks listed on the Taiwan Stock Exchange over the period 1971-1993. The results indicate a strong inverse relationship between returns and systematic risk, unique risk, and total risk respectively which is contrary to the prediction of the CAPM. Further they observed that the movement of stock prices is not symmetric, and that the risk-return relationship is explained by more than one factor. Moreover, they found that the estimated market risk premiums of both up and down markets are insignificantly different from the corresponding expected market risk premiums. They concluded that the estimated security market line (SML) is positive but flatter in the up market and steeper negatively in the down market.

Song *et al* (1998) used the GARCH-M models to study the risk return relationship in the Shanghai and Shenzhen Stock Exchanges in China. They chose these exchanges which have much smaller capitalization and fewer listed companies when compared to well-developed financial markets. The results of the study found the evidences of a significant

positive risk premia on stock prices in both exchanges which suggests that higher risk results in higher return.

Salman (2002) studied the risk-return-volume relationship in the Istanbul Stock Exchange (ISE) for the period from 2nd January 1992 to 29th May 1998. They used the Generalized Autoregressive Conditional Heteroscedasticity-in-Mean (GARCH-M) model. In the model volume is taken as a proxy for the information arrival to the market and is introduced both in the return and variance equations. The study found that the return is positively associated with risk. They concluded the existence of positive risk-return relationship, when volume is incorporated to both return and variance equation.

Shin (2005) studied the relationship between expected stock returns and conditional volatility in 14 emerging international stock markets using both parametric and semi parametric GARCH in mean estimation. He found that a positive relationship prevails for the majority of the emerging markets, while such a relationship is insignificant in most cases. He found the evidences of positive but insignificant relationship between expected stock returns and volatility in emerging stock markets using

Menggen (2007) studied the risk-return relationship in Chinese emerging stock markets using daily, weekly and monthly market return series. The study concluded that the conditional mean is positively related to the conditional variance of stock market returns. He found that the empirical results for the daily returns in Shenzhen Stock Exchange were found to be in favor of ICAPM, and depicted a positive and statistically significant risk-return relationship.

Yakob *et al* (2007) argued that the expected rate of return for a security is influenced by the systematic risk which is the non-diversifiable component of the total risk. The author studied the risk return relationship using daily closing values for stock indices of ten exchanges in Asia Pacific countries, namely in Australia, China, Hong Kong, India, Indonesia, Japan, Malaysia, Singapore, South Korea and Taiwan. The study used the data from the beginning of January 2000 to the end of February 2005. The author postulated a positive linear relationship between risk and return. Using the GARCH (1, 1)-M model, the study determined the relationship between risk and return within the framework of the conditional CAPM. The result failed to produce convincing evidence to fully support the positive linear relationship in the Asia Pacific stock markets as postulated by the CAPM.

Guo *et al* (2008) used the daily and weekly MSCI gross excess total stock market returns for 19 international markets, including the World, from January 7th, 1974 to August 29th, 2003. The study found positive risk-return relation using daily data and component GARCH (CGARCH) models. The study further suggests that long-run volatility appears to be important in determining the conditional equity premium, but the evidence might be spurious.

Hossain *et al* (2009) studied the volatility for Bangladesh stock market namely Dhaka Stock Exchange (DSE). The study found the evidence of a positive risk-return relationship for DSI and DS20 and negative relationship for DSEG index of DSE but not statistically significant, which is not consistent with portfolio theory. The negative risk-return relationship happened due to the weak corporate profit performance.

Dorfman *et al* (2010) studied the risk return trade-off by using bivariate GARCH-M models on monthly return data on agricultural production and food manufacturing portfolios, the market portfolio, and the one-month Treasury bill rate. The study found positive relation between stock return and its risks for both industries. The study further found a high posterior probability of a positive tradeoff for the agricultural production portfolio.

Jiranyakul (2011) provided new evidence on the positive risk-return tradeoff in the Thai stock market using monthly data from January 1981 to December 2009. Using an AR(p)-GARCH-in-mean model the study found the presence of positive risk-return tradeoff in the stock market w.r.t both capital gain and dividend excess returns. The study further suggests that size of the risk-return tradeoff is higher and highly significant when the market dividend yield is used to obtain the excess return.

Abdalla *et al* (2012) empirically examined the trade-off between risk (conditional volatility) and expected returns for the Saudi Arabian and Egyptian stock indices. The study used the both symmetric (GARCH-M) and asymmetric (EGARCH-M) models. The study discovered the difference in risk-return relationship between Saudi Arabian and Egyptian stock markets. The study found negative but insignificant relationship between expected returns and conditional volatility for daily returns in Egypt. In contrast, it was found that the conditional mean of the stock returns is positively but insignificantly related to its conditional variance in Saudi stock market, which is consistent with the theory of a positive risk premium on stock indices which states that higher the risk higher the returns.

Abonongo *et al* (2016) modeled the volatility and the risk-return relationship of data of 8 equities of the Ghana Stock Exchange from the period 2nd January, 2004 to 16th January 2015 using univariate GARCH-M (1, 1). It was found that, the market was bullish for investors for most of the stocks and that there was a high probability of gains than losses. The study found the existence of positive risk premium which means the investors were compensated for holding risky assets. The authors suggested that, the asymmetric models provide a better fit than the symmetric models indicating the presence of leverage effect. It was concluded that there exists a positive relationship between risk and return.

Aslanidis *et al* (2016) tested the intemporal risk-return relation for 13 European stock markets from 1986-2012. They used the conditional returns and conditional risk measures

using factors that are based upon a large number of macro-finance variables. They suggested that it is important to account for country specific, euro area, as well as global macro-finance factors when determining the conditional return and volatility. The study found the proofs of weaker negative risk-return trade-off.

#### **2.4 Risk return relationship in commodity markets:**

The relationship between the return on an asset and its volatility as a proxy for risk has been an important topic in financial research. However, there is mixed evidence on the nature of this relationship. It has been found to be positive as well as negative. As commodities are concerned, asymmetric nature of volatility can be explained through inverse leverage effect in many commodities and through leverage effect in crude oil (Aboura *et al* 2013, Chen *et al* 2020). The other group of studies found that it can be explained through leverage and a volatility feedback effect (Baur 2012, Kristoufek 2014, Chevallier 2017).

Dusak (1973) examined the existence of risk premium in the framework of the Capital Asset Pricing Model. She did her study on the basis of the concept that the futures contract should depend on the extent to which the variations in prices are systematically related to variation in return on total wealth. She found that the systematic risks of the three commodity contracts namely wheat, corn, and soybean futures, were not significantly different from zero.

Bodie (1980) analyzed the major commodities traded in futures markets in the United States over the study period from December 1949 to December 1976. The author found that the commodity futures proved to be very good inflation hedges. He found the mean rate of return on a well diversified portfolio of commodity futures to be more than the average risk-free rate. They concluded that the relation between the means and the corresponding beta coefficients appears to be inconsistent with the conventional form of the capital asset pricing model.

Murphy (1987) studied the seasonality of risk and returns on agricultural futures positions using U.S. futures contracts on all agricultural commodities from 1965-1983. They observed that the seasonal changes in the variance are uncorrelated with the return on the market portfolio. The author found that the contribution of agricultural futures to the risk of investment portfolios does not vary seasonally.

Beck (1993) modeled the role of spot price risk, in futures market risk premia. They used the price data for different commodities from 1966 to 1987. The author observed that the price volatility can be predicted by seasonal factors in commodity markets. They found that an ARCH process exist in the futures prices of storable commodity but variance had no effect on the return. They concluded that the hedging theory is an inadequate explanation for the risk premium in commodities futures markets.

Theodossiou *et al* (1995) studied the nature of stock market volatility and its relation to expected returns for ten industrialized countries (Australia, Belgium, Canada, France, Italy, Japan, Switzerland, the United Kingdom, the United States, and (West) Germany) from January 16, 1976, to December 27, 1991. The study used the generalized autoregressive conditional heteroskedasticity in the mean (GARCH-M). The study found the proof of significant conditional heteroskedasticity in the return series of all ten markets. The study found no relationship between conditional volatility and expected returns in any of the ten national stock markets.

Adding a new paradigm to the trading volume-price relationships Gervais *et al* (2001) investigated the role of trading activities in terms of the information it contains about future prices. The study is based on the power of trading volume in predicting the directions of future price movements. It was found that individual stocks, whose trading volume is usually large (small) over period of a day or a week, tend to experience large (small) returns over the subsequent month.

Lee *et al* (2002) tested the impact of noise trader risk on both the formation of conditional volatility and expected return using three different market indices, namely, the DJIA, S&P 500, and NASDAQ from January 5th, 1973 to October 6th, 1995. The empirical results of the study depicted that sentiment is a systematic risk. The study found contemporaneous positive relation between excess returns and shifts in sentiment. Further the study found that the magnitude of bullish (bearish) changes in sentiment leads to downward (upward) revisions in volatility and higher (lower) future excess returns. The study also found that higher (lower) excess returns are associated with a decrease (increase) in conditional volatility resulting from larger bullish (bearish) shifts in sentiment for both small as well as large capitalization stocks.

Gorton (2006) found that although the risk premium on commodity futures is essentially the same as that on equities for the study period, commodity futures returns are negatively correlated with equity returns and bond returns. The negative correlation is the result, primarily, of commodity futures' different behavior over a business cycle. Commodity futures are positively correlated with inflation, unexpected inflation, and changes in expected inflation.

Lucey *et al* (2006) found no evidence of an ARCH-in-Mean effect. The finding that these markets appear to be driven almost entirely by their own lagged values, the autoregressive and moving average terms being significant, with neither risk (ARCH-in-Mean) nor non-risk (constant in the mean) variables having any significant impact which indicates that returns to these assets are perhaps separate from other influences.

Worthington *et al* (2007) found that the inflation hedging quality of gold depends on the presence of a stable long-term relationship between the price of gold and the rate of inflation. He found a strong relationship between gold and inflation which suggest that gold is a useful inflation hedge in the post-war and post-1970s period.

Kumar (2008) studied the risk-return relationship using symmetric GARCH (1, 1)-in-Mean with seasonal dummies in risk and return equation using the data from May 1, 2006 to April 30, 2008. They used five commodities namely, Gold, Copper, Petroleum Crude, Refined Soya Oil and Chana (Chick pea). They found the presence of negative relationship between transaction cost and trading volume, and a positive relationship between transaction cost and volatility. He found that the gold shows a significant positive risk return relationship.

Mahajan *et al* (2008) examined the causal relationship between volume and return, and volume and volatility. The study focused on sensitive index of the Bombay Stock Exchange (SENSEX). The study found positive contemporaneous relationship between volume and volatility. The study further explained process by using causality test that there is always sequential arrival of information and this information is not equally available to all traders in the market. So it takes time to absorb in the market and ultimately hampers the price discovery efficiency of the market. Further the GARCH technique and Granger causality test were also used to examine the empirical relationship between return, volume and volatility. The study found the evidence of positive impact of volume on return and volatility.

Brajesh *et al* (2008) empirically studied the volatility, risk premium and seasonality in risk-return in relation of the Indian stock and commodity markets. The study focused on market index S&P CNX Nifty for a period of 18 years from January 1990 to December 2007. The study investigated the risk-return relationship and seasonality in risk-return through GARCH-in-Mean modeling. The study found that the stock and commodity markets returns show persistence as well as clustering and asymmetric properties. A positive though insignificant risk-return relationship was found for Nifty and Soybean where as significant positive relationship was found in the case of Gold. Seasonality was found to be present in risk and return which suggests the asymmetric nature of return, i.e. Negative correlation between return and its volatility.

Hossain (2009) empirically examined the risk-return relationship of Bangladesh stock market namely Dhaka Stock Exchange (DSE) using the monthly price index data for the period spanning from January 1987 to August 2010. This study employed the GARCH (p, q)-M model and it was found that there exists a positive risk-return relationship for DSI and DS20 and negative relationship for DSEG index of DSE but not statistically significant at all. The study further suggested that the negative risk-return relationship is due to the weak corporate profit performance.

Mahajan *et al* (2009) argued that trading volume is a major consideration without which stock prices convey vague information. The study examined the empirical relationship between volume, return and volatility. The study found the evidence of positive and significant correlation between volume and return volatility that is indicative of both the mixture of distribution and sequential arrival hypothesis of information flow. The study found positive correlation between volatility and trading volume. It is there because of the affect that informed traders have on the prices because of revealing of private information to the market. So the study suggests that informed traders trade on the basis of private information and their trading activities affects the prices.

Brajesh *et al* (2010) empirically examined the relationship between volatility, returns and trading volume. The study examined the correlation between trading volume and returns and asymmetric relation between level of trading volume and returns. The study also examined the contemporaneous and asymmetric relation between unconditional volatility and volume. It was found that there exist positive relation between volume and returns.

Hunjra (2011) studied the risk and return relationship on the basis of univariate modeling approach. He studied the asymmetric and nonlinear relationship between risk and return on the basis of GARCH-M and E -GARCH modeling approach. The study found the presence of asymmetric and seasonal effect in commodities market and stock markets. The growing economic uncertainty and developments need mechanism that can be used by investors to minimize the exposure to risk. As per the portfolio theory the performance of the portfolio can be improved by diversifying it to unique asset class. This asset class is lacking or having a zero correlation to regular equities, which makes them attractive assets for diversified portfolios (Almargo *et al* 2009). It is believed that by adding commodities to the portfolio it might act as inflation proxies in the portfolio.

Dimitrios *et al* (2011) empirically investigated the relationship between expected returns and conditional variance in twelve stock markets of the European Union as well as five large stock markets and two world indices. The sample period from December 1992 - December 2007 was used. Both parametric and semi-parametric estimation methods of the conditional variance were applied to daily data from the above markets. The study found a statistically significant negative relationship of the risk-return tradeoff in most markets except Austria, Belgium and Luxemburg. Furthermore, the significant negative asymmetry was found in almost all markets. Based on parametric GARCH in mean models the study found a weak relationship between expected returns and volatility for most of the markets.

Tiwari (2011) observed that commodity markets have become more like financial markets in some respects. Financial investors are increasingly active on both sides of trades,

creating a kind of financial trading sphere. Yet the characteristics of physical markets, such as inventory levels and the marginal cost of production, are still important.

Panait *et al* (2012) used the data mining to compare the volatility structure of high (daily) and low (weekly, monthly) frequencies for seven Romanian companies traded on Bucharest Stock Exchange and three market indices for the period 1997-2012. The study using the GARCH-in-mean failed to confirm the theoretical hypothesis that an increase in volatility leads to a rise in future returns. The study further found the variance coefficient of mean equation to be insignificant to hedge against holding a risky asset. The study found that GARCH-in-mean was well fitted on the weekly and monthly time series but behaved less well on the daily time series. In the study majority of the time series and frequencies the coefficients from the variance equation of the model proved to be statistically significant indicating that conditional volatility tends to revert to the long term average (with only a single exception).

Zapata *et al* (2012) examines the cyclical relationship between stocks and commodities and the function of commodity and agribusiness indexes in portfolios. The study used the data of different indices from the time period 1871-2010. They found that for a risk-averse investor, irrespective of the period analyzed, placing funds in agribusiness and/or agricultural commodity indexes was sound investing.

Basu *et al* (2013) found positive relationship between hedging pressure risk premiums and the lagged conditional volatility of commodity futures markets. The author also found the price of commodity risk based on hedging pressure is positive and often significant, while the price of risk associated with the S&P-GSCI is zero, both statistically and economically.

Goswami *et al* (2013) did the empirical study of ten agricultural commodity futures (Chana, Jute, Kapas, Pepper, Wheat, Rice, Potato, Yellow peas, Sugar and Urad) for the period 2004–2012. He did not find commodity futures as a best hedging tool against inflation.

Mahajan *et al* (2013) focused on examining the impact of rolling settlement on contemporaneous and causal relationships between return, volume and volatility in Indian stock market using daily data of closing prices and volume of NIFTY index of NSE and SENSEX of BSE from January 1997 to June 2007. The study did not find any contemporaneous relationship between volume and returns in post rolling settlement period for both the indices. The study found positive relationship between volume and return in only pre-rolling settlement period in both indices (NIFTY and SENSEX). This indicates that markets have become more efficient after introduction of rolling settlement. In addition, causality results also provide conclusive evidence of improvement in efficiency at NSE and

BSE with the introduction of rolling settlement. The study suggests that the rolling settlement has made shares more attractive, investors would be more willing to supply risk capital in the country if they know that shares can be rapidly converted into cash when need arises.

Naik *et al* (2014) investigated stock market volatility asymmetry and the relationship it has with equity trading volume in stock market of India. The study used the data from 2nd January 1997 to 30th May 2013. The study found the presence of significant volatility asymmetry in the Indian equity market which supports the leverage effect hypothesis. The study also found a positive relationship between volume and volatility. It was found that even after the inclusion of trading volume as an explanatory variable the level of volatility persistence still remains high in the volatility model.

Bhardwaj (2015) found that the commodity market depict rise in correlations in periods of heightened financial risk/turmoil associated with macroeconomic activity. This feature is shared by many asset classes. Commodity correlations have spiked during the financial crisis, in a way that resembles other episodes of increased risk in history. The fundamental relationship between return and risk (as measured by carry) has been similar across the in-sample and out of sample period.

Goswami (2015) compared the risk & return performance of different groups of commodity futures in India over the study period 2004-2012. He found that the lowest returns in all forms are provided by the energy futures. He further found that oil & oil related products earned the highest return as well act as the most risky asset among the various group of commodity futures. The study suggested that energy futures earned lowest return, but it is also the least risky asset followed by agricultural commodity futures and metal futures which were at modest position with respect to both risk and return.

Seasonality in returns or variances is expected if the average returns were not same in all periods. Many researchers (Crain *et al* 1996, Richter *et al* 2002, Lucey *et al* 2006) found that commodities exhibit seasonality patterns in both spot price level and volatility. They also found seasonal pattern in both volatilities and convenience yields.

Singhal (2017) found that as a result of the combined efficient frontier an investor who is risk averse and whose preference is risk protection will prefer to invest in combination of SENSEX, BOND & MCX Energy whereas an investor who gets utility by taking more risk for more returns will prefer to invest in combination of SENSEX, BOND & MCX Metal. Investor having inclination towards moderate risk return would tend to invest in MCX AGRI along with SENSEX and BOND.

Daigler (2017) investigated commodity futures risk–return strategy in relation to an equity portfolio. They used Markowitz mean variance on commodity and financial futures

samples and used out of the sample performance for different time periods. They found that including commodity futures in one's investment portfolio improves portfolio performance not only on an ex ante, but also on an ex post basis, with such portfolios consistently outperforming equity-only portfolios. They further concluded that commodity futures can be used for both diversification and portfolio optimization.

## **2.5 Volatility Modeling**

Franses *et al* (1996) evaluated the performance of GARCH models and its non-linear modifications like Quadratic GARCH to forecast weekly stock market volatility. The study used the weekly observed indices for the stock markets in Germany (DAX), The Netherlands (EOE), Spain (MAD), Italy (MIL) and Sweden (VEC) from 1986 to 1994. The study found that QGARCH model to be the most suitable in absence of extreme observations like stock market crashes in a particular year. The study suggested that the model can improve on linear GARCH model. The study do not recommend GJR model.

Wei (1999) studied the performance of GARCH model and its modifications. The study used daily returns of Kuala Lumpur Stock Exchanges (KLSE) including composite Index, Tins Index, Plantations Index, Properties Index, and Finance Index. The various GARCH models have been used namely the stationary GARCH, unconstrained GARCH, non-negative GARCH, GARCH-M, exponential GARCH and integrated GARCH. The study found that EGARCH model performs best in describing the skewness in stock market indices but it is not the best model in the goodness-of-fit statistics. Further the study found the integrated GARCH model to be the poorest model in both respects.

Gokcan (2000) tried to forecast volatility of emerging stock and commodity markets using linear and non linear GARCH models. The study used the monthly stock market returns of seven emerging countries from February 1988 to December 1996. The study found that the linear GARCH model produced better results as compared to non-linear GARCH model. The study was conducted using within the sample and out of the sample model. It was found within-sample that the conditional estimates of linear GARCH model outperformed the conditional estimates of non-linear GARCH models. The study further found from out-of-sample that monthly volatilities are predicted better when the linear GARCH model is applied.

Yu (2002) evaluated the performance of nine alternative models for predicting stock price volatility using daily New Zealand stock market data. The study was conducted using, simple models such as the random walk and smoothing models and complex models such as ARCH-type models and a stochastic volatility model. The accuracy of forecasting models was measured using four different measures. The study found that the stochastic volatility model

provides the best performance among all the models. The study suggested that ARCH-type models can perform well or badly depending on the form of chosen test. The study further found the performance of the GARCH (3, 2) model to be the best model within the ARCH family. The study concluded that the regression and exponentially weighted moving average models do not perform well according to any assessment measure.

Weixian (2002) tried to forecast the stock market volatility with non-linear GARCH models using weekly observed indices for Shanghai Stock Exchange Composite (HSEC) and Shenzhen Stock Exchange Component (ZSEC) in China. The study used the weekly data of Friday's closing prices from 1992 to 1998. The study used the performance of the GARCH model and two of its non-linear modifications to forecast China's weekly stock market volatility. The study found the QGARCH model to be best when the estimation sample does not contain extreme observations such as the stock market crash. The study further concluded that the GJR model to be poor performer and do not recommend it for forecasting.

Karmakar (2005) estimated the conditional volatility models to capture the salient features of Indian stock market volatility. The study evaluated the models in terms of out-of sample forecast accuracy. This study also investigated the presence of leverage effect in Indian companies. For the study S&P CNX Nifty and BSE Sensex indices have been used for estimation of volatility. The evidences of time varying volatility and high persistence and predictability of volatility were found. The study found that the GARCH (1, 1) model provides reasonably good forecasts of market volatility.

Poon *et al* (2005) performed tests of volatility forecasting methods on varied financial asset returns. The study argued that financial market volatility can be clearly forecasted. The study found that the forecasting results of option implied volatility were more accurate than time series models. The study ranked the time series models. It was observed that between historical volatility and ARCH models, historical volatility model were better than the generalized autoregressive conditional heteroscedasticity, and stochastic volatility. The study concluded both historical volatility and ARCH models to be better than the stochastic volatility model.

Frimpong *et al* (2006) modeled and forecasted the volatility on the Ghana Stock Exchange using a random walk (RW), GARCH(1,1), EGARCH(1,1), and TGARCH(1,1) models. The study used a unique 'three days a week' Databank Stock Index (DSI) to study the dynamics of the Ghana stock market volatility over a 10-year period. The volatility of the DSI returns have been modeled for forecasting using a linear random walk model (RW), a nonlinear symmetric GARCH (1,1) model, and two nonlinear asymmetric models TGARCH(1,1) and EGARCH(1,1). It was found that the GARCH (1, 1) model outperformed the other competing models.

Ladokhin *et al* (2009) studied the problem of forecasting volatility in financial markets. The study used the secondary data of S&P 500 stock index to test accuracy of different methods. It was found that there are some methods that are simple but the results they yield are of poor quality (e.g., historical average model). On the other side there are some methods that are good at results but their implementation is difficult (e.g., Implied Volatility method). The study found that Exponentially Weighted and Simple Moving Average methods yield good results and these are relatively easy to implement. The study concluded that the Moving Average method to be good for a quick approximation of the volatility forecast.

Ahmed *et al* (2011) modeled the volatility of principal stock exchanges of Sudan namely the Khartoum Stock Exchange (KSE) index from January 2006 to November 2010 using a univariate Generalized Autoregressive Conditional Heteroscedastic (GARCH) model. The study used both symmetric and asymmetric models that capture most common stylized facts about index returns such as volatility clustering and leverage effect like GARCH(1,1), GARCH-M(1,1), exponential GARCH(1,1), threshold GARCH(1,1) and power GARCH(1,1). The study found that the daily returns could be characterized by the above mentioned models. The study found the evidences of presence of heteroscedasticity in the residuals series. The study concluded that the asymmetric models provide better fit than the symmetric models, which confirms the presence of leverage effect.

Wennstrom (2014) studied volatility forecasting performance and tried to evaluate GARCH type volatility using six commonly used forecasting models namely the simple moving average, the exponentially weighted moving average, the ARCH model, the GARCH model, the EGARCH model and the GJR-GARCH models. The study conducted a comparative study of the volatility models in terms of the in-sample and out-of-sample fit. The study found that the more complex models provide better in-sample fit than the more parsimonious models. In terms of the out-of-sample forecasting performance the study did not found conclusive results. The study suggested there is not a single volatility model that is preferred based on all the loss functions.

Bond (2015) identified the most accurate models based on the lowest mean squared estimation error. The study found the discrete historical, ARMA, GARCH (1, 1) and EWMA as the most accurate forecasting methods. The study suggested that the predictive efficiency of a model depends on the asset class and frequency of observations. It was also found that some models have better predicting ability to predict equity market volatility while others can better predict interest rates or currencies.

Gurmeet (2015) investigated the relation between return, volume and volatility in Indian stock market using the Nifty index of NSE during the period from Jan 2007 to March

2014. It was found that the ARCH family models outperform the conventional OLS models. The study found TGARCH model as a better fit as compared to GARCH and EGARCH models on the basis of SIC and AIC criteria. The study found significant effect of ARCH and GARCH models which indicates the inefficiency of market. Further the EGARCH and TGARCH models indicated the presence of leverage effect and showed the positive impact of volatility on returns. The study also found the one way causality from volatility to trading volume and from returns to volume.

Saurabh (2016) empirically investigated the volatility pattern of Indian stock market based on time series data which comprises of daily closing prices of the S&P CNX Nifty Index for period from 1st April 2001 to 31st March 2016. The study used both symmetric and asymmetric models of Generalized Autoregressive Conditional Heteroscedastic (GARCH). The study found GARCH-M (1, 1) and EGARCH (1, 1) to be best symmetric and asymmetric models as per the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Log Likelihood ratios. The study further found that there exist positive and insignificant risk premium as per GARCH-M (1, 1) model. The study found GARCH-M (1, 1) model to be the best fitted model among all to capture the symmetric effect as per AIC criterion and Log Likelihood ratio and EGARCH (1, 1) model to be the best fitted model to capture the asymmetric volatility based on the highest Log Likelihood ratios and minimum AIC and SIC criterion.

## **2.6 Perception of Market participants about volatility**

In commodity market volatility is considered to be the highest of all the different asset classes. Volatility is the variance in the price of an asset over a period of time. The prices of many commodities have shown an upward trend since 2002. The prices of commodities have depicted extremely high volatility (Devlin *et al* 2011, Dwyer *et al*, 2011, Algieri 2012, Nissanke 2012). In such an environment, volatility is a major concern for most investors. Commodity price risk is the financial risk on an entity's financial performance. Fluctuations in the prices of commodities that are out of the control are primarily driven by external market forces. Sharp fluctuations in commodity prices create significant business challenges that can affect production costs, product pricing, earnings, and credit availability. This price volatility makes it imperative for an entity to manage the impact of commodity price fluctuations across its value chain to effectively manage its financial performance and profitability. In commodity markets as in stock markets, return and risk are directly proportional. In the world of commodities, greater returns come with a higher degree of risk. Many research studies have found oil to be the most volatile commodity followed by energy and then agricultural commodities. The studies have further proved that high returns in these

commodities are associated with high risk (Goswami *et al* 2015, Nirmala *et al* 2018). Many studies have been conducted to assess the perception of traders and brokers regarding volatility.

Indian market provides an avenue for retail investors and traders to participate in commodity derivatives. For those who want to diversify their portfolios beyond shares, bonds and real estate, commodities are the best option. Many researchers (William 2017, Hymavathi *et al* 2018, Prasad *et al* 2019) have found that a large proportion of non-professionals trade in Indian commodity markets. A large number of investors in commodity want to earn a high return in a short term period. So investors should choose the right product to enter into the market based on time and ability. The government, stock exchange, and brokers conduct awareness programs regarding commodity trading in the urban and semi-urban areas to develop the investor's literacy level. Further many studies (Purohit 2013, Senthil 2015, Tiwari 2017, Melbha *et al*, 2017, Chandrakumar 2018, and Azhar 2020) have found that most investors are interested to invest in the commodity futures market but they don't know how to invest and the associated risk factors. Proper investor awareness programs only can help them to know the commodity market and commodity futures markets as these are a new and emerging market. There is a strong need for educating the investors about the opportunities, features and risk factors of commodity investment and to motivate them in investing in various avenues of investment available in the commodity market. Many researchers for example Deepak *et al* 2018 has found that attitude and perception influence preference for specific investment asset.

Aranganathan (2013) empirically studied investors' preference in Indian commodities market using the primary data collected using questionnaire consisting of 6 socio-demographic and 29 close ended questions. The study found that the investors take their investment decision on the basis of various factors because of risky nature of commodity markets. Moreover it was found that the commodity market is perceived as a market with long term benefits to the investors. The study suggested that the investors should prefer long term investment than the short term investment to understand the trend and direction of commodity market.

Sornaganesh (2014) studied the investment preference of salaried class people using primary data collected from the sample of 225 units which includes consist of government employees, Private employees, Businessman, Professionals and Other employees. They found that occupation is a factor that has the most significant impact on the investment pattern of the investors. This has impact on risk and uncertainty in future and option, cash market and size of investment in future and option.

Dhinakar *et al* (2016) studied the investment behavior of investors towards commodity market using primary data collected from 50 retail investors in commodity market in Dindigul district based on simple random sampling technique. The study found that in Indian commodity market various investors under each and every socioeconomic status have implemented the 'tolerable' way to deal with the risk in the commodity market.

Gakhar (2016) empirically examined the impact on volatility and investor perception about Indian derivative market using 522 questionnaires. Using the AR (1)-GARCH (1, 1) model the study found that with the introduction of derivatives overall volatility has reduced in the spot market. The study found that the investors perceive that there must be proper grievance redressal mechanism. Further for investors awareness and training programmers must be conducted. The study found that the regulators should work on increasing investment opportunities. It was further found that investors perceive that there will be some global integration in the economy and the derivatives market will affect growth of the economy. Investors further feel that there must be some consolidation of exchanges.

The study of investors' perception about volatility in commodity markets or any other field falls under the area of behavioral finance. The perception of traders is influenced by many factors. Many demographic characteristics like age and income influence trader's perception of traders (Karthikeyan 2014, Sood *et al* 2014 and Rajagopalan *et al* 2014). On the other hand, some researchers found that age and income do not influence investor perception (Tripathi 2014 and Deo *et al* 2015).

Sainy (2006) studied the perception of stock brokers regarding factors affecting stock price volatility using 70 brokers of M.P. The study revealed seven external factors primarily influencing the investment decision of the brokers. Post liberalization the Indian stock market has been plagued by high volatility. The result of the study suggests that economic environment, GDP and government policies, foreign trade and investments, disclosure, seasonal effect, asymmetry of information and liberalization policies of the government are major factors effecting stock prices. The study suggested that for making Indian stock market more efficient the Indian government needs to adopt various policies and measures.

Gupta *et al* (2016) empirically examined the broker's perception about efficiency of Indian commodity market using the primary data collected from the 250 brokers registered with MCX, in NCR-Delhi. The study found that the majority of the share in commodity derivatives is of high net worth individuals followed by retail investors. The study revealed that the price discovery and hedging effectiveness functions are well performed by all the futures except the energy commodities futures. The study further found that the energy commodities are most volatile commodities and are perceived to be comparatively less hedging effective.

Magdalene *et al* (2017) studied the customer perception towards investment in gold in commodity market and the awareness level of investors about regional, national, international commodity exchange and brokerage houses using data collected from traders of the Bangalore city. This study found that awareness level among traders about future trading is negligible. The study has also found that the perception of the traders in commodity market is influenced by many factors like the information on overall commodities (MCX) and fluctuations of gold prices in domestic and international markets.

Peter (2017) found that specific investment in a particular commodity is influenced by many factors particularly in the case of gold. The information on overall commodities and awareness towards domestic and international factors and market news also create much impact on the commodities.

Venkatesha *et al* (2017) investigated the perception of the investors in NSE and BSE derivatives markets. The study focused on investor's perception. The study used the data collected from 150 respondents via a questionnaire survey. The study found that the investors perceive the derivatives as risk hedging tool. It was observed that the derivative trading is affected by the trend of the spot market. Further it was found that the respondents perceive market risk and credit risk as the two major risks in capital markets. The study has also found that in last few years the level of awareness among the investors has increased. The study suggested that the SEBI and government should take responsibility to create more awareness among investors and need to educate individual investors through different seminars or training programs regarding the advantages and risk factors associated with derivative instruments.

Venkateswari (2017) studied the awareness and perception of investors about commodity markets. They used a sample of 100 investors. They found that most of the investors are involved in short term trading and the investor is ready to take high risk in trading. Investors are interested mainly in increasing their wealth through the commodity futures market. Majority of the investors considers commodity futures as a good avenue for diversification.

Gupta *et al* (2018) compared the perception of investors towards derivatives and equity through survey method using primary data collected from 200 investors in Indore city. The study concluded that every investor want to save extra and perceives that added risk directs to more profit because of which the perception of the investor changes when it comes to the investment in equity and derivatives. The study found various factors that affect the choice of investors in investment decisions. The study concluded that there is no difference in the perception of the investors towards equity and derivatives.

Chandrakumar (2018) studied the level of awareness among derivative investors towards commodity markets by using the primary data collected from 50 derivative investors. The study found that the investors are interested to invest in commodity market but the level of awareness is very less among the investors. The study suggested that the investors can be made aware about the various commodity market investments and associated risk by conducting proper programmes.

Deepak *et al* (2018) examined the investors' decision towards commodity trading using sample data of 200 respondents. The study found that investor's investment preferences are influenced by the attitude and perception of investors. It was found that there exists low relationship between perception and awareness of investors. The study suggested that the investors should make their investment decision by discussing the market condition and performance of portfolio with the experts like brokers and dealers instead of friends. Further the study suggested the conduction of camps, seminars and other specialist seminar for improving investor's awareness.

Kumar (2018) found that there is influence of attitude and perception on preference. The study found that low relationship between perception and investors' awareness. Hence, it was suggested that the investor has to discuss about the market condition and performance with the share broker and dealers beyond discussing only with friend to make efficient investment decisions. Hence, it was concluded that the arrangement of commodity market experts and specialist seminar to investors will help to improve investors' awareness level.

Rajaram *et al* (2019) indicated that the socio economic factors of the commodity market traders affect their perception. The study found that the price movements of commodity market from last five years show that the investors are satisfied by the reasonable returns from the commodity market. The study concluded that the investors can make substantial returns only if investments are made in a disciplined manner.

Most of the available research evidences especially in Indian context are related to the volatility in stock markets. There were many researches related to risk return relationship in stock markets. Very few of the reviewed studies have tried to analyze the risk return relationship in commodity markets. There are many studies where volatility in stock and commodity markets have been forecasted and modeled, but there were no common results in most of the studies as there are many GARCH family models available for modeling volatility.

## **CHAPTER III**

### **MATERIALS AND METHODS**

This chapter describes the methodology that has been adopted for achieving the objectives of the study with the help of various techniques and models. This chapter is divided into various sections to understand the systematic method adopted for conducting the study. The various sections are as under:

#### **3.1 Conceptual framework of the study**

#### **3.2 Research Design**

#### **3.3 Data Collection**

#### **3.4 Data Analysis**

3.4.1 Nature of Volatility in stock and commodity markets

3.4.2 Relationship between return and volatility

3.4.3 Impact of macro-economic variables on volatility

3.4.4 Forecasting volatility in Indian stock and commodity markets

3.4.5 Perception of market participants regarding volatility

3.4.6 Descriptive data analysis

3.4.7 Inferential data analysis

#### **3.5 Limitation of the study**

#### **3.1 Conceptual Framework of the study**

The volatility in the stock and commodity market has been studied in quite detail after the introduction of ARCH (Engle 1982) and later GARCH models (Bollerslev 1986). These models are based on the conditional time-varying volatility of time series, which was ignored in the earlier asset pricing models like the CAPM model (Treynor 1965). These studies found mixed results about the nature of volatility and the forecasting ability of different models. The study of the volatility in stock and commodity markets has gained importance as the investors are interested in forecasting volatility for risk management, asset allocation, and taking bets on future volatility. In view of the same study of the nature of volatility, forecasting ability of different models, return and volatility relation, and impact of various macroeconomic variables on volatility is important. The idea whether calendar anomalies like day of the week effect, month of the year effect and volatility clustering and spikes present in price series of financial assets has been extensively studied in literature. Further, several researchers (Franses *et al* 1996, Chong *et al* 1999, Gokcan 2000) studied various symmetric and asymmetric models to find the best forecasting model.

The present study has been conceptualized to understand the nature of volatility by studying the calendar anomalies namely day of the week effect, the month of the year effect, and yearly volatility of daily and monthly returns and monthly volatility of daily returns. The study aimed to examine the relationship between return and volatility in stock and commodity market indices. In addition the study also measured the impact of various macroeconomic variables namely Foreign Institutional Investor (FII) flows, Domestic Institutional Investor flows (DII) and interest rates on volatility in stock and commodity markets. Further, attempt has been made to assess the forecasting ability of various volatility models. Lastly, the study has evaluated the perception of market participants about volatility in stock and commodity markets.

### **3.2 Research Design**

The research design for present study is both descriptive and conclusive in nature. The study attempted to describe the nature of volatility in stock and commodity market. The study used the day of the week effect, the month of the year effect, yearly volatility of monthly returns, yearly volatility of daily returns, and monthly volatility of daily returns. The study has described the risk-return relationship in stock and commodity market indices. In addition, the study has also analyzed the impact of macroeconomic variables namely FII flows, DII flows, and interest rates on volatility. The study has further analyzed the forecasting ability of different models in stock and commodity markets. In addition, the study analyzed the perception of traders and brokers regarding volatility in stock and commodity markets. For achieving the objectives of the study and attempting to generalize the findings of the study, hypotheses have been formulated to guide the research process. The hypotheses of the study have been formulated partly on the basis of the literature reviewed and partly on the basis of intuition. The study has been conducted under the broad framework of the following null hypotheses.

**H<sub>0-1</sub>**: There are no significant differences in the volatility of the stock/commodity indices across the days of the week/ month of the year

**H<sub>0-2</sub>**: There is no ARCH effect in stock/commodity market indices.

**H<sub>0-3</sub>**: There is no significant relation between volatility and return in stock/commodity market indices.

**H<sub>0-4</sub>**: There is no correlation between volatility in stock/ commodity market indices and Macro economic variables.

**H<sub>0-5</sub>** There is no causal relationship among macroeconomic determinants and volatility in stock / commodity markets.

**H<sub>0.6</sub>** There is no difference in perception regarding importance of sources of information among various categories of stock/ commodity brokers and traders.

**H<sub>0.7</sub>** There is no difference in perception regarding volatility among various categories of stock/ commodity brokers/traders

The study has attempted to test all these hypotheses and the detail analytical tests adopted for the same have been provided in section 3.4.

### 3.3 Data Collection

In order to achieve the objectives of the study, secondary data has been collected with respect to selected stock and commodity market indices, and in addition data regarding various macroeconomic variables like FII flows, DII flows, and interest rates have been collected. Further, for the completion of fifth objective, the primary data was collected using the questionnaire method. The details of the data collection are provided in this section.

The secondary data for study consisted of returns of the stock and commodity market indices namely Nifty 50 (representing entire large-cap stock), Nifty Midcap 50 (representing mid-cap stock), Nifty Smallcap 50 (representing small-cap stock) and Nifty 500 (representing broader market). The data related to stock/ commodity market indices was collected from [www.nseindia.com](http://www.nseindia.com). Details of the data regarding stock/commodity market indices is provided in table 1.

**Table 1: Data collection details of stock and commodity market indices**

Index	From date	To date
<b>Stock Indices</b>		
Nifty 50	3 <sup>rd</sup> November 1995	31 December 2018
Nifty Midcap 50	1 <sup>st</sup> January 2004	31 December 2018
Nifty Smallcap 50	1 <sup>st</sup> April 2005	31 December 2018
Nifty 500	7 <sup>th</sup> June 1999	31 December 2018
<b>Commodity Indices</b>		
Nkrishi	1 <sup>st</sup> October 2010	31 <sup>st</sup> December 2018
MCX-Comdex	13 <sup>th</sup> May 2006	31 <sup>st</sup> December 2018
MCX- Metal	13 <sup>th</sup> May 2006	31 <sup>st</sup> December 2018
MCX- Energy	13 <sup>th</sup> May 2006	31 <sup>st</sup> December 2018
MCX –Agri	13 <sup>th</sup> May 2006	31 <sup>st</sup> December 2018

Among the commodity market indices five indices have been selected namely Nkrishi, MCX-Comdex, MCX-Metal, MCX-Energy, and MCX-Agri. The data for commodity market indices were collected from [www.ncdex.com](http://www.ncdex.com) and [www.mcxindia.com](http://www.mcxindia.com). The study used index secondary data from 2006 to 2019. The details of the data collection are provided in Table 1.

The data on various macroeconomic variables was collected to assess the impact of same on volatility in stock market indices. The data pertaining to Foreign Institutional Investor's net flow, Domestic Institutional investor' net flow and return on 10 year Government bonds was collected. The data related to monthly FII net flows and DII net flows was collected from January 2007 to December 2018 and monthly return of 10 year Government bonds was collected from the year 2000 to 2018 from the websites of Reserve Bank of India ([www.rbi.org.in](http://www.rbi.org.in)) and SEBI ([www.sebi.gov.in](http://www.sebi.gov.in)). Further to assess the impact of macroeconomic variables on commodity markets data for macroeconomic variables namely Gross Domestic Product growth rate and Consumer Price Index has been collected. The data for GDP growth rate and Consumer price index was collected from the year 2010 to 2018 from the website of Reserve Bank of India ([www.rbi.org.in](http://www.rbi.org.in)). The details of the data collection on macroeconomic variables are provided in Table 2.

**Table 2: Data collection details of Macro Economic variables**

Macroeconomic Variables	Data From	Data To
<b>For stock market</b>		
FII net flows	January 2007	December 2018
DII net flows	April 2007	December 2018
Interest rates (Yield on 10 year govt. bond)	May 2000	December 2018
<b>For commodity markets</b>		
GDP growth rate	March 2010	December 2018
Consumer Price Index	July 2010	December 2018
Interest rates (Yield on 10 year govt. bond)	March 2010	December 2018

### 3.4 Data Analysis

The study focuses on the anomalies in the stock and commodity markets, risk-return relationship in stock and commodity markets, impact of macroeconomic variables on volatility, forecasting volatility, and perception of traders and brokers regarding volatility in stock and commodity markets. In view of the objective the study has been carried out in the framework of the following approach towards analysis

### 3.4.1 Nature of Volatility in stock and commodity markets

The volatility of an asset is measured by the variability in the price over time measured as variance or the standard deviation of the asset return. The higher the standard deviation the more is the volatility of asset. To understand nature of volatility the study used yearly volatility of monthly returns, yearly volatility of daily returns, and monthly volatility of daily returns. The study used daily and monthly log returns which were calculated using the following formula:

$$R_t = \ln(I_t|I_{t-1})$$

Where

$R_t$  = return on day 't'

$I_t$  = index mean value on day 't'

$I_{t-1}$  = index mean value on day 't-1'

$\ln$  = natural log.

Using daily and monthly returns yearly volatility of daily returns and monthly volatility of daily returns were calculated with the help of standard deviation. Similarly yearly volatility of monthly returns and monthly volatility of daily returns was also calculated using standard deviation

#### Day of the week effect

This study has tested the presence of the day of the week effect in both the return and volatility equations. There are many proves of presence of the day of the week effect in mean return in the literature. The study used the dummy linear regression to estimate the day of the week effect in return equation. The study used the daily return as dependent and day dummies as independent variables. The term dummy variable here means a day of the week where its value is 1 for the specific day and 0 for all other days of the week. The study also calculated Monthly volatility of daily returns and yearly volatility of daily and monthly returns. Log returns (daily/ monthly) were calculated using following formula. Further standard deviation of the log return was used to study volatility and its nature.

$$R_t = \ln (I_t|I_{t-1})$$

Where  $R_t$  is the daily return of market,  $I_t$  is the current stock/commodity index closing price at time t and  $I_{t-1}$  is the previous stock /commodity index closing price. To measure the day of the week effect in underlying stock /commodity market GARCH(1,1) model has been used. This study has tested the presence of the day of the week effect using day dummies in variance equation of GARCH (1,1) model.

$$h_t = \alpha_0 + \beta_1 e^2_{t-1} + \gamma_1 h_{t-j} + X_1 D_{1t} + X_2 D_{2t} + X_3 D_{3t} + X_4 D_{4t}$$

where  $h_t$  is the conditional variance which is used as a measure of the volatility. The variables from  $D_{1t}$  to  $D_{4t}$  are dummy variables for each day of the week such that  $D_1=1$ , if day  $t$  is Tuesday and 0 otherwise;  $D_2=1$ , if the day  $t$  is Wednesday and 0 otherwise and so on. In the equation  $\alpha$  is the constant,  $\beta_1$  is the ARCH term, which shows the effect of latest information on the volatility of the underlying stock market,  $\gamma_1$  is the GARCH term, which shows the effect of last year volatility on the current year volatility, the coefficients  $X_1, X_2, X_3$  and  $X_4$  are showing the impact that day dummies have on the volatility of stock returns. This study has tested the presence of calendar anomaly using month dummies in variance equation of GARCH (1,1) model.

$$h_t = \alpha_0 + \beta_1 e^2_{t-1} + \gamma_1 h_{t-j} + X_1 D_{1M} + X_2 D_{2M} + X_3 D_{3M} + X_4 D_{4M} + X_5 D_{5M} + X_6 D_{6M} + X_7 D_{7M} + X_8 D_{8M} + X_9 D_{9M} + X_{10} D_{10M} + X_{11} D_{11M}$$

where  $h_t$  is the conditional variance which is used as a measure of the volatility. The variables from  $D_{1M}$  to  $D_{11M}$  represents month dummies, where  $D_1=1$ , if Month  $m$  is February and 0 otherwise;  $D_2 = 1$ , if the Month  $m$  is March and 0 otherwise and so on. In the equation  $\alpha$  is the constant,  $\beta_1$  is the ARCH term, which shows the effect of latest information on the volatility of the underlying stock market,  $\gamma_1$  is the GARCH term, which shows the effect of last year volatility on the current year volatility, the coefficients  $X_1$  to  $X_{11}$  are showing the impact the month dummies have on the volatility in stock returns.

### 3.4.2 Relationship between return and volatility

The risk return relationship is used for taking investment decisions. It is a basis of equilibrium asset pricing model. The risk return relationship in capital market has been explored extensively by many researchers. There are many traditional asset-pricing models (e.g. Sharpe 1964, Merton, 1980) that found a positive relationship between expected stock returns and volatility. There exist sufficient research evidence and models (Abdalla *et al* 2012, Panait *et al* 2012, Menggen 2007, Shin 2005, Salman 2001) which found that the GARCH-in-mean model is the best model from the GARCH models to estimate risk return relationship. In GARCH(p, q)-M model unlike the traditional OLS model conditional variability of returns is used which states that the volatility is time varying. Under GARCH-in mean model the interdependence between expected returns and changing volatility of asset is calculated. For applying the GARCH-in-mean model the daily series of selected stock and commodity indices, were converted into compound returns given by;

$$Y_t = \log (p_t/p_{t-1})$$

where  $Y_t$  denotes returns on asset at time  $t$ ,  $p_t$  is the current stock/ commodity index closing price at time  $t$  and  $p_{t-1}$  is the previous stock/commodity index closing price. Several

assumptions namely Stationarity, normality and autocorrelation of time series was checked through Unit root test, Jarque-Bera test and Durbin Watson test

### Unit Root Test: ADF Test

Before carrying out any time series analysis, it is mandatory to evaluate Stationarity. For this purpose the Augmented Dickey-Fuller (ADF) test has been applied to test the Stationarity of the series. The ADF test assumes the following hypothesis:

$H_0: \lambda = 1$  (non-stationary)

$H_1: \lambda < 1$  (covariance stationary)

The ADF test statistic is given by;

$$\Delta Y_t = \alpha + \beta T + \lambda Y_{t-1} + \gamma_1 Y_{t-2} + \gamma_2 Y_{t-2} \varepsilon_t$$

where  $\alpha$  is the intercept,  $T$  is the trend,  $\lambda$  is the unit root and the null hypothesis is rejected if the  $p$  - value  $< \alpha$  significance level. (This study has used significance level of 0.05)

### Phillip Perron

Stationarity was also tested using Phillip Perron test. The test statistics of the Phillip Perron test are given by

$$Y_t = c + \delta t + a y_t + e(t).$$

### Jarque-Bera Test:

Jarque-Bera Test was employed to assess the normality of the distribution. The test statistic is given as;

$$JB = T \cdot \left( \frac{s^2}{6} + \frac{(K - 3)^2}{24} \right)$$

where  $S$  represents the sample skewness and  $K$  represent the sample kurtosis. The Hypothesis is given by;

$H_0$ : Series is normally distributed

$H_1$ : Series is not normally distributed

### The Durbin-Watson Test

This test was employed to determine whether the error term in the mean equation is auto correlated. As per this test the error term should be normally distributed with mean zero and constant variance. The test statistic is given as;

$$d = \frac{\sum_{i=2}^n (e_i - e_{i-1})}{\sum_{i=2}^n e_i^2}$$

where  $e_i = y_i - \hat{y}_i$  and  $y_i$  and  $\hat{y}_i$  are, the observed and predicted values of the response variable for individual  $i$ . In this test the value of  $d$  statistics will becomes smaller with increase in serial correlations. The hypothesis is given by;

$$H_0: \rho = 0$$

$$H_1: \rho > 0$$

The presence of autocorrelation can be estimated from the value of  $d$  statistics. The value of the  $d$  statistics ranges from 0 to 4 and under the null hypothesis the value of  $d$  statistics is equal 2. Values of  $d$  less than 2 infers presence of positive autocorrelation ( $\rho > 0$ ), and values of  $d$  greater than 2 suggest negative autocorrelation ( $\rho < 0$ ).

For estimating GARCH, presence of ARCH effect is tested using ARCH-LM test. The statistics of ARCH LM test are given as:

$$\hat{U}_t^2 = b_0 + b_1 \hat{u}_{t-1}^2 + b_2 \hat{u}_{t-2}^2 + b_3 \hat{u}_{t-3}^2 + \dots + b_q \hat{u}_{t-q}^2 + e_t$$

where  $\hat{U}_t^2$  is the residual,  $b_0$  is the constant and  $b_1$  through  $b_3$  are lags of the residuals. The significance of the parameter  $b_i$  indicates the presence of ARCH effect. If the series is found to be homoscedastic ARCH model cannot be applied.

### **GARCH MEAN (1, 1)**

Literature clearly demonstrates that, the return of a security may depend on its volatility. The present study has adopted the basic GARCH in mean models GARCH-M (Engle *et al* 1987; Bollerslev *et al* 1988) to investigate the risk-return tradeoff. The main reason to choose GARCH specification instead of ARCH specification basically lies in the fact that higher order ARCH representation represented by GARCH is easier to identify and estimate (Enders, 1995). For estimating or predicting volatility of stock or commodity returns GARCH models can be used, in which prediction is done on the basis of past returns and past volatility measures at a given point of time. It is an extension of the basic GARCH model which allows the conditional mean of a sequence to depend on its conditional variance or standard deviation. Before applying GARCH model the presence of ARCH effect is tested using ARCH- LM test. The ARCH effect is tested through :

$$\hat{U}_t^2 = b_0 + b_1 \hat{u}_{t-1}^2 + b_2 \hat{u}_{t-2}^2 + b_3 \hat{u}_{t-3}^2 + \dots + b_q \hat{u}_{t-q}^2 + e_t$$

where  $\hat{U}_t^2$  is the residual,  $b_0$  is the constant and  $b_1$  through  $b_3$  are lags of the residuals. The significance of the parameter  $b_i$  indicates the presence of ARCH effect. If the series is found to be homoscedastic ARCH model cannot be applied.

The study has adopted the simplest GARCH-M (1,1) model. The general form of the GARCH (p, q) model is given by

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^q \alpha_i \epsilon_{t-i}^2 + \sum_{j=1}^p \beta_j \sigma_{t-j}^2$$

where  $\sigma_t^2$  is the volatility of the returns,  $\alpha_0$  is a constant ( $\alpha_0 \neq 0$ ),  $\alpha_i$  is the coefficient of the lagged squared residuals ( $\alpha_i \geq 0$ ),  $\epsilon_{t-i}^2$  is the lagged squared residual and  $\beta_j$  is the coefficient for the GARCH component ( $\beta_j \geq 0$ ). The simplest GARCH-M (1, 1) is given by;

Mean Equation

$$R_t = \alpha + \beta X_{t-1} + \lambda \sigma_t^2 + \varepsilon_t \quad \varepsilon_t \sim N(0, \sigma_t^2)$$

Variance Equation

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

where  $R_t$  is the realized excess return, and  $\sigma_t$  is its conditional variance where,  $R_t$  is the return of the asset at time  $t$ ,  $\beta_1$  is the average return of an asset, and  $\varepsilon_t$  is the residual return. The parameter  $\lambda$  in the mean equation is an additional parameter that is introduced in mean equation to measure the risk. This parameter is called as the risk premium. The positive value of  $\lambda$  infers a positive risk-return relation and vice versa.

If  $\lambda$  is positive or negative and statistically significant, then increased risk given by an increase in conditional variance, leads to a rise or fall in the mean return or in other words  $\lambda$  is used as a time-varying risk premium. A statistically positive relationship suggests that investors are compensated for assuming greater risk. A significant negative coefficient infers that investors have been penalized for bearing risk.

### 3.4.3 Impact of macro-economic variables on volatility

For ascertaining the impact of macroeconomic variables on volatility firstly, the series were tested for presence of Stationarity. Further, the causality among the macroeconomic variables and volatility in stock and commodity indices returns was tested using Granger causality test. In the present study the volatility in daily returns of selected stock indices for the period from 1995 to 2018 has been used. Data was also collected for selected macroeconomic variables, namely, FII flows (Foreign institutional investment flows) DII flows (domestic Institutional investment), and yield on 10 year Government bonds. Similarly for commodity markets the data regarding volatility in daily returns of selected commodity indices was collected for the period from 2006 to 2018. Data was also collected for selected macroeconomic variables, namely, GDP growth rate (Gross Domestic Product), CPI (Consumer Price Index). The data pertaining to the macroeconomic variables was collected from the official website of [www.sebi.gov.in](http://www.sebi.gov.in) and [www.rbi.org.in](http://www.rbi.org.in).

In the study the correlation test has been applied to find the existence of correlation among macroeconomic variables and volatility in stock and commodity returns. Further, the stochastic properties of the variables have been tested. The Unit Root Test to test has been employed to test the stationarity of the variables. For testing Stationarity the Augmented Dickey Fuller (ADF) tests has been used. The ADF test entails regressing the first difference of a variable  $y$  on its lagged level, exogenous variable(s) and  $k$  lagged first differences:

$$\Delta Y_t = \alpha + \beta_t + \rho Y_{t-1} + \sum \gamma \Delta Y_{t-1} + e_t$$

where  $Y_t$  is the variable in period  $t$ ,  $t$  denotes a time trend,  $\Delta$  is the difference operator,  $e_t$  is an error term. To test the causal relationship Granger causality test was employed. The dependent variable that has been used in the study includes volatility of stock and commodity daily returns. The correlation, multiple regression and Granger causality test have been applied in this study to analyze the impact of macroeconomic variables on volatility in returns of selected Indian stock and commodity market indices.

The correlation between the variables has been studied using the following formula:

$$r_{xy} = \frac{\text{cov}(x,y)}{\sqrt{\text{var}(x)} \cdot \sqrt{\text{var}(y)}}$$

Further significance of correlation at 5% level of significance was tested using following formula:

$$t = \frac{r \sqrt{n-2}}{\sqrt{1-r^2}}$$

The Granger Causality test was applied to check the causal relationship between the variables. The Engle-Granger (1969) causality model has been employed in the study to test the causality between the stock market and macro economic variables. The following model is adopted in the study to examine the hypothesis. One variable is said to Granger cause another variable if another variable can be predicted with greater accuracy by using past values of the first variable. The test statistics are given by:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \beta_1 X_{t-1} + u_t$$

Further the impact of macroeconomic variables on the volatility in stock market price and commodity market price is analyzed using regression analysis. To study the impact of selected macroeconomic fundamentals on stock market and commodity market volatility, multiple regression technique has been applied. The regression model is given as:

$$Y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$$

where

$Y$  = volatility in stock market Index

$X_1$  = FII net flows

$X_2$  = DII net flows

$X_3$  = Yield on 10 year Govt. Bond

Further the impact of macroeconomic determinants on the volatility in commodity market price was analyzed using regression analysis. To analyze the impact of selected macroeconomic fundamentals on commodity market volatility, multiple regression technique has been applied. The regression model is given as:

$$Y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$$

where  $X_1$ ,  $X_2$  and  $X_3$  are coefficients of the independent variables namely GDP growth rate, Consumer price index and yield on 10 year government bonds respectively.

#### 3.4.4 Forecasting volatility in Indian stock and commodity markets

For forecasting and modeling volatility many asymmetric and symmetric models are available. A symmetric model is one in which the conditional variance only depends on the magnitude, and not the sign, of the underlying asset. An asymmetric model is one in which the shocks of the same magnitude, positive or negative, have different effect on future volatility. For modeling the stock or commodity market volatility GARCH family of models is applied. The present study used the symmetric models namely the GARCH (1, 1) and GARCH-M (1, 1) for modeling conditional volatility and asymmetric models, EGARCH (1, 1) and TGARCH (1, 1) models for modeling asymmetric volatility. The following GARCH techniques have been applied to capture the volatility in the return series of stock and commodity markets. In presenting these different GARCH models, two distinct equations have been employed, the first is for the conditional mean and the second one is for the conditional variance.

##### The Generalized ARCH Model (GARCH)

As per the GARCH model (Bollerslev 1986), the conditional variance underlying asset is dependent upon previous lags of the underlying asset. This equation is given as:

$$\sigma_t^2 = \alpha_0 + \beta_1 \varepsilon_{t-1}^2 + \beta_2 \sigma_{t-1}^2$$

where  $\sigma_t^2$  is the volatility to be predicted,  $\alpha_0$  is the constant,  $\beta_1$  is the error term which indicates any shock or news,  $\beta_2$  is today's forecasted volatility. The size of parameters determines the short-run dynamics of the volatility time series. If the coefficient of  $\beta_1$  comes out to be significant it indicates that tomorrow's volatility is due to present shocks. If the sum of the coefficients  $\beta_1$  and  $\beta_2$  is equal to one, then any shock will lead to a permanent change in all future values. Hence, shock to the conditional variance is 'persistence.'

##### The GARCH-in-Mean (GARCH-M Model)

In GARCH-M model, a new parameter (conditional variance) is introduced in the mean equation. The return of a security is considered to be dependent on its volatility. A simple GARCH-M (1, 1) model can be written as:

Mean Equation

$$R_t = \alpha + \beta X_t + \lambda \sigma_t^2 + \varepsilon_t$$

Variance Equation

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 \sigma_{t-1}^2$$

where  $R_t$  is the realized excess return, and  $\sigma_t$  is its conditional variance where,  $R_t$  is the return of the asset at time  $t$ ,  $\beta_1$  is the average return of an asset, and  $\varepsilon_t$  is the residual return. The parameter  $\lambda$  in the mean equation is an additional parameter that is introduced in mean equation to measure the risk. This parameter is called as the risk premium. The positive value of  $\lambda$  infers a positive risk-return relation and vice versa.

### Asymmetric Measurement

The symmetric models have some limitations. The symmetric models respond symmetrically to the rise or fall in the stock returns. The Symmetric models do not capture the effect of good or bad news on volatility. Hence, a number of asymmetric models have been introduced to deal with the limitation of symmetric models and are called asymmetric models viz., EGARCH, TGARCH and PGARCH. In the present study asymmetric models namely the EGARCH (1, 1) and TGARCH (1, 1) have been employed to study the asymmetric relation between return and volatility.

### The Exponential GARCH Model

This model is expresses the conditional variability in the logarithmic terms. Under this model the presence of leverage effect is tested. Many researchers found EGARCH model to be the best model to capture asymmetric volatility of the Indian stock market (Nelson 1991). This model can be stated with the help of following equation:

$$\log \sigma_{t-1}^2 = \alpha + \beta_1 \frac{|e_{t-1}|^2}{\sqrt{\sigma_{t-1}^2}} + \beta_2 \frac{e_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \beta_3 \log \sigma_{t-1}^2$$

Where  $\beta_1$  and  $\beta_2$  represents the impact of shock or news.  $\beta_1$  denotes the size effect or magnitude and  $\beta_2$  represents the sign effect of shocks or news and  $\beta_3$  is the GARCH term. The left-hand side is the log of the conditional variance. The coefficient  $\beta_1$  and  $\beta_2$  are known as the asymmetry or leverage term. The term, accounts for the presence of the leverage effects, which makes the model asymmetric. If  $\beta_1$  and  $\beta_2 = 0$ , then the model is symmetric. If is negative and statistically different from zero, it indicates the existence of the leverage effect.

### Threshold GARCH Model

The generalized specification of the threshold GARCH for the conditional variance (Zakoian 1994) is given by:

$$\sigma_t^2 = \alpha_0 + \beta_1 \varepsilon_{t-1}^2 + \beta_2 d_{t-1} + \beta_3 \sigma_{t-1}^2 + \varepsilon_{t-1}^2$$

The  $\beta_3$  is known as the asymmetry or leverage parameter. In this model, good news ( $\varepsilon_{t-1} > 0$ ) and the bad news ( $\varepsilon_{t-1} < 0$ ) have differential effect on the conditional variance. The significant coefficient  $\beta_3$  represents that the volatility is asymmetrical. The positive value of  $\beta_3$  indicates that negative news has more impact on volatility. The decision for choosing a

particular model is taken on the basis of Akaike Information Criterion (AIC) and Schwarz Information criterion. The model with the lowest values of AIC and SIC have been considered for selection.

For the study purpose the data was divided into two parts. Out of the total data 80% of the data was taken as In-sample data for modeling volatility and rest 20% of the data was taken as Out of the Sample data for validation of the In-sample data chosen model. The details of In-sample data and Out of sample data for the selected stock/commodity indices are presented in Table 3.

**Table 3: Details of In-sample and Out of Sample data**

<b>Stock /Commodity indices</b>	<b>In-Sample Data</b>	<b>Out of the Sample Data</b>
Nifty 50	3.11.1995-25.4.2014	26.04.2014-31.12.2018
Nifty Mid Cap 50	1.06.2004-23.12.2015	24.12.2015-31.12.2018
Nifty 500	7.06.1999-20.1.2015	21.01.2015-31.12.2018
Nifty Small Cap 50	1.04.2005-30.03.2016	31.03.2016-31.12.2018
Nkrishi	1.10.2010-02.03.2017	03.03.2017-31.12.2018
MCX Comdex	13.05.2006-3.03.2016	04.03.2016-31.12.2018
MCX Metal	13.05.2006-2.03.2016	03.03.2016-31.12.2018
MCX Energy	13.05.2006-2.03.2016	03.03.2016-31.12.2018
MCX Agri	13.05.2006-3.03.2016	04.03.2016-31.12.2018

### **3.4.5 Perception of market participants regarding volatility**

The study used primary data collected from stock and commodity traders and brokers. The research design is descriptive in nature. To achieve the objectives of the study the data was collected with respect to perception of the commodity and stock traders about volatility. Data was collected from 100 commodity and 100 stock traders and 50 commodity and 50 stock brokers of Ludhiana. The trader for the purpose of the study has been defined as “the person who does speculation or hedge trading in commodity trading on stock trading contract, has position in the nearest month contract and is active in trading for last 6 months at the time of data collection”. A list of commodity traders was made with the help of brokerage houses. The list contained details of 279 commodity traders along with their contact details. Random sampling of 100 commodity traders was carried out and in order to draw sample for 100 respondents 117 traders were surveyed (17 filled questionnaires were not in order). Similarly, a list of stock traders was made with the help of brokerage houses. The list contained details of 290 commodity traders along with their contact details. Random sampling of 100 commodity traders was carried out and in order to draw sample for 100 respondents 125

traders were surveyed (25 filled questionnaires were not in order). Besides, data was also collected from 50 commodity brokers and 50 stock brokers. For the purpose of study, broker has been defined as “a person or organization currently operational in stock or commodity markets, who carries out trade on behalf of clients and is operational in the markets for last 2 years at the time of data collection. A well-structured questionnaire was prepared and was personally administered to collect the trader’s and broker’s perception. The questionnaire consisted of demographic and other variables which defined trader’s and broker’s business characteristics like trading experience, mode of trading and trading volume, source of finance of trading, type of traders, number of commodities traded and expected rate of return. Likert scale was employed (5 point scale) to measure the variables. Data was further checked for normality and accordingly inferential tests were applied to check the significance of various hypotheses formulated. The study made use of student’s t test for testing the significant differences.

The test statistics are calculated as:

$$t = \frac{\bar{x} - \mu}{\sqrt{\frac{s^2}{n}}}$$

where  $\bar{x}$  is the sample mean,  $s^2$  is the sample variance,  $n$  is the sample size,  $\mu$  is the specified population mean and  $t$  is a Student  $t$  quantile with  $n-1$  degrees of freedom.

Further one way ANOVA test has also been employed. The one-way analysis of variance (ANOVA) has been used to determine whether there are any statistically significant differences between the means of three or more independent (unrelated) groups.

$$F = \frac{\sum n_j (\bar{X}_j - \bar{X})^2 / (k - 1)}{\sum \sum (X - \bar{X}_j)^2 / (N - k)}$$

Where  $n_j$  = the sample size in the  $j^{\text{th}}$  group (e.g.,  $j = 1, 2, 3,$  and  $4$  when there are 4 comparison groups),  $\bar{X}_j$  is the sample mean in the  $j^{\text{th}}$  group, and  $\bar{X}$  is the overall mean.  $k$  represents the number of independent groups, and  $N$  represents the total number of observations in the analysis.

### 3.4.6 Descriptive Data Analysis

For all the variables under the analysis descriptive statistics have been mentioned. Various descriptive statistics like mean, standard deviation, maximum value, minimum value, median, skewness, and kurtosis have been reported. The distribution has been checked for their normality using Jarque Bera test statistics at 5% level of significance. The  $p$  value has been reported for the same. All the calculations have been performed using SPSS 20.0 and

Microsoft excel 2007. The study has adopted annualized standard deviation of daily and monthly returns and monthly standard deviation of daily returns.

Mean return:

$$\bar{X} = \frac{1}{n} \sum_{i=1}^n X_i = \frac{1}{n} (X_1 + \dots + X_n)$$

where  $\bar{x}$  is mean return,

Standard deviation is a statistical measure which is used to determine the average amount of variance or difference in the set of values or data. It is denoted with the symbol s.

$$S = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (X_i - \bar{X})^2}$$

where S= sample standard deviation, n= number of observation,  $X_i$  = a particular observation,  $\bar{X}$ = mean of sample.

Skewness is a measure of symmetry or the lack of symmetry used to test the normality of the distribution. Kurtosis refers to the measure of flatness or peakedness which is used to examine whether data are heavy tailed or light tailed to the normal distribution. Both skewness and kurtosis have been mentioned for each variable under study and values have been reported along with mean. Kolmogorov Simonov test statistic which is a non parametric test is used to check the normality distribution, along with the test statistic p value has also reported and significance has been checked at 5% level of significance.

### **3.4.7 Inferential data analysis:**

Various hypotheses that have been formulated were tested using inferential statistics tests namely one sample test, independent two sample t-test. One way ANOVA and regression analysis was also carried out to achieve the objective the study. For all the tests p values have been reported. The impact of macroeconomic variables on stock and commodity market volatility was found using regression equations representing the models. For each of the regression equation, all the coefficients along with their significance was recorded and reported. The coefficient of determination of these regression equations was also noted.

### **3.5 Limitation of the study**

1. The study has focused only on selected stock and commodity market indices
2. The study has used only three variables for calculating impact of macroeconomic variables on volatility in stock market indices and three variables for calculating impact of macroeconomic variables on volatility in commodity market indices.
3. Only historical volatility was checked. The study didn't consider implied volatility.

## **CHAPTER IV**

### **RESULTS AND DISCUSSION**

This chapter contains the results of the nature of volatility pertaining to Indian stock and commodity markets. Volatility is defined as a change in the price of the asset over a period of time. Volatility also depicts the riskiness of the asset. The nature of volatility can be studied by observing daily, monthly and yearly volatility in asset prices. This chapter contains the results regarding the nature of volatility, the relationship between return and volatility, the impact of macroeconomic variables on volatility, forecasting volatility and the perception of market participants regarding volatility. Specifically, the chapter is divided into following sub-sections as follows:

#### **4.1 Nature of volatility in Indian stock and commodity markets**

#### **4.2 Relationship between return and volatility in Indian stock and commodity markets**

#### **4.3 Impact of macroeconomic variables on volatility in Indian stock and commodity markets**

#### **4.4 Forecasting volatility in Indian stock and commodity markets**

#### **4.5 Perception of market participants regarding volatility in Indian stock and commodity markets.**

#### **4.6 Discussion**

The sections are described in detail as under:

#### **4.1 Nature of volatility in Indian stock and commodity markets**

This section includes the results of study of nature of volatility using four different stock indices namely Nifty 50 (representing entire large-cap stocks), Nifty Midcap 50 (representing mid-cap stocks), Nifty Smallcap 50 (representing small-cap stocks) and Nifty 500 (representing broader market) and five commodity markets indices namely Dhaanya index of NCDEX, MCX-Comdex, MCX-Metal, MCX-Energy, and MCX-Agri. The nature of volatility has been studied using monthly volatility of daily returns, yearly volatility of daily returns, and yearly volatility of monthly returns. The pattern of the volatility was observed through the day of week effect and month of the year effect.

Table 4 depicts the descriptive statistics of returns from selected stock indices. Daily log returns have been calculated for stock indices. Nifty 50 yielded a positive mean return ( $M=0.000414$ ,  $S.D=0.01547$ ). Nifty 50 daily returns have been found to be negatively skewed ( $-0.169381$ ), indicating asymmetric nature of the stock returns. Further the kurtosis of the distribution has been found to be greater than 3 ( $10.60512$ ), implying that the return distribution is fat tailed and does not follow a normal distribution that is further confirmed by Jarque-Bera test statistics ( $JB=13923.10$ ,  $p=0.000001$ ).

Nifty 500 yielded a positive mean return ( $M=0.000431$ ,  $S.D. = 0.017142$ ). The returns of Nifty 500 have been found to be negatively skewed ( $-0.831579$ ), indicating asymmetric nature of the stock returns. The Kurtosis of the distribution has been found to be greater than 3 ( $11.04371$ ) implying the return series is fat tailed and does not follow a normal distribution the fact is further confirmed by Jarque-Bera test statistics ( $JB= 10460.25$ ,  $p=0.00001$ ). For Nifty Small cap 50 also the descriptive statistics shows the same trend. Nifty Smallcap 50 index also yielded positive returns ( $M=0.000339$ ,  $S.D= 0.016945$ ). The returns have been found to be negatively skewed ( $-0.926066$ ) indicating asymmetric nature of stock return. The kurtosis of the distribution has been found to be greater than 3( $9.460698$ ), implying that the return distribution is fat tailed and does not follow a normal distribution. It is further confirmed by Jarque-Bera test statistics ( $JB =6406.756$   $p=0.00010$ ). The descriptive statistics of Nifty Midcap 50 yielded a positive mean return ( $M=0.000504$ ,  $S.D. = 0.014687$ ). The Nifty Midcap returns have been found to be negatively skewed ( $-0.831579$ ) indicating asymmetric nature of stock return. The kurtosis of the distribution has been found to be greater than 3( $10.87203$ ), indicating that the return distribution is fat tailed and does not follow a normal distribution the fact is further confirmed by Jarque-Bera test statistics ( $JB= 12803.45$   $p=0.0001$ ). The highest and the lowest mean return from the selected stock indices have been observed in Nifty Midcap 50 ( $0.000504$ ) and Nifty Smallcap 50 ( $0.000339$ ) respectively.

**Table 4: Descriptive Statistics of Stock Indices (Daily log Returns)**

<b>Indices/Parameters</b>	<b>Nifty 50</b>	<b>Nifty 500</b>	<b>Nifty Small cap</b>	<b>Nifty Midcap</b>
Mean Returns (Daily log returns)	0.000414	0.000431	0.000339	0.000504
Median	0.000759	0.002036	0.001856	0.001427
Standard Deviation	0.01547	0.017142	0.016945	0.014687
Skewness	-0.169381	-0.831579	-0.926066	-0.524959
Kurtosis	10.60512	11.04371	9.460698	10.87203
Jarque-Bera	13923.10	10460.25	6406.756	12803.45
Probability	0.000001	0.000010	0.000010	0.00001

Table 5 depicts the descriptive statistics of returns from selected commodity indices. The Nkrishi index yielded a positive mean return ( $M=0.000503$ ,  $S.D. = 0.007775$ ). Nkrishi index returns have been found to be negatively skewed ( $-0.082783$ ) indicating asymmetric nature of stock return. Further the Kurtosis of the distribution has been found to be greater than 3 ( $3.822544$ ), implying that the return distribution is fat tailed and does not follow a normal distribution that is further confirmed by Jarque-Bera test statistics ( $JB= 99.17468$ ,  $p=0.000001$ ). The descriptive statistics of MCX Comdex yielded a positive mean return

(M=0.0000831, S.D. = 0.00935). The MCX Comdex returns has been found to be negatively skewed (-0.343804) indicating asymmetric nature of stock return. The distribution of MCX Comdex returns, exhibit fatter tails than those of a normal distribution i.e. it exhibit excess kurtosis implying that the return series does not follow a normal distribution the fact is further confirmed by Jarque-Bera test statistics (JB= 2101.446, p=0.000010). The descriptive statistics of MCX Metal yielded a positive mean return (M=0.000137, S.D. = 0.010337).

The return series has been found to be negatively skewed (-0.900193) indicating asymmetric nature of stock return. Further, Kurtosis (11.15152) as a measure for tail thickness shows a larger value relative to normally distributed series. It is further confirmed by Jarque-Bera test statistics (JB= 0531.70, p=0.00001). The descriptive statistics of MCX Energy yielded a negative mean return (M= -0.000036, S.D. = 0.016339). The MCX Energy returns has been found to be negatively skewed (-0.052999) indicating asymmetric nature of stock return. The distribution of MCX Energy returns, exhibit fatter tails than those of a normal distribution- i.e. they exhibit excess Kurtosis (5.184096) implying that the return series does not follow a normal distribution. It is further confirmed by Jarque-Bera test statistics (JB= 722.6058, p=0.0001). The descriptive statistics of MCX Agri yielded a positive mean return (M=0.000137, S.D. = 0.009435). The return series is negatively skewed (-4.919311) indicating asymmetric nature of stock return. The Kurtosis of the distribution has been found to be greater than 3 (123.9213), implying that the return distribution is fat tailed and does not follow a normal distribution that is further confirmed by Jarque-Bera test statistics (JB= 99.1746, p=0.000001).

**Table 5: Descriptive statistics of Commodity Indices**

**(Daily log Returns)**

Indices/Parameters	Nkrishi	MCX Comdex	MCX Metal	MCX Energy	MCX AGRI
Mean Returns	0.000503	0.0000831	0.000137	-0.000036	0.000137
Median	0.000480	0.000393	0.000535	0.000568	0.0000393
Standard Deviation	0.007775	0.009355	0.010337	0.016339	0.009435
Skewness	-0.082783	-0.343804	-0.900193	-0.052999	-4.919311
Kurtosis	3.822544	6.665044	11.15152	5.184096	123.9213
Jarque-Bera	99.17468	2101.446	10531.70	722.6058	2224374
Probability	0.000000	0.000000	0.000000	0.000000	0.000000

Table 6 depicts the yearly volatility of daily returns with respect to Stock indices namely Nifty 50, Nifty Midcap 50, Nifty 500, and Nifty Smallcap 50. For Nifty 50 the highest volatility was found in the year 2008 (0.027) and the lowest volatility was found in the year 2017 (0.0005). For Nifty Midcap 50 the highest volatility was found in the year 2008 (0.031) and the lowest volatility was found in the year 2017 (0.009).

**Table 6: Year wise Average Daily Log Returns and Volatility of Stock Indices****(Average daily log Returns (Volatility))**

<b>Year</b>	<b>Nifty 50</b>	<b>Nifty Midcap 50</b>	<b>Nifty 500</b>	<b>Nifty Smallcap 50</b>
1995	-0.002 (0.015)			
1996	0.001 (0.018)			
1997	-0.001 (0.017)			
1998	0.002 (0.018)			
1999	-0.001 (0.019)		0.002 (0.015)	
2000	-0.001 (0.016)		-0.001 (0.023)	
2001	0.002 (0.011)		-0.001 (0.018)	
2002	0.002 (0.012)		0.001 (0.011)	
2003	0.001 (0.017)		0.003 (0.012)	
2004	0.002 (0.011)	0.001 (0.020)	0.001 (0.018)	
2005	-0.002 (0.013)	0.001 (0.013)	0.001 (0.011)	0.002 (0.015)
2006	0.002 (0.016)	0.001 (0.019)	0.001 (0.016)	0.001 (0.020)
2007	0.001 (0.016)	0.002 (0.017)	0.002 (0.015)	0.003 (0.015)
2008	-0.002 (0.027)	-0.004 (0.031)	-0.003 (0.027)	-0.005 (0.029)
2009	0.002 (0.022)	0.003 (0.023)	0.002 (0.013)	0.004 (0.023)
2010	0.001 (0.010)	0.0005 (0.0116)	0.001 (0.010)	0.000 (0.012)
2011	-0.001 (0.013)	-0.002 (0.014)	-0.001 (0.012)	-0.002 (0.014)
2012	0.001 (0.009)	0.001 (0.013)	0.001 (0.009)	0.001 (0.014)
2013	0.001 (0.011)	0.000 (0.014)	0.000 (0.011)	0.000 (0.014)
2014	0.001 (0.007)	0.002 (0.015)	0.001 (0.008)	0.002 (0.015)
2015	-0.001 (0.010)	0.000 (0.014)	0.000 (0.010)	0.000 (0.015)
2016	0.001 (0.009)	0.000 (0.015)	0.000 (0.010)	0.000 (0.015)
2017	0.001 (0.005)	0.0017 (0.0096)	0.001 (0.006)	0.002 (0.011)
2018	0.001 (0.008)	-0.0004 (0.0129)	0.000 (0.008)	-0.002 (0.016)

For Nifty 500 the highest volatility was found in the year 2008 (0.027) and the lowest volatility was found in the year 2017 (0.006). In a similar pattern for Nifty Smallcap 50, the highest volatility was found in the year 2008 (0.029) and the lowest volatility was found in

the year 2017 (0.011). In all the four indices the highest volatility was observed for Nifty midcap 50 for the year 2008 (0.031) and the lowest volatility was found in Nifty 50 in the year 2017 (0.005). So for years 1995-2018, it can be concluded that the most volatile year was 2008 and the least volatile year was 2017. This may be due to the fact that 2008 leading to huge day to day volatility in asset prices.

For Nifty 50 the highest average return was observed in the years 2001,2002, 2004 and 2006 (0.002) and the lowest average return was observed in the year 1995 and 2008 (-0.002). For Nifty Midcap 50 the highest average return was observed in the year 2009 (0.003) and the lowest average return was observed in the year 2008 (-0.004). For Nifty 500 the highest average return was observed in the year 2003 and the lowest average return was observed in the year 2008 (-0.003). For Nifty midcap 50 also the highest average return was observed in the year 2009 (0.004) and the lowest average return was observed in the year 2008 (-0.005).

Table 7 depicts the yearly volatility of daily returns with respect to commodity indices namely Nkrishi, MCX Comdex, MCX Metal, MCX Energy, MCX Agri. For Nkrishi the highest average volatility was found in the year 2011 (0.023) and the lowest volatility was found in the year 2010 and 2017 (0.006). For MCX Comdex the highest volatility was found in the year 2008 (0.016) and the lowest volatility was found in the year 2012 and 2017 (0.006). For MCX Metal the highest volatility was found in the year 2006 (0.017) and the lowest volatility was found in both 2012 and 2017 (0.007). For MCX Energy the highest volatility was found in the year 2008 (0.023) and the lowest volatility was found in the year 2010 and 2012 (0.011). For MCX Agri the highest volatility was found in the year 2012 (0.015) and the lowest volatility was found in the years 2007, 2017 and 2018 (0.006).

For Nkrishi the highest average return was observed in the year 2012 (0.002). For MCX Comdex highest average return was found in the years 2009, 2010, 2011 and 2016 (0.001) and the lowest average return was observed in the years 2008, 2014 and 2015 (-0.001). For MCX Metal the highest average return was found in the year 2009, 2010 and 2016 (0.001) and the lowest average return was observed in the year 2018 (-0.002). For MCX Energy the highest average return was found in the year 2009 and 2016 (0.001) and the lowest average return was observed in the year 2014 (-0.002). For MCX Agri the highest average return was found in the years 2009, 2010, 2011 and 2016 (0.001) and the lowest average return was observed in the year 2012 and 2014 (-0.001).

**Table 7: Year wise Average Daily Log Returns and Volatility of Commodity Indices****(Average daily log return (Volatility))**

<b>Year</b>	<b>Nkrishi</b>	<b>MCX Comdex</b>	<b>MCX Metal</b>	<b>MCX Energy</b>	<b>MCX Agri</b>
2006		0.000 (0.011)	-0.001 (0.017)	-0.001 (0.013)	0.000 (0.008)
2007		0.000 (0.008)	0.000 (0.009)	0.001 (0.013)	0.000 (0.006)
2008		-0.001 (0.016)	0.000 (0.016)	-0.001 (0.023)	0.000 (0.013)
2009		0.001 (0.011)	0.001 (0.011)	0.002 (0.021)	0.001 (0.010)
2010	0.001 (0.006)	0.001 (0.007)	0.001 (0.008)	0.000 (0.011)	0.001 (0.008)
2011	0.000 (0.023)	0.001 (0.010)	0.000 (0.012)	0.001 (0.015)	0.001 (0.011)
2012	0.002 (0.009)	0.000 (0.006)	0.000 (0.007)	0.000 (0.011)	-0.001 (0.015)
2013	0.000 (0.007)	0.000 (0.009)	0.000 (0.011)	0.001 (0.012)	0.000 (0.007)
2014	0.000 (0.007)	-0.001 (0.007)	0.000 (0.008)	-0.002 (0.012)	-0.001 (0.009)
2015	0.000 (0.008)	-0.001 (0.010)	0.000 (0.008)	-0.001 (0.021)	0.000 (0.009)
2016	0.000 (0.007)	0.001 (0.008)	0.001 (0.008)	0.002 (0.022)	0.001 (0.007)
2017	0.000 (0.006)	0.000 (0.006)	0.001 (0.007)	0.000 (0.013)	0.000 (0.006)
2018	0.000 (0.009)	0.000 (0.008)	-0.0002 (0.008)	0.000 (0.017)	0.000 (0.006)

Table 8 depicts the yearly volatility of monthly returns with respect to stock indices namely Nifty 50, Nifty Midcap 50, Nifty 500, and Nifty Smallcap 50. For Nifty 50 the highest volatility was found in the year 2008 (0.111) and the lowest volatility was found in the year 2017 (0.028). For Nifty Midcap 50 the highest volatility was found in the year 2009 (0.148) and the lowest volatility was found in the year 2017 (0.045). For Nifty 500 the highest volatility was found in the year 2008 (0.116) and the lowest volatility was found in the year 2017 (0.026).

**Table 8: Year wise Average Monthly Log Returns and Volatility of Stock Indices****Average Monthly Log returns (Volatility)**

<b>Year</b>	<b>Nifty 50</b>	<b>Nifty Midcap 50</b>	<b>Nifty 500</b>	<b>Nifty Smallcap 50</b>
1996	-0.001 (0.082)			
1997	0.018 (0.070)			
1998	-0.014 (0.079)			
1999	0.051 (0.076)			
2000	-0.011 (0.070)			
2001	-0.012 (0.077)			
2002	0.004 (0.057)			
2003	0.049 (0.078)			
2004	0.011 (0.072)			
2005	0.028 (0.066)			
2006	0.030 (0.061)			
2007	0.039 (0.068)			0.018 (0.066)
2008	-0.053 (0.111)	-0.059 (0.144)	-0.048 (0.116)	-0.027 (0.151)
2009	0.052 (0.098)	0.075 (0.148)	0.059 (0.111)	0.042 (0.063)
2010	0.015 (0.048)	0.002 (0.058)	0.006 (0.049)	0.006 (0.052)
2011	-0.022 (0.061)	-0.012 (0.090)	-0.004 (0.070)	0.019 (0.066)
2012	0.022 (0.052)	0.010 (0.070)	0.014 (0.042)	-0.001 (0.055)
2013	0.006 (0.044)	-0.005 (0.074)	0.000 (0.048)	0.020 (0.071)
2014	0.024 (0.036)	0.044 (0.075)	0.037 (0.036)	-0.043 (0.071)
2015	-0.003 (0.035)	-0.009 (0.051)	-0.008 (0.028)	-0.017 (0.105)
2016	0.004 (0.049)	0.021 (0.075)	-0.0113 (0.069)	0.035 (0.077)
2017	0.026 (0.028)	0.028 (0.045)	0.023 (0.026)	0.000 (0.047)
2018	0.000 (0.043)	-0.014 (0.061)	-0.00466 (0.0463)	-0.007 (0.093)

For Nifty Small cap 50, the highest volatility was found in the year 2008 (0.151) and the lowest volatility was found in the year 2017 (0.047). In all the four indices the highest volatility was observed in Nifty Midcap 50 for the year 2008 (0.148) and the lowest volatility was found in Nifty 500 in the year 2017 (0.026). The table concludes that the highest yearly volatility of monthly returns across the stock indices was observed in 2008, corresponding to the financial subprime crisis.

For Nifty 50 the highest average return was observed in the years 2009 (0.0052) and the lowest average return was observed in the year 2008 (-0.053). For Nifty Midcap 50 the highest average return was observed in the year 2009 (0.075) and the lowest average return was observed in the year 2008 (-0.059). For Nifty 500 the highest average return was observed in the year 2009 (0.059) and the lowest average return was observed in the year 2008 (-0.048). For Nifty Smallcap 50 the highest average return was observed in the year 2009 (0.042) and the lowest average return was observed in the year 2014 (-0.043).

Table 9 depicts the yearly volatility of monthly returns with respect to commodity indices namely Nkrishi, MCX Comdex, MCX Metal, MCX Energy, MCX Agri. For Nkrishi the highest volatility was found in the year 2012 (0.094) and the lowest volatility was found in the year 2017 (0.030).

**Table 9: Year wise Average Monthly Log Returns and Volatility of Commodity Indices**

**Average Monthly Log returns (Volatility)**

Year	Nkrishi	MCX Comdex	MCX Metal	MCX Energy	MCX Agri
2006					
2007		0.007 (0.036)	0.001 (0.032)	0.018 (0.066)	-0.004 (0.023)
2008		-0.019 (0.097)	-0.013 (0.079)	-0.027 (0.151)	-0.002 (0.079)
2009		0.036 (0.029)	0.036 (0.031)	0.042 (0.063)	0.028 (0.053)
2010		0.016 (0.035)	0.023 (0.034)	0.006 (0.052)	0.021 (0.048)
2011	0.027 (0.043)	0.013 (0.049)	0.010 (0.067)	0.019 (0.066)	0.013 (0.039)
2012	0.049 (0.094)	0.001 (0.034)	0.010 (0.031)	-0.001 (0.055)	-0.021 (0.088)
2013	0.000 (0.042)	0.006 (0.065)	-0.005 (0.076)	0.020 (0.071)	0.008 (0.046)
2014	0.009 (0.040)	-0.022 (0.039)	-0.007 (0.042)	-0.043 (0.071)	-0.013 (0.056)
2015	0.007 (0.055)	-0.012 (0.050)	-0.010 (0.034)	-0.017 (0.105)	-0.003 (0.047)
2016	0.007 (0.042)	0.021 (0.034)	0.015 (0.051)	0.035 (0.077)	0.022 (0.028)
2017	-0.003 (0.030)	0.007 (0.028)	0.011 (0.035)	0.000 (0.047)	0.006 (0.047)
2018	0.009 (0.043)	-0.005 (0.041)	-0.004 (0.027)	-0.007 (0.093)	0.001 (0.031)

For MCX Comdex the highest volatility was found in the year 2008 (0.097) and the lowest volatility was found in the year 2017 (0.028). For MCX Energy the highest volatility was found in the year 2008 (0.079) and the lowest volatility was found in the year 2018 (0.027). For MCX Energy the highest volatility was found in the year 2008 (0.151) and the lowest volatility was found in the year 2017 (0.047). For MCX Agri the highest volatility was found in the year 2012 (0.088) and the lowest volatility was found in the year 2007 (0.023). In all the five indices the highest volatility was observed in MCX Metal in the year 2008 (0.151) and the lowest volatility was observed in, MCX Agri in 2007(0.023).

For Nkrishi the highest average return was observed in the year 2012 (0.049) and the lowest average return was in the year 2017(-0.003). For MCX Comdex highest average return was found in the year 2009 (0.036) and the lowest average return was observed in the year 2014 (-0.022). For MCX Metal the highest average return was found in the year 2009 (0.036) and the lowest average return was observed in the year 2008 (-0.013). For MCX Energy the highest average return was found in the year 2009 (0.042) and the lowest average return was observed in the year 2014 (-0.043). For MCX Agri the highest average return was found in the year 2009 (0.028) and the lowest average return was observed in the year 2012 (-0.021).

Table 10 depicts the average monthly volatility of daily log returns with respect to Nifty 50, Nifty Midcap 50, j 500, and Nifty Smallcap 50. For Nifty 50 the highest volatility was found in the month of May (0.011) and the lowest volatility was found in the month of October (0.01). For Nifty Midcap, the highest volatility was found in the month of May (0.012) and the lowest volatility was found in the month of October (0.01). For Nifty 500 the highest volatility was found in the month of May (0.015) and the lowest average volatility was found in the month of August, November, and December (0.11). For Nifty Small-cap, the highest volatility was found in the month of October (0.011) and the lowest average volatility was found in the month of January (0.01). For all the four indices the highest volatility was found in Nifty 500 (0.015).

For Nifty 50 the highest average return was observed in the months of March, May, October (0.015) and the lowest average return was observed in the months of July, November, and December (0.012). For Nifty Midcap 50 the highest average return was observed in the months of January and May (0.018) and the lowest average return was observed in the months of November and December (0.013). For Nifty 500 the highest average return was observed in the month of May (0.015) and the lowest average return was observed in the month of November and December (0.011). For Nifty Smallcap 50 the highest average return was observed in the month of January and May (0.017) and the lowest average return was observed in the months of April and July (0.013).

**Table 10: Month wise Average Daily Log Returns and Volatility of Stock Market Indices**

(Average daily log Returns (Volatility))

Month	Nifty 50	Nifty Midcap	Nifty 500	Nifty Smallcap 50
January	0.014 (0.008)	0.018 (0.011)	0.014 (0.008)	0.017 (0.001)
February	0.013 (0.006)	0.016 (0.005)	0.013 (0.006)	0.016 (0.006)
March	0.015 (0.008)	0.015 (0.007)	0.014 (0.008)	0.015 (0.009)
April	0.014 (0.008)	0.014 (0.005)	0.013 (0.008)	0.013 (0.005)
May	0.015 (0.011)	0.018 (0.012)	0.015 (0.011)	0.017 (0.009)
June	0.013 (0.007)	0.015 (0.008)	0.012 (0.007)	0.016 (0.009)
July	0.012 (0.006)	0.014 (0.007)	0.012 (0.006)	0.013 (0.006)
August	0.012 (0.005)	0.014 (0.006)	0.011 (0.005)	0.015 (0.006)
September	0.013 (0.005)	0.014 (0.004)	0.013 (0.006)	0.014 (0.004)
October	0.015 (0.001)	0.015 (0.001)	0.013 (0.009)	0.015 (0.011)
November	0.012 (0.007)	0.013 (0.006)	0.011 (0.007)	0.015 (0.006)
December	0.012 (0.005)	0.013 (0.004)	0.011 (0.005)	0.015 (0.004)

Table 11 depicts the monthly volatility of daily returns with respect to with respect to commodity indices namely Nkrishi, MCX Comdex, MCX Metal, MCX Energy, MCX Agri. For Nkrishi the same volatility was found for all the months (0.002) except for May for which volatility was found to be 0.001. For MCX Comdex the highest volatility was found in the month of October (0.005) and the lowest volatility was found in the month of April and July (0.002). For MCX Metal the highest volatility was found in the month of September and October (0.006) and the lowest volatility was found in the month of February, June, and July (0.002). For MCX Energy the highest volatility was found in the month of January and February (0.009) and the lowest volatility was found in the month of May and July (0.004). For MCX Agri the highest volatility was found in the month of December (0.006) and the

lowest volatility was found in the month of May (0.001). In all the five indices the highest volatility was observed in MCX energy in the month of January and February (0.009) and the lowest volatility was observed in Nkrishi, MCX Agri (0.01).

For Nkrishi the highest average return was observed in the months of July, August and September (0.008) and the lowest average return was found in the month of March (0.006). For MCX Comdex highest return was found in the months of May, August, September, October, and December (0.009) and the lowest average return was observed in the month of July (0.007).

**Table 11: Month wise Average Daily Log Returns and Volatility of Commodity Market Indices**

**Average daily log Returns (volatility)**

<b>Month</b>	<b>Nkrishi</b>	<b>MCX Comdex</b>	<b>MCX Metal</b>	<b>MCX Energy</b>	<b>MCX Agri</b>
January	0.007 (0.002)	0.008 (0.004)	0.009 (0.003)	0.016 (0.009)	0.008 (0.004)
February	0.007 (0.002)	0.008 (0.003)	0.009 (0.002)	0.017 (0.009)	0.007 (0.004)
March	0.007 (0.002)	0.008 (0.004)	0.009 (0.005)	0.015 (0.006)	0.008 (0.004)
April	0.007 (0.002)	0.008 (0.002)	0.009 (0.003)	0.014 (0.006)	0.008 (0.003)
May	0.006 (0.001)	0.009 (0.002)	0.009 (0.003)	0.015 (0.004)	0.011 (0.001)
June	0.007 (0.002)	0.008 (0.003)	0.008 (0.002)	0.016 (0.007)	0.007 (0.002)
July	0.008 (0.002)	0.007 (0.002)	0.007 (0.002)	0.014 (0.004)	0.007 (0.002)
August	0.008 (0.002)	0.009 (0.004)	0.009 (0.005)	0.016 (0.006)	0.008 (0.004)
September	0.008 (0.002)	0.009 (0.004)	0.010 (0.006)	0.016 (0.005)	0.007 (0.003)
October	0.007 (0.002)	0.009 (0.005)	0.009 (0.006)	0.015 (0.006)	0.008 (0.004)
November	0.007 (0.002)	0.010 (0.003)	0.010 (0.003)	0.017 (0.007)	0.008 (0.004)
December	0.007 (0.002)	0.009 (0.004)	0.009 (0.004)	0.016 (0.008)	0.009 (0.006)

Table 12 depicts the results of the day of the week effect with respect to volatility in stock indices namely Nifty 50, Nifty Midcap 50, Nifty 500, and Nifty Smallcap 50. For finding day of the week effect, the GARCH procedure with dummy variables in the variance equation has been used. Dummy for Monday's volatility was used as constant. The highest and the lowest volatility were observed on Monday (0.00000980) and Tuesday (-0.00002320) respectively. The estimated coefficient of the Monday's volatility is 0.00000980 and it has been found to be statistically significant at 5% level of significance ( $p=0.0106$ ). The estimated coefficient of Tuesday's volatility is -0.00002320 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Wednesday is -0.00000397 and this has been found to be statistically indifferent from Monday's volatility at 5% level of significance. The estimated coefficient of Thursday's volatility is -0.00000512 and this has been found to be statistically in different from Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Friday is -0.00000381 and again this has been found to be statistically indifferent from Monday's volatility at 5% level of significance. So it has been found that volatility on Tuesday is significantly different from the rest of the days, which suggest that the day of the week effect exist in volatility pertaining to returns of Nifty 50.

For Nifty Midcap 50 the highest and the lowest volatility was observed on Monday (0.00000246) and Tuesday (-0.0000422) respectively. The estimated coefficient of Monday's volatility is 0.0000246 and is statistically significant at 5% level of significance ( $p=0.0028$ ). The estimated coefficient of volatility on Tuesday is -0.0000422 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of Wednesday's volatility is -0.00000233 and this has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Thursday is -0.0000068 and this has been found to be statistically indifferent from Monday's volatility at 5% level of significance. The estimated coefficient of Friday's volatility is 0.0000047 and it has been found to be statistically indifferent from Monday's volatility at 5% level of significance. So it has been found that volatility on Tuesday and Wednesday is significantly different from the rest of the days, which suggest that the day of the week effect exist in volatility pertaining to returns of Nifty 500.

For Nifty 500 the highest and the lowest volatility was observed on Monday (0.00000933) and Tuesday (-0.00002430) respectively. The estimated coefficient of Monday's volatility is 0.00000933 and it has been found to be statistically significant at 5% level of significance ( $p=0.0195$ ). The estimated coefficient of Tuesday's volatility is -0.00002430 and this is found to be significantly less than Monday's volatility at 5% level of

significance. The estimated coefficient of volatility on Wednesday is -0.00000512 and this has been found to be statistically indifferent from Monday's volatility at 5% level of significance. The estimated coefficient of Thursday's volatility is -0.00000392 and this has been found to be statistically indifferent from Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Friday is 0.00000428 and this has been found to be statistically indifferent from Monday's volatility at 5% level of significance. So it has been found that volatility on Tuesday is significantly different from the rest of the days, which suggest that the day of the week effect exist in volatility pertaining to returns of Nifty 500.

For Nifty Smallcap 50 the highest and the lowest volatility was observed on Monday (0.00003010) and Tuesday (-0.00003660) respectively. The estimated coefficient of volatility on Monday is 0.00003010 and is statistically significant at 5% level of significance ( $p=0.0007$ ). The estimated coefficient of Tuesday's volatility is -0.00003660 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of Wednesday volatility is -0.00002280 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Thursday is -0.00001650 and it has been found to be statistically indifferent from Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Friday is 0.00000479 and this has been found to be statistically indifferent from Monday's volatility at 5% level of significance. So it has been found that volatility on Tuesday and Wednesday is significantly different from the rest of the days, which suggest that the day of the week effect exist in volatility pertaining to returns of Nifty Smallcap 50.

**Table 12: Day of the Week Effect With Respect to Volatility in Stock Market Indices**

	<b>Nifty 50</b>	<b>Nifty Midcap 50</b>	<b>Nifty 500</b>	<b>Nifty Smallcap 50</b>
Daily volatility (p value)				
Monday (Constant)	0.00000980 (0.0106)	0.0000246 (0.0028)	0.00000933 (0.0195)	0.00003010 (0.0007)
Tuesday	-0.00002320 (0.0001)	-0.0000422 (0.001)	-0.00002430 (0.0001)	-0.00003660 (0.0076)
Wednesday	-0.00000397 (0.5011)	-0.0000233 (0.0329)	-0.00000512 (0.3723)	-0.00002280 (0.0475)
Thursday	-0.00000512 (0.3493)	-0.0000068 (0.5598)	-0.00000392 (0.4813)	-0.00001650 (0.1619)
Friday	-0.00000381 (0.5604)	-0.0000047 (0.7501)	0.00000428 (0.5307)	0.00000479 (0.7508)

Table 13 depicts the results of day of the week effect with respect to volatility in Nkrishi, MCX Comdex, MCX Metal, MCX Energy, and MCX Agri. For finding day of the week effect, the GARCH procedure with dummy variable in the variance equation has been used. Dummy for Monday was used as constant. The highest and the lowest volatility was observed on Monday (0.0000188) and Tuesday (-0.0000305) respectively. The estimated coefficient of Monday's volatility is 0.0000188 and it has been found to be statistically significant at 5% level of significance ( $p=0.0000$ ). The estimated coefficient of volatility on Tuesday is -0.0000305 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of Wednesday's volatility is -0.0000183 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of Volatility on Thursday is -0.0000239 and it has been found to be significantly less than Monday at 5% level of significance. The estimated coefficient of volatility on Friday is -0.0000122 and is significantly less than Monday at 5% level of significance. The estimated coefficient of volatility on Saturday is -0.0000177 and it has been found to be significantly less than Monday's volatility at 5% level of significance. So it has been found that volatility on all days is significantly different from each other, which suggest that the day of the week effect exist in volatility pertaining to returns of MCX Comdex.

For MCX Comdex the highest and the lowest volatility was observed on Monday (0.0000611) and Saturday (-0.0000882) respectively. The estimated coefficient of volatility on Monday is 0.0000611 and this has been found to be statistically significant at 5% level of significance ( $p=0.0000$ ). The estimated coefficient of volatility on Tuesday is -0.0000371 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Wednesday is -0.0000322 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Thursday is -0.0000483 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Friday is -0.0000416 and this has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of Saturday's volatility is -0.0000882 and it has been found to be significantly less than Monday's volatility at 5% level of significance. So it has been found that volatility on all days is significantly different from each other, which suggest that the day of the week effect exist in volatility pertaining to returns of MCX Comdex.

For MCX Metal the highest and the lowest volatility was observed on Monday (0.0000489) and Saturday (-0.0000827) respectively. The estimated coefficient of volatility

on Monday is 0.0000489 and is statistically significant at 5% level of significance ( $p=0.0000$ ). The estimated coefficient of volatility on Tuesday is -0.0000084 and it has been found to be statistically indifferent from Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Wednesday is -0.0000165 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Thursday is -0.0000249 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Friday is -0.0000351 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Saturday is -0.0000827 and this has been found to be significantly less than Monday's volatility at 5% level of significance. So it has been found that volatility on all days is significantly different from each other, which suggest that the day of the week effect exist in volatility pertaining to returns of MCX Metal.

For MCX Energy the highest and the lowest volatility were observed on Monday (0.000150) and Saturday (-0.0002490) respectively. The estimated coefficient of Monday's volatility is 0.000150 and it has been found to be statistically significant at 5% level of significance ( $p=0.0000$ ). The estimated coefficient of volatility on Tuesday is -0.0000824 and it has been found to be statistically indifferent from Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Wednesday is -0.0000598 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Thursday is -0.0000922 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Friday is -0.0001110 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Saturday is -0.0002490 and it has been found to be significantly less than Monday's volatility at 5% level of significance. So it has been found that volatility on all days is significantly different from each other, which suggest that the day of the week effect exist in volatility pertaining to returns of MCX Energy.

For MCX Agri the highest and the lowest volatility were observed on Wednesday (0.0000805) and Friday (-0.0000357) respectively. The estimated coefficient of Monday's volatility is 0.0000201 and it has been found to be statistically significant at 5% level of significance ( $p=0.0000$ ). The estimated coefficient of volatility on Tuesday is -0.0000085 and it has been found to be significantly less than Monday's volatility at 5% level of significance. The estimated coefficient of Wednesday's volatility is 0.0000805 and it has been found to be significantly greater than Monday's volatility at 5% level of significance. The estimated

coefficient of volatility on Thursday is 0.0000347 and it has been found to be significantly greater than Monday's volatility at 5% level of significance. The estimated coefficient of Friday's volatility is 0.0000357 and this has been found to be significantly more than Monday's volatility at 5% level of significance. The estimated coefficient of volatility on Saturday is 0.0000049 and it has been found to be statistically indifferent from Monday's volatility at 5% level of significance. So it has been found that volatility on all days except Saturday is significantly different from each other, which suggest that the day of the week effect exist in volatility pertaining to returns of MCX Agri.

**Table 13: Day of the week effect with respect to volatility in Commodity Market Indices**

	<b>Nkrishi</b>	<b>MCX Comdex</b>	<b>MCX Metal</b>	<b>MCX Energy</b>	<b>MCX Agri</b>
Daily volatility (p value)					
Monday (Constant)	0.0000188 (0.00001)	0.0000611 (0.0000)	0.0000489 (0.00001)	0.000150 (0.00001)	0.0000201 (0.00001)
Tuesday	-0.0000305 (0.00001)	-0.0000371 (0.00001)	-0.0000084 (0.0673)	-0.0000824 (0.00001)	-0.0000085 (0.0134)
Wednesday	-0.0000183 (0.00010)	-0.0000322 (0.00001)	-0.0000165 (0.0005)	-0.0000598 (0.00001)	0.0000805 (0.00001)
Thursday	-0.0000239 (0.000001)	-0.0000483 (0.00001)	-0.0000249 (0.00001)	-0.0000922 (0.00001)	0.0000347 (0.00001)
Friday	-0.0000122 (0.02370)	-0.0000416 (0.00001)	-0.0000351 (0.00001)	-0.0001110 (0.00001)	-0.0000357 (0.00001)
Saturday	-0.0000175 (0.00001)	-0.0000882 (0.00001)	-0.0000827 (0.00001)	-0.0002490 (0.00001)	-0.0000049 (0.0760)

Table 14 depicts the results of Month of the year effect with respect to volatility in Stock indices namely Nifty 50, Nifty Midcap 50, Nifty 500, and Nifty Smallcap 50. For finding Month of the year effect the GARCH procedure with dummy variable in the variance equation has been used. Dummy for January was used as constant. For Nifty 50 the highest and the lowest volatility was observed on September (0.00000367) and October (-0.00000362) respectively. The estimated coefficient of January's volatility is 0.00000344 and it has been found to be statistically significant at 5% level of significance (p=0.0106). The estimated coefficient of volatility in February is 0.00000051 and this has been found to be statistically indifferent from January at 5% level of significance. The estimated coefficient of volatility in March is -0.00000193 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of volatility in April

is -0.00000133 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of volatility in May is -0.00000103 and this has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of volatility in June is -0.00000265 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of volatility in July is -0.00000128 and it has been found to be statistically indifferent from January at 5% level of significance. The estimated coefficient of volatility in August is -0.00000167 and it has been found to be statistically insignificant at 5% level of significance. The estimated coefficient of volatility in September is -0.00000367 and it has been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of October's volatility is -0.00000362 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of volatility in November is -0.00000145 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of December's volatility is -0.00000114 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. So it has been found that volatility in June, September and October is significantly different from rest of the months, which suggest that the month of the year effect exist in volatility pertaining to returns of Nifty 50.

For Nifty Midcap 50 the highest and the lowest volatility was observed in January (0.00000216) and October (-0.00000180) respectively. The estimated coefficient of January's volatility is 0.00000216 and it has been found to be statistically significant at 5% level of significance ( $p=0.0106$ ). The estimated coefficient of volatility in February is 0.00000121 and this has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of March's volatility is -0.00000142 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of April's volatility is -0.00000155 and it was found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of May's volatility is -0.00000073 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of June's volatility is -0.00000150 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of July's volatility is -0.00000170 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of volatility in August is -0.00000099 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of volatility in September is -0.00000059 and it has been found to be significantly

more than January's volatility at 5% level of significance. The estimated coefficient of October's volatility is -0.00000180 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of November's volatility is -0.00000137 and is significantly less than January's volatility at 5% level of significance. The estimated coefficient of December's volatility is -0.00000132 and it has been found to be significantly less than January's volatility at 5% level of significance. So it has been found that volatility of all months except September is significantly different from rest of the months, which suggest that the month of the year effect exist in volatility pertaining to returns of Nifty Midcap 50.

For Nifty 500 the highest and the lowest volatility was observed in January (0.00000517) and March (-0.00000336) respectively. The estimated coefficient of January's volatility is 0.00000517 and this has been found to be statistically significant at 5% level of significance ( $p=0.0106$ ). The estimated coefficient of February's volatility is -0.00000099 and this has been found to be statistically insignificant at 5% level of significance. The estimated coefficient of volatility in March is -0.00000336 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of volatility in April is -0.00000297 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of May's volatility is -0.00000012 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of June's volatility is -0.00000340 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of July's volatility is -0.00000247 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of volatility in August is -0.00000237 and this has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of September's volatility is 0.00000293 and it has been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of October's volatility is -0.00000509 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of November's volatility is -0.00000221 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of December's Volatility is -0.00000187 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. So it is found that volatility in March, April, June, July, September and October is significantly different from rest of the months, which suggest that the month of the year effect exist in volatility pertaining to returns of Nifty 500.

**Table 14: Month of the Year Effect with respect to Volatility in Stock Market Indices**

	<b>Nifty 50</b>	<b>Nifty Midcap 50</b>	<b>Nifty 500</b>	<b>Nifty Small Cap 50</b>
Daily volatility (p value)				
January	0.00000344 (0.0001)	0.0000216 (0.00001)	0.00000517 (0.00001)	0.00002680 (0.00001)
February	0.00000051 (0.7251)	-0.0000121 (0.0069)	-0.00000099 (0.5999)	-0.00000883 (0.1074)
March	-0.00000193 (0.1328)	-0.0000142 (0.0001)	-0.00000336 (0.0171)	-0.00001500 (0.0020)
April	-0.00000133 (0.3115)	-0.0000155 (0.00001)	-0.00000297 (0.0397)	-0.00001760 (0.0001)
May	-0.00000103 (0.4289)	-0.0000073 (0.0417)	-0.00000012 (0.9410)	-0.00000097 (0.8297)
June	-0.00000265 (0.0153)	-0.0000150 (0.0000)	-0.00000340 (0.0061)	-0.00001420 (0.0010)
July	-0.00000128 (0.2174)	-0.0000170 (0.0000)	-0.00000247 (0.0374)	-0.00001730 (0.0000)
August	-0.00000167 (0.1007)	-0.0000099 (0.0020)	-0.00000237 (0.0549)	-0.00000577 (0.1773)
September	0.00000367 (0.0053)	-0.0000059 (0.0969)	0.00000293 (0.0474)	-0.00000265 (0.5421)
October	-0.00000362 (0.0017)	-0.0000180 (0.00001)	-0.00000509 (0.0005)	-0.00002050 (0.00001)
November	-0.00000145 (0.1993)	-0.0000137 (0.0002)	-0.00000221 (0.1209)	-0.00001330 (0.0049)
December	-0.00000114 (0.3816)	-0.0000132 (0.0009)	-0.00000187 (0.2406)	-0.00000901 (0.0814)

For Nifty Smallcap 50 the highest and the lowest volatility were observed in January (0.00002680) and October (-0.00002050) respectively. The estimated coefficient of volatility in January is 0.00002680 and is statistically significant at 5% level of significance ( $p=0.0000$ ). The estimated coefficient of volatility in February is -0.00000883 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of volatility in March is -0.00001500 and this has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of April's volatility is -0.00001760 and this has been found to be significantly less

than January's volatility at 5% level of significance. The estimated coefficient of volatility in May is -0.00000097 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of June's volatility is -0.00001420 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of volatility in July is -0.00001730 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of volatility in August is -0.00000577 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of September's volatility is -0.00000265 and it has been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of October's volatility is -0.00002050 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of November's volatility is -0.00001330 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of December's volatility is -0.00000901 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. So it has been found that volatility on March, April, June, July, October and November is significantly different from rest of the months, which suggest that the month of the year effect exist in volatility pertaining to returns of Nifty Smallcap 50.

Table 15 depicts the results of month of the year effect with respect to volatility in commodity market indices namely Nkrishi, MCX Comdex, MCX Metal, MCX Energy, and MCX Agri. For Nkrishi the highest volatility was observed in the month of January and March (0.00000118) and the lowest volatility was observed in the month of February (-0.00000084). The estimated coefficient of volatility of all the months has been found to be statistically indifferent at % level of significance. So it has been found that the month of the year effect does not exist in volatility pertaining to returns of Nkrishi.

For MCX Comdex the highest and the lowest volatility was observed in the months of November (0.00000177) and December (-0.00000104) respectively. The estimated coefficient of January's volatility is 0.00000082 and it has been found to be statistically indifferent at 5% level of significance ( $p=0.0214$ ). The estimated coefficient of February's volatility is 0.00000025 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of March's Volatility is -0.00000044 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of April's volatility is 0.00000125 and this has been found to be significantly more than January's volatility at 5% level of significance. The

estimated coefficient of volatility in May is 0.00000129 and it has been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of volatility in June is -0.00000038 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of July's volatility is -0.00000008 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of volatility in August is 0.00000055 and it has also been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of September's volatility is 0.00000145 and it has been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of October's volatility is -0.00000090 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of November's volatility is 0.00000177 and this has been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of December's volatility is -0.00000104 and it has been found to be significantly less than January's volatility at 5% level of significance. So it has been found that volatility on January, April, May, September and November is significantly different from rest of the months, which suggest that the month of the year effect exist in volatility pertaining to returns of MCX Comdex.

For MCX Metal the highest and the lowest volatility was observed in April (0.00000313) and May (-0.00000143) respectively. The estimated coefficient of January's volatility is 0.00000099 and it has been found to be statistically significant at 5% level of significance ( $p=0.0000$ ). The estimated coefficient of February's volatility is 0.00000025 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of March's volatility is -0.00000044 and this has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of April's volatility is 0.00000125 and it has been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of volatility in May is 0.00000129 and it has been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of June's volatility is -0.00000038 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of July's volatility is -0.00000008 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of volatility in August is 0.00000055 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of September's volatility is 0.00000145 and it has

been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of October's volatility is -0.00000090 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of November's volatility is 0.00000177 and it has been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of December's volatility is -0.00000104 and it has been found to be significantly less than January's volatility at 5% level of significance. So it has been found that volatility in January, April, May, September and November is significantly different from rest of the months, which suggest that the month of the year effect exist in volatility pertaining to returns of MCX Metal.

For MCX Energy the highest and the lowest volatility was observed in the months of August (0.00000376) and October (-0.00000188) respectively. The estimated coefficient of January's volatility is 0.00000102 and it has been found to be statistically indifferent at 5% level of significance ( $p=0.2016$ ). The estimated coefficient of February's volatility is 0.00000086 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of March's volatility is -0.00000026 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of volatility in April is 0.00000222 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of May's volatility is 0.00000275 and it has been found to be statistically more than January's volatility at 5% level of significance. The estimated coefficient of June's volatility is -0.00000123 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of July's volatility is -0.00000020 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of volatility in August is 0.00000376 and it has been found to be statistically more than January's volatility at 5% level of significance. The estimated coefficient of September's volatility is 0.00000315 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of October's volatility is -0.00000188 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of November's volatility is 0.00000109 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of December's volatility is -0.00000078 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. So it has been found that volatility in May and August has been found to be significantly different from rest of the months, which suggest that the month of the year effect exist in volatility pertaining to returns of MCX Metal.

**Table 15: Month of the Year Effect with respect to Volatility in Commodity Market Indices**

	<b>Nkrishi</b>	<b>MCX Comdex</b>	<b>MCX Metal</b>	<b>MCX Energy</b>	<b>MCX Agri</b>
Daily volatility (p value)					
January (Constant)	0.00000118 (0.0810)	0.00000082 (0.0214)	0.00000099 (0.0000)	0.00000102 (0.2016)	0.00000099 (0.00001)
February	-0.00000084 (0.3004)	0.00000025 (0.6511)	0.00000066 (0.2350)	0.00000086 (0.5232)	0.00000066 (0.2350)
March	0.00000118 (0.1079)	-0.00000044 (0.3526)	-0.00000058 (0.2525)	-0.00000026 (0.8125)	-0.00000058 (0.2525)
April	-0.00000058 (0.4302)	0.00000125 (0.0188)	0.00000313 (0.00001)	0.00000222 (0.0559)	0.00000313 (0.00001)
May	-0.00000030 (0.6756)	0.00000129 (0.0037)	-0.00000143 (0.0128)	0.00000275 (0.0287)	-0.00000143 (0.0128)
June	0.00000014 (0.8554)	-0.00000038 (0.4700)	0.00000063 (0.1634)	-0.00000123 (0.3996)	0.00000063 (0.1634)
July	0.00000013 (0.8663)	-0.00000008 (0.8656)	-0.00000060 (0.1622)	-0.00000020 (0.8819)	-0.00000060 (0.1622)
August	0.00000015 (0.8586)	0.00000055 (0.3081)	0.00000150 (0.0056)	0.00000376 (0.0059)	0.00000150 (0.0056)
September	0.00000043 (0.6007)	0.00000145 (0.0171)	0.00000044 (0.3544)	0.00000315 (0.0620)	0.00000044 (0.3544)
October	-0.00000054 (0.4458)	-0.00000090 (0.1260)	0.00000013 (0.8017)	-0.00000188 (0.2315)	0.00000013 (0.8017)
November	0.00000021 (0.7654)	0.00000177 (0.0105)	0.00000175 (0.0235)	0.00000109 (0.4027)	0.00000175 (0.0235)
December	-0.00000012 (0.8863)	-0.00000104 (0.0638)	-0.00000057 (0.3324)	-0.00000078 (0.5750)	-0.00000057 (0.3324)

For MCX Agri the highest and the lowest volatility was observed in the months of April (0.00000313) and May (-0.00000143) respectively. The estimated coefficient of January's volatility is 0.00000099 and it has been found to be statistically significant at 5% level of significance (p=0.0000). The estimated coefficient of volatility in February is 0.00000066 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of volatility in March is -0.00000058 and it has been found to be statistically indifferent from January's volatility at 5% level of

significance. The estimated coefficient of volatility in April is 0.00000313 and it has been found to be significantly more than January at 5% level of significance. The estimated coefficient of May's volatility is -0.00000143 and it has been found to be significantly less than January's volatility at 5% level of significance. The estimated coefficient of volatility in June is 0.00000063 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of July's volatility is -0.00000060 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of volatility in August is 0.00000150 and it has been found to be significantly more than January's volatility at 5% level of significance with  $p=0.0056$ . The estimated coefficient of September's volatility is 0.00000044 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of October's volatility is 0.00000013 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. The estimated coefficient of November's volatility is 0.00000175 and it has been found to be significantly more than January's volatility at 5% level of significance. The estimated coefficient of December's volatility is -0.00000057 and it has been found to be statistically indifferent from January's volatility at 5% level of significance. So it has been found that volatility in January, April, May, August and November is significantly different from rest of the months, which suggest that the month of the year effect exist in volatility pertaining to returns of MCX Agri.

#### **4.2 Relationship between return and volatility in Indian stock and commodity markets**

This section includes the results of the relationship between return and volatility using returns and volatility of selected stock and commodity market indices. The return and standard deviation series of indices were tested for Stationarity using ADF and Phillip Perron test. Before applying GARCH-M model the presence of ARCH effect has been tested using ARCH-LM test. The return and volatility relationship has been studied using GARCH-M model.

Table 16 depicts Stationarity tests with respect to daily log return of stock indices. Testing of Stationarity through unit root test is the basic requirement before conducting time series analysis. Stationarity has been tested using Augmented Dicky fuller test (ADF) and Phillip Perron (PP) tests. For Nifty 50 returns the  $p$  values of ADF and Phillip Parron test has been found to be less than 0.05 at level with none, at level with intercept only and at level with trend and intercept, which leads to the conclusion that the data of the time series is stationary. Both the ADF and PP test statistics reported in Table 13 for Nifty 50 rejects the Stationarity hypothesis at 5% level. Stationarity was tested for Nifty 500 using ADF and PP

test. The series was found be stationary with  $p < 0.05$  at all three levels with intercept only (0.0001) with intercept and trend (0.0001) and at level with none (0.0001). Both the ADF and PP test statistics reported in table for Nifty 500 rejects the hypothesis at 5% level, hence the series is stationary. For Nifty Small cap returns the  $p$  values of ADF and Phillip Parron test are  $< 0.05$  at level with none ( $p=0.0001$ ), at level with intercept only ( $p=0.0001$ ) and at level with trend and intercept (0.0000), which lead to conclude that the data of the time series is stationary. Both the ADF and PP test statistics reported in table for Nifty small cap 50 rejects the hypothesis at 5% level. Stationarity has been tested for Nifty 500 using ADF and PP test. The series has been found be stationary with  $p < 0.05$  at all three levels with intercept only, with intercept and trend and at level with none. Both the ADF and PP test statistics reported in Table 13 for Nifty 500 rejects the hypothesis at 5% level, hence the series is stationary. Nifty mid cap return series has been found to be stationary. The Stationarity has been tested using ADF and PP test. The series has been found be stationary with  $p < 0.05$  at all three levels with intercept only, with intercept and trend and at level with none. Both the ADF and PP test statistics reported in Table 13 for Nifty midcap return series rejects the hypothesis at 5% level, hence the series has been found to be stationary.

**Table 16: Test of Stationarity: Augmented Dicky Fuller test and Phillip Perron test**

(Stock Market Indices)

Indices	AT LEVEL with None		AT Level Intercept Only		At Level with trend and Intercept	
	ADF	PP	ADF	PP	ADF	PP
Nifty 50	-71.1509 (0.0001)	-71.0674 (0.0001)	-71.1958 (0.0001)	-71.0913 (0.0001)	-71.1905 (0.0001)	-71.0864 (0.0001)
Nifty 500	-61.6242 (0.0001)	-62.0099 (0.0001)	-61.6815 (0.0001)	-61.9466 (0.0001)	-61.6759 (0.0001)	-61.9404 (0.0001)
Nifty Smallcap	-48.5823 (0.0001)	-49.2733 (0.0001)	-48.5913 (0.0001)	-49.2665 (0.0001)	-48.5920 (0.0001)	-49.2591 (0.0001)
Nifty Midcap	-53.2206 (0.0001)	-53.1008 (0.0001)	-53.2417 (0.0001)	-53.1153 (0.0001)	-53.2351 (0.0001)	-53.1083 (0.0001)

Table 17 depicts Stationarity tests with respect to daily log returns of commodity indices. Testing of Stationarity through unit root test is the basic requirement before conducting time series analysis. Stationarity has been tested using both Augmented Dicky fuller test (ADF) and Phillip Parron (PP) tests. For Nkrishi Index the  $p$  values of ADF and pp are  $< 0.05$  at level with intercept only, at level with trend an intercept and at level with none (0.001), which lead to the conclusion that the data of the time series for the entire study period

is stationary. Both the ADF and PP test statistics reported in Table 14 reject the Stationarity hypothesis at 5% level. Hence, the results of both the tests confirm that the series are stationary. Stationarity was tested for MCX Comdex using both Augmented Dicky fuller test (ADF) and Phillip Parron (PP) tests. The series was found be stationary with  $p < 0.05$  at all three levels with intercept only, with intercept and trend and at level with none (0.0001). Both the ADF and PP test statistics reported in Table 14 for Nifty 500 rejects the Stationarity hypothesis at 5% level, hence the series is stationary. For MCX Energy returns the  $p$  values of ADF and Phillip Parron test are  $< 0.05$  at level with none, at level with intercept only and at level with trend and intercept, which lead to conclude that the data of the time series is stationary. Both the ADF and PP test statistics reported in Table 14 for MCX Energy rejects the Stationarity hypothesis at 5% level. Further, Stationarity was tested for MCX Metal using ADF and PP test. The series was found be stationary with  $p < 0.05$  at all three levels with intercept only with intercept and trend and at level with none. Both the ADF and PP test statistics reported in Table 14 for MCX Metal rejects the hypothesis at 5% level, hence the series is stationary. MCX Agri return series was also found to be stationary.

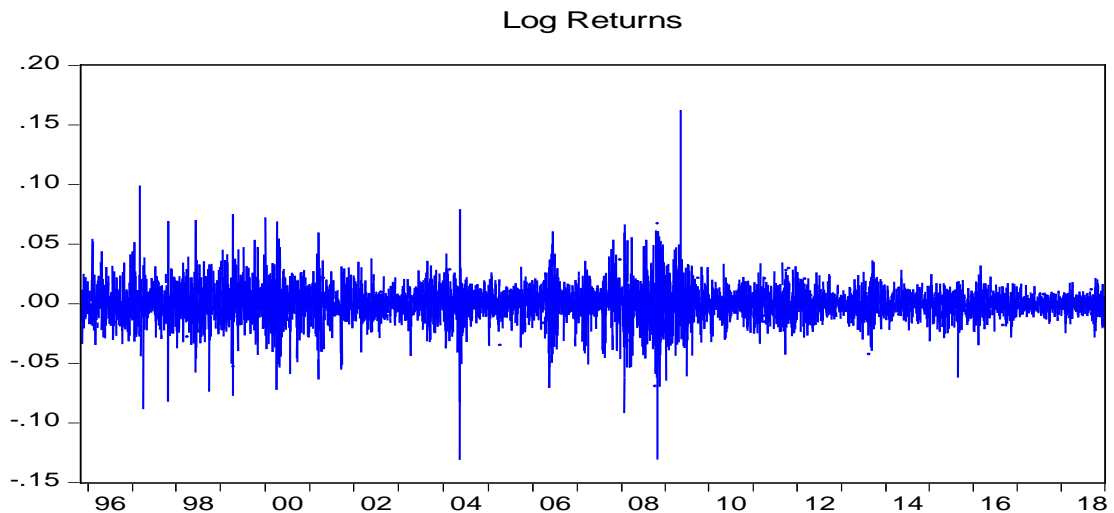
**Table 17: Test of Stationarity: Augmented Dicky Fuller test and Phillip Perron test**

**(Commodity Market Indices)**

Indices	AT LEVEL with None		AT Level with Intercept Only		At Level with trend and Intercept	
	ADF	PP	ADF	PP	ADF	PP
Nkrishi Index	-36.4871 (0.0001)	-56.9220 (0.0001)	-36.6887 (0.0001)	-56.6441 (0.0001)	-36.7015 (0.0001)	-56.6255 (0.0001)
MCX Comdex	-59.2543 (0.0001)	-59.3971 (0.0001)	-59.2517 (0.0001)	-59.3820 (0.0001)	-59.2463 (0.0001)	-59.3761 (0.0001)
MCX Energy	-57.8481 (0.0001)	-58.0406 (0.0001)	-57.8343 (0.0001)	-58.0332 (0.0001)	-57.8288 (0.0001)	-58.0273 (0.0001)
MCX Metal	-62.3484 (0.0001)	-62.3061 (0.0001)	-62.3535 (0.0001)	-62.3112 (0.0001)	-62.3455 (0.0001)	-62.3034 (0.0001)
MCX Agri	-58.1116 (0.0001)	-58.7769 (0.0001)	-58.1164 (0.0001)	-58.7662 (0.0001)	-58.1086 (0.0001)	-58.7587 (0.0001)

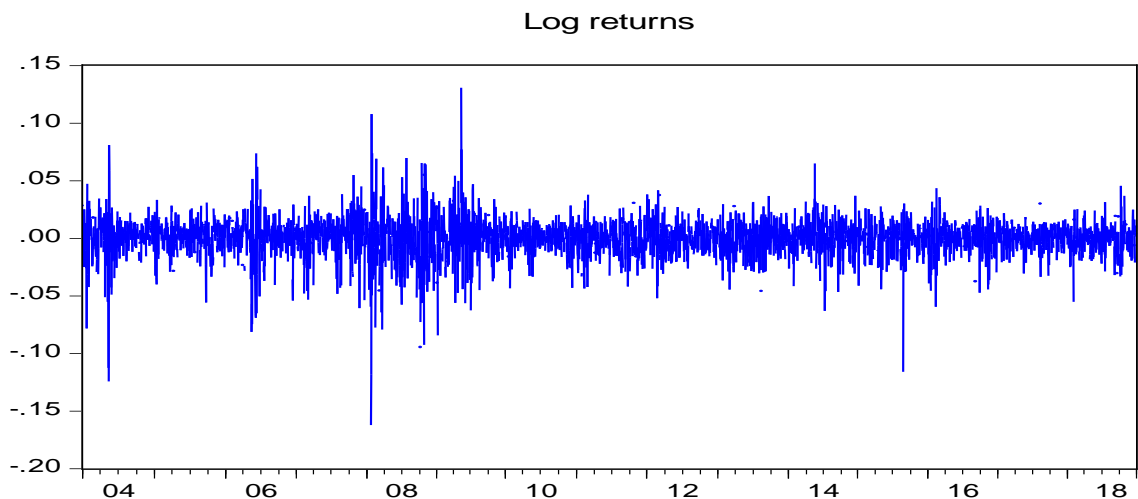
The Stationarity was tested using ADF and PP test. The series was found be stationary with  $p < 0.05$  at all three levels with intercept only (0.0001) with intercept and trend (0.0001) and at level with none (0.0001). Both the ADF and PP test statistics reported in table for MCX Agri return series rejects the hypothesis at 5% level, hence the series is found to be stationary.

Figures 4.1 depict the evidence of ARCH effect in Nifty 50 Index log returns for the study period from November 1996 to December 2018. From the figure, it can be seen that the period of low volatility tends to be followed by period of low volatility for a prolonged period and the period of high volatility is followed by period of high volatility, referred to as volatility clustering. Volatility clustering can be observed in the year 1998-2000 and from the year 2007-2009 for Nifty 50 returns.



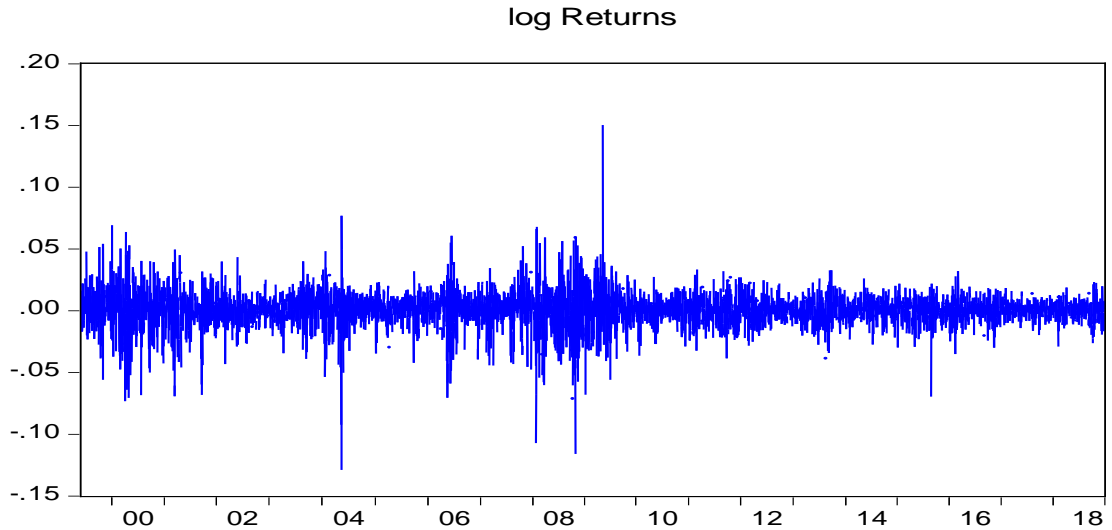
**Fig 4.1. Evidence of ARCH effect in NIFTY 50 (1996-2018)**

Figure 4.2 depicts the evidence of ARCH effect in Nifty Midcap 50 Index log returns for the study period from November 2004 to December 2018. From the figure, it is inferred that nifty Midcap 50 also shows some volatility clustering from the year 2008-2010.



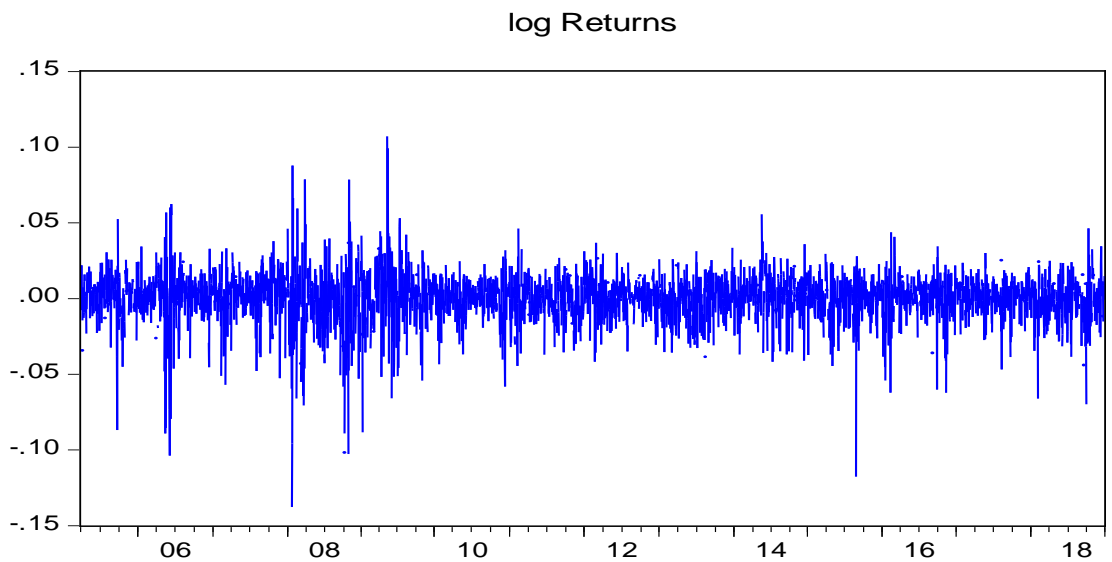
**Fig 4.2. Evidence of ARCH effect in Nifty Midcap 50 (2004-2018)**

Figure 4.3 depicts the evidence of ARCH effect in Nifty 500 Index log returns for the study period from June 1999 to December 2018. For Nifty 500 also volatility clustering can be observed from the year 2000-2001 and from the year 2007-2009.



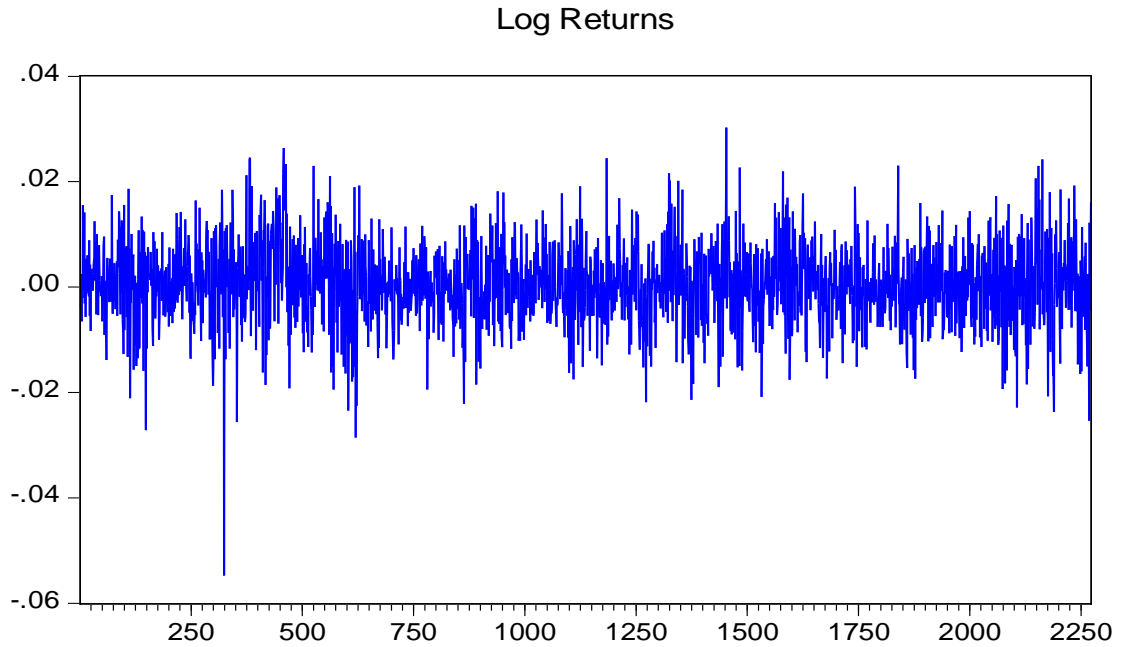
**Fig 4.3 Evidence of ARCH effect in NIFTY 500 (2000-2018)**

Figure 4.4 depicts evidence of ARCH effect in Nifty Smallcap 50 Index log returns for the study period from April 2005 to December 2018. The volatility clustering has been observed for the year 2007-2009 and 2013-2015 for Nifty Smallcap. Further comparatively more volatility has been observed in Nifty Smallcap. It also shows the presence of ARCH effect in all four indices.



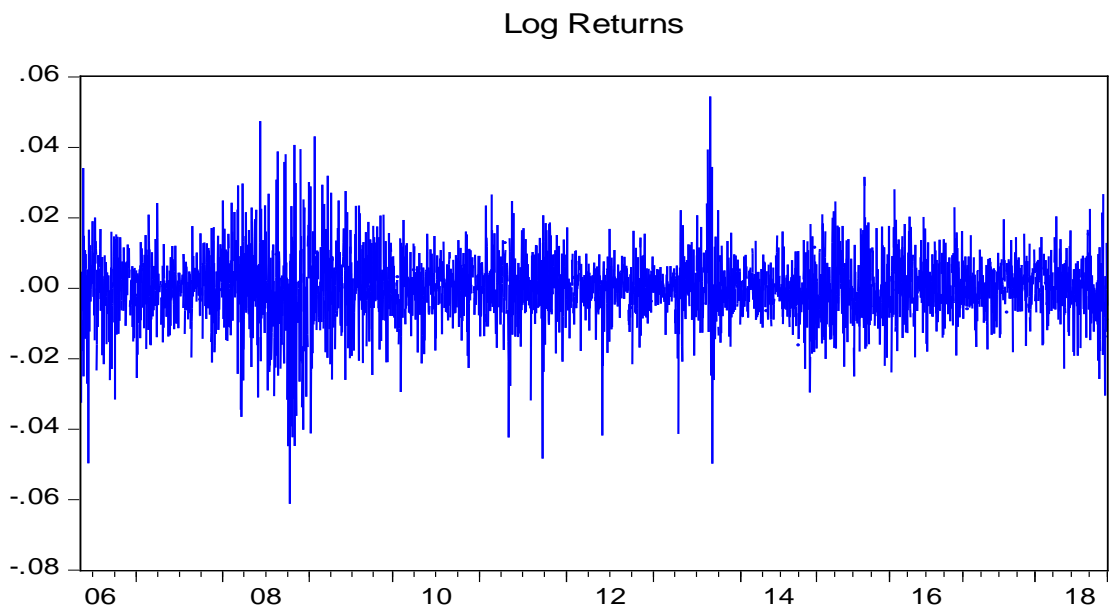
**Fig 4.4. Evidence of ARCH effect in NIFTY SMALL CAP 50 (2006-2018)**

Figure 4.5 depicts the evidence of ARCH effect in Nkrishi Index log returns for the study period from October 2010 to December 2018. For Nkrishi index volatility clustering has been observed for the period 2007-2009, 2011-2013, 2015-2016.



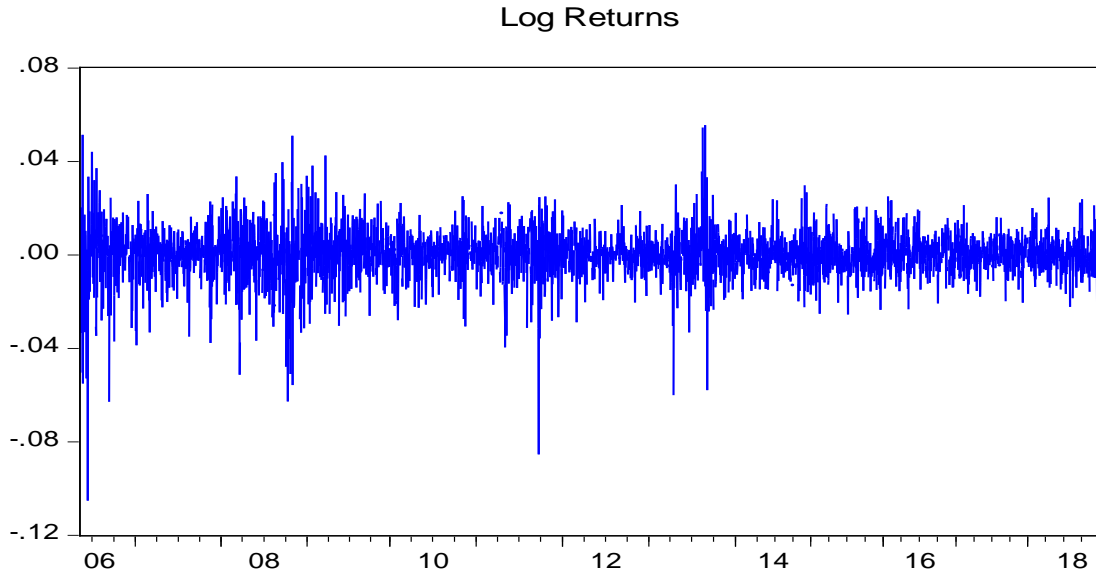
**Fig 4.5 Evidence of ARCH effect in NKRISHI (2006-2018)**

Figure 4.6 depicts the nature of volatility for MCX Comdex Index log returns for the study period from May 2006 to December 2018. For MCX Comdex index volatility clustering has been observed for the period 2007-2009.



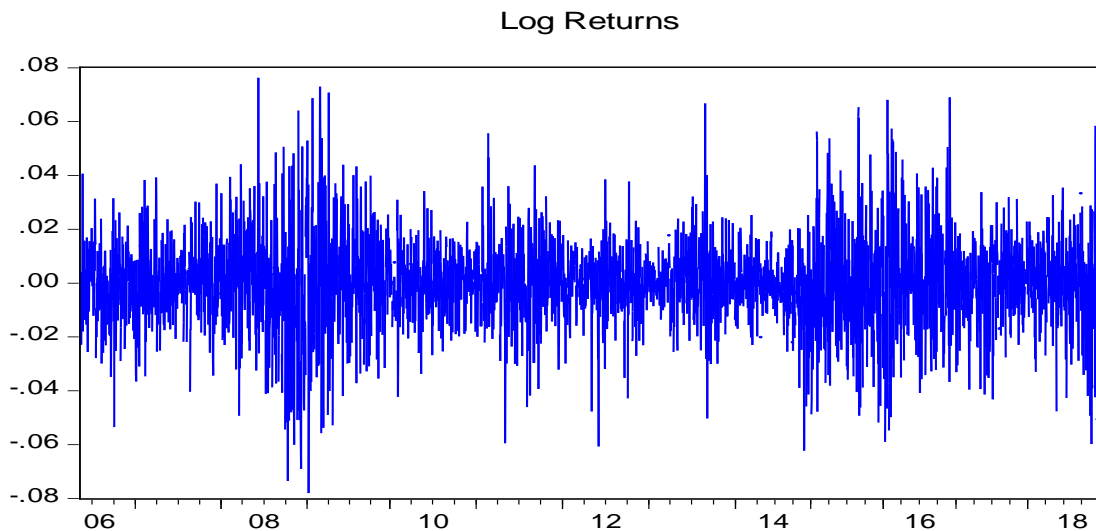
**Fig 4.6 Nature of volatility in MCX COMDEX (2006-2018)**

Figure 4.7 depicts the nature of volatility for MCX Metal Index log returns for the study period from May 2006 to December 2018. For MCX Metal index volatility clustering has been observed for the period 2007-2009.



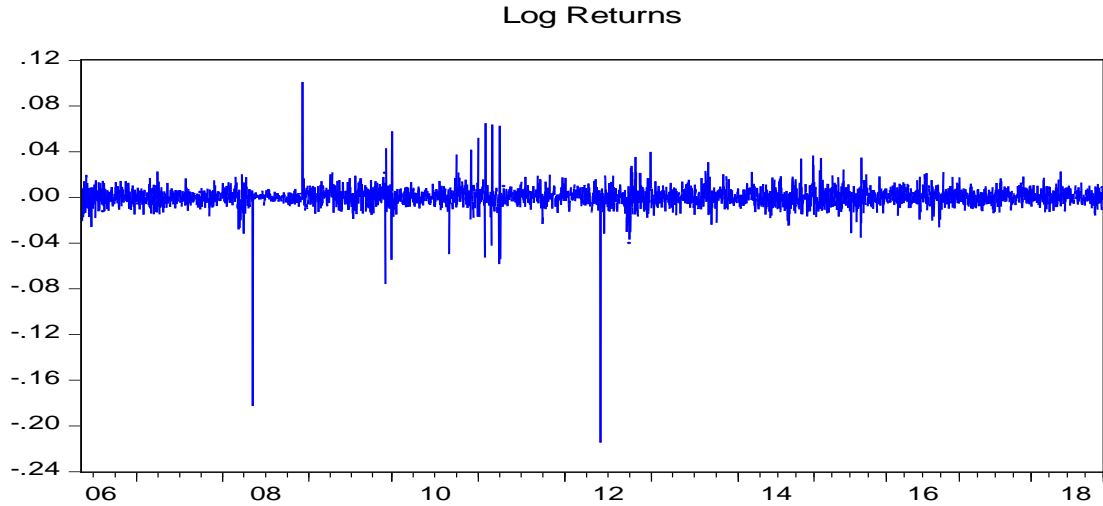
**Fig 4.7 Evidence of ARCH effect in MCX METAL (2006-2018)**

Figure 4.8 depicts the evidence of ARCH effect in for MCX Energy Index log returns for the study period from May 2006 to December 2018. For MCX Energy index volatility clustering has been observed for the period 2007-2009, 2014-2017.



**Fig 4.8 Evidence of ARCH effect in MCX ENERGY (2006-2018)**

Figure 4.9 depicts evidence of ARCH effect in MCX Agri Index log returns for the study period from May 2006 to December 2018. For MCX Agri index volatility clustering has been observed to be absent. From the figures, comparatively highest volatility clustering has been observed in Nkrishi followed by MCX energy and MCX Comdex. The least volatility clustering has been observed in MCX Agri index.



**Fig 4.9 Evidence of ARCH effect in MCX AGRI (2006-2018)**

Table 18 depicts the results of ARCH-LM test for stock market indices namely Nifty 50, Nifty 500, Nifty Smallcap and Nifty Midcap 50. The residuals of the individual equations have been examined for the presence or absence of conditional heteroskedasticity. The ARCH-LM test has been conducted. It is evident from table that all the returns series of stock market indices exhibited ARCH effects at the 5% significance level, thereby depicting clustering effect statistically significant presence of ARCH effect leads to GARCH analysis of the return series.

**Table 18: ARCH effect in Stock market indices**

Index	Constant	ARCH term	p value
Nifty 50	0.000157	0.317674	0.0001
Nifty 500	0.000132	0.400374	0.0001
Nifty Smallcap	0.000014	0.155553	0.0001
Nifty Midcap	0.000197	0.292348	0.0001

Table 19 depicts the results of ARCH-LM test for Nkrishi, MCX Comdex, MCX Metal, MCX Energy, and MCX Agri. The residuals of the individual equations were examined for the presence or absence of conditional heteroskedasticity. The ARCH-LM test was conducted. It is evident from table that all the returns series of commodity markets except MCX Agri, exhibited ARCH effects at the 5 % significance level thereby depicting clustering effect statistically significant presence of ARCH effect leads to GARCH analysis of the return series

**Table 19: ARCH effect in Commodity market indices**

Index	Constant	ARCH term	p value
Nkrishi	0.00000121	0.043547	0.0001
MCX Comdex	0.0000698	0.201974	0.0001
MCX Metal	0.0000841	0.220458	0.0001
MCX Energy	0.0002060	0.225900	0.0001
MCX Agri	0.0000880	0.011153	0.1432

Table 20 depicts the risk return relation for all the stock indices namely Nifty 50, Nifty Midcap, Nifty Smallcap and Nifty 500. For Nifty 50 the risk aversion parameter, GARCH coefficient  $\lambda$  in the mean equation has been found to be insignificant with  $\lambda$  1.077432 (0.4097). This practically invalidates our initial hypothesis that there is correlation between risk and expected return. For Nifty Midcap 50 the GARCH coefficient  $\lambda$  for the variance term in the mean equation has been found to be statistically insignificant with  $\lambda$  1.551392 (0.3196). This indicates that there is insignificant relationship between risk and Nifty Midcap 50 returns. For Nifty 500, the GARCH coefficient  $\lambda$  for the variance term in the mean equation has been found to be statistically insignificant with  $\lambda$  1.288789 (0.3668). This indicates that there is insignificant relationship between risk and Nifty 500. For Nifty Smallcap 50 the GARCH coefficient  $\lambda$  for the variance term in the mean equation has been found to be statistically significant with  $\lambda$  3.745217 (0.0231) with positive value which supports the presence of risk return relationship between risk and expected return for Nifty Smallcap 50. Consistent with the CAPM, this finding indicates that investors investing in Nifty 50, Nifty Midcap 50 and Nifty 500 index have been compensated for bearing high risk.

**Table 20: GARCH in Mean Model for Stock Market Indices**

Index	Mean Equation		Variance Equation			Persistence Effect
	Constant ( $\mu$ )	GARCH coefficient ( $\lambda$ )	$\beta_0$ (Constant)	$\beta_1$ (ARCH)	$\beta_2$ (GARCH)	$\beta_1 + \beta_2$
Nifty 50	0.000621 (0.0034)	1.077432 (0.4097)	0.00000243 (0.0001)	0.105687 (0.0001)	0.889169 (0.0001)	0.994856
Nifty Midcap	0.000554 (0.1239)	1.551392 (0.3196)	0.00000899 (0.0001)	0.139257 (0.0001)	0.833909 (0.0001)	0.973166
Nifty 500	0.000680 (0.0016)	1.288789 (0.3668)	0.00000324 (0.0001)	0.124422 (0.0001)	0.865180 (0.0001)	0.988408
Nifty Smallcap	0.0000142 (0.9712)	3.745217 (0.0231)	0.0000146 (0.0001)	0.159671 (0.0001)	0.791106 (0.0001)	0.950777

The table also depicts the persistency and Stationarity of volatility. In the variance equation the parameters  $\beta_0$ ,  $\beta_1$  and  $\beta_2$ , has been found to be highly significant at 5% level of significance. The sum of  $\beta_1$  and  $\beta_2$  should be less than 1, which infers that shocks will persist in the future period. It has been found that the volatility of returns is persistent in all indices as the sum of  $\beta_1$  and  $\beta_2$  has been found to be around 1 ranging from 0.9507 to 0.994. It is evident that most of the conditional volatilities are mean reverting and are stationary since the summation of  $\alpha$  and  $\beta$  are less than one.

Table 21 depicts the risk return relation for all the commodity indices namely Nkrishi, MCX Comdex, MCX Metal, MCX Energy and MCX Agri. For Nkrishi the risk aversion parameter, GARCH coefficient  $\lambda$  in the mean equation has been found to be insignificant with  $\lambda$  12.2145(0.2137). This indicates that there is insignificant relationship between risk and Nkrishi returns. For MCX Comdex the GARCH coefficient  $\lambda$  for the variance term in the mean equation has been found to be statistically insignificant with  $\lambda$  -2.283077 (0.5052). This indicates that there is no significant relationship between risk and MCX Comdex returns. For MCX Metal, the GARCH coefficient  $\lambda$  for the variance term in the mean equation has been found to be statistically insignificant with  $\lambda$  0.021374 (0.9946). This indicates that there is insignificant relationship between risk and MCX Comdex returns. For MCX Energy the GARCH coefficient  $\lambda$  for the variance term in the mean equation has been found to be statistically insignificant with  $\lambda$  0.089367 (0.9600). This practically invalidates our initial hypothesis that there is correlation between risk and expected return. For MCX Agri the GARCH coefficient  $\lambda$  for the variance term in the mean equation has been found to be statistically insignificant with  $\lambda$  2.409938 (0.78940). This practically invalidates our initial hypothesis that there is correlation between risk and expected return.

**Table 21: GARCH in Mean Model for Commodity Market Indices**

Index	Mean Equation		Variance Equation			Persistence Effect
	Constant ( $\mu$ )	GARCH coefficient ( $\lambda$ )	$\beta_0$ (Constant)	$\beta_1$ (ARCH)	$\beta_2$ (GARCH)	$\beta_1 + \beta_2$
Nkrishi	-0.000306 (0.5724)	12.2145 (0.2137)	0.00000117 (0.0021)	0.04359 (0.0001)	0.936913 (0.0001)	0.98050
MCX Comdex	0.000318 (0.2266)	-2.283077 (0.5052)	0.00000113 (0.0001)	0.054607 (0.0001)	0.931980 (0.0001)	0.98659
MCX Metal	0.000159 (0.5638)	0.021374 (0.9946)	0.00000137 (0.0001)	0.053405 (0.0001)	0.932418 (0.0001)	0.98582
MCX Energy	0.000185 (0.6466)	0.089367 (0.9600)	0.00000183 (0.0001)	0.050335 (0.0001)	0.943633 (0.0001)	0.99397
MCX-Agri	NO ARCH EFFECT					

The table also depicts the persistency and Stationarity of volatility. In the variance equation the parameters  $\beta_0$ ,  $\beta_1$  and  $\beta_2$ , has been found to be highly significant at 5% level of significance. The sum of  $\beta_1$  and  $\beta_2$  should be less than 1, which infers that shocks will persist in the future period. It has been found that the volatility of returns is persistent in all indices as the sum of  $\beta_1$  and  $\beta_2$  has been found to be around 1 ranging from 0.9805 to 0.9939. It is evident that most of the conditional volatilities are mean reverting and are stationary since the summation of  $\alpha$  and  $\beta$  are less than one. In case of MCX Agri the returns does not show any volatility clustering so GARCH (1 1) M model is not applicable.

### **4.3 Impact of macroeconomic variables on volatility in Indian stock and commodity markets**

This section includes the results of the impact of macroeconomic variables namely Foreign Institutional investment net flow, Domestic Institutional Investment flow and yield on 10 year government bond on volatility in selected stock market indices. Further this section includes the results of the impact of GDP growth rate, Consumer Price Index, and yield on 10 year government bond on volatility in selected commodity market indices. The series has been tested for correlation and causality using Pearson's correlation and Granger causality test. Further, the impact of macroeconomic variables has been studied using multiple regression.

Table 22 depicts the correlation between volatility in stock indices returns and selected macro economic variables namely FII flows, DII flows and interest rates. The correlation results reveal the positive and significant association of volatility in Nifty 50 index with domestic institutional investment flows ( $r=0.165$ ,  $p=0.049$ ) while negative and significant association with foreign institutional investment flows ( $r=-0.247$ ,  $p = 0.003$ ) and negative but no significant association with market interest rates ( $r = -0.140$ ,  $p=0.095$ ).

The correlation results reveal the positive and significant association of volatility in Nifty Mid Cap 50 index with Domestic institutional investment flows ( $r=0.245$ ,  $p=0.003$ ) while negative and significant association with foreign institutional investment ( $r=-0.332$ ,  $p=0.001$ ) and negative but no significant association with market interest rates ( $r=-0.092$ ,  $p=0.275$ ). The correlation results reveal the positive association of volatility in Nifty 500 index with domestic institutional investment flows( $r = 0.222$ ,  $p=0.008$ ) while negative and significant association with foreign institutional investment ( $r= -0.301$ ,  $p=0.001$ ) and negative but no significant association with market interest rates ( $r = -0.120$ ,  $p = 0.153$ ). The correlation results reveal the positive association of volatility in Nifty small cap with domestic institutional investment flows ( $r=0.369$ ,  $p=0.001$ ) while negative and significant association with foreign institutional investment flows ( $r=-0.419$ ,  $p=0.000$ ) and negative but no significant association with market interest rates ( $r=-0.052$ ,  $p=0.535$ ).

**Table 22: Correlation between Stock Indices Volatility and Selected Macro Economic Variables**

Volatility in returns of	FII flows	DII flows	Yield on 10 year Govt. Bond
	r (p value)	r (p value)	r (p value)
Nifty 50	-0.247 (0.003)	0.165 (0.051)	-0.096 (0.254)
Nifty Midcap	-0.332 (0.001)	0.245 (0.003)	-0.035 (0.681)
Nifty 500	-0.301 (0.001)	0.222 (0.008)	-0.106 (0.206)
Nifty Small cap	-0.419 (0.001)	0.369 (0.001)	-0.125 (0.134)

Table 23 depicts the results of unit root test for volatility in returns of stock market indices and other selected macroeconomic variables. The unit root test is applied to test the Stationarity of the data. All the selected variables are found to be stationary

**Table 23: Unit Root Test for Stock Market and Commodity Market Indices Volatility and selected Macro Economic Variables**

Variable	At trend and intercept	
	ADF test statistics	p value
FII net flows	-8.599	0.001
DII net flows	-7.270	0.001
Yield on 10 year Govt. bonds	-7.638	0.001
Volatility in Nifty 50	-6.788	0.001
Volatility in Nifty Midcap	-8.025	0.001
Volatility in Nifty 500	-6.931	0.001
Volatility in Nifty Small Cap	-8.427	0.001
Volatility in Nkrishi	-6.203	0.001
Volatility in MCX Comdex	-5.667	0.001
Volatility in MCX Metal	-7.936	0.001
Volatility in MCX energy	-3.444	0.049
Volatility in MCX Agri	-9.406	0.001

The Granger causality test result in Table 24 shows two ways causal relationship among volatility in different stock indices returns and DII. No causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty 50 returns and DII flows ( $f = 0.81307$ ,  $p = 0.4457$ ). For Nifty 500 no causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty 500 returns and DII flows ( $f = 0.42365$ ,  $p = 0.6555$ ). For Nifty Midcap 50 no causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty Midcap 50 returns and DII flows ( $f = 0.37768$ ,  $p = 0.6862$ ). For Nifty Smallcap 50 no causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty Smallcap 50 returns and DII flows ( $f = 0.04343$ ,  $p = 0.6496$ ).

**Table 24: Granger Causality test of Stock Market Indices Volatility with DII net flows**

Null Hypothesis	Observations	F-Statistic	p Value
Volatility in Nifty 50 Volatility does not Granger Cause DII net flows	139	0.81307	0.4457
DII net flows does not Granger Cause Volatility in Nifty 50	139	0.12468	0.8829
Volatility in Nifty 500 Volatility does not Granger Cause DII net flows	139	0.42365	0.6555
DII net flows does not Granger Cause Volatility in Nifty 500	139	9.4E-05	0.9999
Volatility in Nifty Midcap 50 Volatility does not Granger Cause DII net flows	139	0.37768	0.6862
DII net flows does not Granger Cause Volatility in Nifty Midcap 50	139	0.48900	0.6143
Volatility in Nifty Smallcap 50 does not Granger Cause DII net flows	139	0.43276	0.6496
DII net flow does not Granger Cause Volatility in Nifty Smallcap 50	139	0.04343	0.9575

The Granger causality test result in Table 25 shows two ways causal relationship among volatility in different stock indices returns and Interest rates. No causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty 50 returns and Interest rates ( $f = 0.59313$ ,  $p = 0.5541$ ). For Nifty 500 no causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty 500 returns and Interest rates ( $f = 0.58954$ ,  $p = 0.5561$ ). For Nifty Midcap 50 no causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty

Midcap 50 returns and Interest rates ( $f = 0.47800$ ,  $p = 0.6211$ ). For Nifty Smallcap 50 no causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty Smallcap 50 returns and Interest rates ( $f = 0.50346$ ,  $p = 0.6056$ ).

**Table 25: Granger Causality test of Stock Market Indices Volatility with Yield on 10 year Govt. Bonds**

Null Hypothesis	Observations	F-Statistic	p Value
Volatility in Nifty Midcap 50 does not Granger Cause yield on 10 year Govt. bonds	135	0.47800	0.6211
Yield on 10 year Govt. bonds does not Granger Cause Volatility in Nifty Midcap 50	135	4.15812	0.0178
Volatility in Nifty 500 does not Granger Cause Yield on 10 year Govt. bonds	135	0.58954	0.5561
Yield on 10 year Govt. bonds does not Granger Cause Volatility in Nifty 500	135	5.74746	0.0041
Volatility in Nifty 50 does not Granger Cause Yield on 10 year Govt. Bonds	135	0.59313	0.5541
Yield on 10 year Govt. Bonds does not Granger Cause Volatility in Nifty 50	135	6.90027	0.0014
Volatility in Nifty Small Cap does not Granger Cause Yield on 10 year Govt. Bonds	135	0.50346	0.6056
Yield on 10 year Govt. Bonds does not Granger Cause Volatility in Nifty Small Cap	135	2.70540	0.0706

The Granger causality test result in Table 26 shows two ways causal relationship among volatility in different stock indices returns and FII flows. No causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty 50 returns and FII flows ( $F = 0.09606$ ,  $p = 0.9085$ ). For Nifty 500 no causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty 500 returns and FII flows ( $F = 0.02434$ ,  $p = 0.9760$ ). For Nifty Midcap 50 no causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty Midcap 50 returns and FII flows ( $F = 0.01960$ ,  $p = 0.9806$ ). For Nifty Smallcap 50 no causal relationship in the form of granger causality has been observed in relationship between volatility in Nifty Smallcap 50 returns and FII flows ( $F = 0.02437$ ,  $p = 0.9759$ ).

**Table 26: Granger Causality test of Stock Market Indices with FII net flows**

<b>Null Hypothesis</b>	<b>Observations</b>	<b>F-Statistic</b>	<b>p Value</b>
Volatility in Nifty 50 does not Granger Cause FII net flows	142	0.09606	0.9085
FII net flows does not Granger Cause Volatility in Nifty 50	142	0.25533	0.7750
Volatility in Nifty 500 does not Granger Cause FII net Flows	142	0.02434	0.9760
FII net flows does not Granger Cause Volatility in Nifty 500	142	0.19805	0.8206
Volatility in Nifty Midcap 50 does not Granger Cause FII net flows	142	0.01960	0.9806
FII net flows does not Granger Cause Volatility in Nifty Midcap 50	142	0.84720	0.4308
Volatility in Nifty Smallcap 50 does not Granger Cause FII net flows	142	0.02437	0.9759
FII net flows does not Granger Cause Volatility in Nifty Smallcap 50	142	0.22250	0.8008

The table 27 depicts the results of multiple regression analysis for stock market indices namely Nifty 50, Nifty Midcap 50, Nifty 500 and Nifty Smallcap 50. In these models the dependent variable is volatility in specific index and independent variable includes FII flows, DII flows and market interest rates. To estimate proportion of variance in volatility of Nifty 50 index return that can be accounted by FII, DII flows and market interest rates, a standard multiple regression analysis was performed.

In combination, the selected independent variables account for significant 9.5 % of variability in volatility of Nifty 50 Index ( $R^2= 0.095$ ,  $F=4.793$ ,  $p= 0.003$ ). Unstandardized regression coefficients along with their significance test for each particular in regression model are reported in table 28. It can be seen that both FII and DII are significant at 5% significance level but same is not true for market interest rates. In combination, the selected independent variables account for significant 13.1 % of variability in volatility of Nifty Midcap ( $R^2= 0.131$ ,  $F= 6.857$ ,  $p= 0.001$ ). Unstandardized regression coefficients along with their significance test for each particular in regression model are reported in table 28. It can be seen that both FII is significant at 5% significance level but same is not true for DII flows and market interest rates.

**Table 27: Impact of Macro Economic variables on Volatility in Stock Market Indices**

	Nifty 50		Nifty midcap		Nifty 500		Nifty Small cap	
	<b>b</b>	<b>t</b> <b>(p value)</b>	<b>b</b>	<b>t</b> <b>(p value)</b>	<b>b</b>	<b>t</b> <b>(p value)</b>	<b>b</b>	<b>t</b> <b>(p value)</b>
Intercept	0.022	3.444 (0.001)	0.019	3.021 (0.003)	0.021	3.527 (0.001)	0.023	3.891 (0.000)
FII net flows	-0.00000043	-3.101 (0.002)	-0.00000045	-3.327 (0.001)	-0.00000041	-3.189 (0.002)	-0.00000035	-2.849 (0.005)
DII net flows	-0.00004	-2.054 (0.042)	-0.000033	-1.740 (0.084)	-0.00000033	-1.828 (0.070)	-0.0000012	-0.676 (0.500)
Yield on 10 Year Govt. Bonds	-0.001	-1.488 (0.139)	0.000	-0.556 (0.579)	-0.001	-1.492 (0.138)	-0.001	-1.292 (0.199)
F value	4.793 (0.003)		6.857 (0.001)		6.151 (0.001)		10.515 (0.001)	
R <sup>2</sup>	0.095		0.131		0.119		0.187	

In combination, the selected independent variables account for significant 11.9 % of variability in volatility of Nifty 500 ( $R^2= 0.119$ ,  $F= 6.151$ ,  $p= 0.001$ ). Unstandardized regression coefficients along with their significance test for each particular in regression model are reported in table 28. It can be seen that both FII is significant at 5% significance level but same is not true for DII flows and market interest rates. In combination, the selected independent variables account for significant 18.7 % of variability in volatility of Nifty Smallcap ( $R^2= 0.187$ ,  $F= 10.515$ ,  $p= 0.001$ ). Unstandardised regression coefficients along with their significance test for each particular in regression model are reported in table 28. It can be seen that both FII is significant at 5% significance level but same is not true for DII flows and market interest rates.

Table 28 depicts the correlation between volatility in commodity indices returns and selected macro economic variables namely GDP growth rate, CPI and interest rates. The correlation results reveal the positive and insignificant association of volatility in Nkrishi index with GDP growth ( $r=0.128$ ,  $p=0.207$ ) and negative and insignificant association with consumer price index ( $r=-0.097$ ,  $p = 0.399$ ) and negative but significant association with market interest rates ( $r = -0.235$ ,  $p=0.019$ ). The correlation results reveal the positive and significant association of volatility in Nifty Mid Cap 50 index with Domestic institutional investment flows ( $r=0.245$ ,  $p=0.003$ ) while negative and significant association with foreign institutional investment ( $r=-0.332$ ,  $p=0.001$ ) and negative but insignificant association with market interest rates ( $r=-0.092$ ,  $p=0.275$ ). For MCX-Comdex the correlation results reveal the positive but insignificant association of volatility in MCX-Comdex with GDP growth rate ( $r = 0.169$ ,  $p=0.084$ ) while negative and insignificant association with consumer price index ( $r = -0.049$ ,  $p=0.663$ ) and positive but not significant association with market interest rates ( $r = 0.153$ ,  $p = 0.117$ ). The correlation results reveal the negative association of volatility in MCX –Metal with GDP growth ( $r=-0.013$ ,  $p=0.894$ ) while negative and insignificant association with consumer price index ( $r=-0.202$ ,  $p=0.071$ ) and negative but insignificant association with market interest rates ( $r=-0.006$ ,  $p=0.939$ ). The correlation results reveal the negative and significant association of volatility in MCX –Energy with GDP growth ( $r=-0.329$ ,  $p=0.001$ ) and negative and significant association with consumer price index ( $r=-0.372$ ,  $p=0.001$ ) and negative and significant association with market interest rates ( $r=-0.217$ ,  $p=0.026$ ). The correlation results reveal the negative association of volatility in MCX –Agri with GDP growth ( $r=-0.001$ ,  $p=0.994$ ) while negative and significant association with consumer price index ( $r=-0.287$ ,  $p=0.009$ ) and negative but insignificant association with market interest rates ( $r=-0.176$ ,  $p=0.071$ ).

**Table 28: Correlation between Commodity Indices Volatility and selected Macro Economic Variables**

Volatility in returns of	GDP growth rate	CPI	Yield on 10 year Govt. Bonds
	r (p value)	r (p value)	r(p value)
Nkrishi	0.128 (0.207)	-0.097 (0.399)	-0.235 (0.019)
MCX –Comdex	0.169 (0.084)	-0.049 (0.663)	0.153 (0.117)
MCX- metal	-0.013 (0.894)	0.202 (0.071)	-0.006 (0.939)
MCX-Energy	0.329 (0.001)	-0.372 (0.001)	0.217 (0.026)
MCX-Agri	-0.001 (0.994)	0.287 (0.009)	-0.176 (0.071)

The Granger causality test result in Table 29 shows two ways causal relationship among volatility in different commodity indices returns and GDP growth rate. No causal relationship in the form of granger causality has been observed in relationship between volatility in Nkrishi returns and GDP growth rate ( $f = 0.47077$ ,  $p = 0.6260$ ). For MCX-Comdex no causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Comdex returns and GDP growth rate ( $f = 1.99047$ ,  $p = 0.3371$ ).

**Table 29: Granger Causality test of Commodity Market Indices volatility with GDP growth rate**

Null Hypothesis	Observation	F-Statistic	p Value
NKRISHI Volatility does not Granger Cause GDP growth rate	97	0.47077	0.6260
GDP growth rate does not Granger Cause Volatility in NKRISHI	97	1.21272	0.3021
MCX-COMDEX Volatility does not Granger Cause GDP growth rate	104	1.09947	0.3371
GDP growth rate does not Granger Cause Volatility in MCX-COMDEX	104	0.72690	0.4860
MCX-METAL Volatility does not Granger Cause GDP growth rate	104	0.20961	0.8113
GDP growth rate does not Granger Cause Volatility in MCX-METAL	104	0.16915	0.8446
MCX-ENERGY Volatility does not Granger Cause GDP growth rate	104	1.48224	0.2321
GDP growth rate does not Granger Cause Volatility in MCX-ENERGY	104	1.12210	0.3297
MCX-Agri Volatility does not Granger Cause GDP growth rate	104	1.42268	0.2460
GDP growth rate does not Granger Cause Volatility in MCX-Agri	104	0.66299	0.5176

For MCX-Metal also no causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Metal returns and GDP growth rate ( $f = 0.20961$ ,  $p = 0.8113$ ). Further for MCX-Energy no causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Energy returns and GDP growth rate ( $f = 1.48224$ ,  $p = 0.2332$ ). For MCX-Agri also no causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Agri returns and GDP growth rate ( $f = 1.42268$ ,  $p = 0.2460$ ).

The Granger causality test result in Table 30 shows two ways causal relationship among volatility in different commodity indices returns and Govt. Bonds. No causal relationship in the form of granger causality has been observed in relationship between volatility in Nkrishi returns and Govt. Bonds ( $f = 0.18059$ ,  $p = 0.8351$ ). For MCX-Comdex no causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Comdex returns and Govt. Bonds ( $f = 2.55367$ ,  $p = 0.0817$ ). For MCX-Metal no causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Metal returns and Govt. Bonds ( $f = 2.59718$ ,  $p = 0.0783$ ).

**Table 30: Granger Causality test of Commodity Market Index with Yield on 10 year Govt. Bonds**

<b>Null Hypothesis</b>	<b>Observation</b>	<b>F-Statistic</b>	<b>p Value</b>
Nkrishi Volatility does not Granger Cause Yield on 10 year Govt. Bonds	90	0.18059	0.8351
Yield on 10 year Govt. Bonds does not Granger Cause Volatility in Nkrishi	90	0.49167	0.6133
MCX-Comdex Volatility does not Granger Cause Yield on 10 year Govt. Bonds	135	2.55367	0.0817
Yield on 10 year Govt. Bonds does not Granger Cause Volatility in MCX-Comdex	135	0.38349	0.6822
MCX-Metal Volatility does not Granger Cause Yield on 10 year Govt. Bonds	135	2.59718	0.0783
Yield on 10 year Govt. Bonds does not Granger Cause Volatility in MCX-Metal	135	1.70555	0.1857
MCX-ENERGY Volatility does not Granger Cause Yield on 10 year Govt. Bonds	135	3.87415	0.0232
Yield on 10 year Govt. Bonds does not Granger Cause Volatility in MCX-Energy	135	0.01131	0.9888
MCX-Agri Volatility does not Granger Cause Govt. Bonds	135	0.84232	0.4330
Yield on 10 year Govt. Bonds does not Granger Cause Volatility in MCX-Agri	135	3.37582	0.0372

For MCX-Energy no causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Energy returns and Govt. Bonds ( $f = 3.87415$ ,  $p = 0.0232$ ). For MCX-Agri causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Agri returns and Govt. Bonds ( $f = 0.84232$ ,  $p = 0.0232$ ). This signifies that causality is running from Govt. Bonds to MCX-Agri. Thus the Govt. Bonds do Granger cause MCX-Agri. Any change in Govt. Bonds can be used to predict volatility in returns of MCX-Agri index. There is no any bidirectional relationship among the macroeconomic determinants and commodity market indices.

The Granger causality test result in Table 31 shows two ways causal relationship among volatility in different commodity indices returns and Consumer price index. No causal relationship in the form of granger causality has been observed in relationship between volatility in Nkrishi index returns and Consumer price index ( $F = 0.07964$ ,  $p = 0.9235$ ). For MCX-Comdex no causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Comdex returns and Consumer price index ( $F = 1.05988$ ,  $p = 0.3520$ ).

**Table 31: Granger Causality test of Commodity Market Indices with CPI**

Null Hypothesis	Observation	F-Statistic	p Value
NKRISHI Volatility does not Granger Cause CPI	72	0.07964	0.9235
CPI does not Granger Cause Volatility in NKRISHI	72	0.12223	0.8851
MCX-COMDEX Volatility does not Granger Cause CPI	75	1.05988	0.3520
CPI does not Granger Cause Volatility in MCX-COMDEX	75	0.26143	0.7707
MCX-METAL Volatility does not Granger Cause CPI	75	3.62812	0.0317
CPI does not Granger Cause in MCX-METAL	75	1.81062	0.1711
MCX-ENERGY Volatility does not Granger Cause CPI	75	0.52107	0.5962
CPI does not Granger Cause Volatility in MCX-ENERGY	75	0.52229	0.5955
MCX- Agri Volatility does not Granger Cause CPI	75	0.54574	0.5819
CPI does not Granger Cause Volatility in MCX-Agri	75	1.63933	0.2015

For MCX-Metal significant causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Metal returns and Consumer price index ( $F = 3.62812$ ,  $p = 0.0317$ ). This states that causality is running from MCX-Metal to Consumer price index. Thus the MCX-Metal does Granger cause Consumer price index. Any change in the volatility in returns of MCX-Metal index can be used to predict the flow of Consumer price index. There is no any bidirectional relationship among the macroeconomic determinants and commodity market indices. For MCX-Energy no causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Energy returns and Consumer price index ( $F = 0.52107$ ,  $p = 0.5962$ ). For MCX-Agri no causal relationship in the form of granger causality has been observed in relationship between volatility in MCX-Agri returns and Consumer price index ( $F = 0.54574$ ,  $p = 0.5819$ ).

The table 32 depicts the results of multiple regression analysis for commodity market indices namely Nkrishi, MCX-Comdex, MCX-Metal, MCX-Energy and MCX-Agri. In these models the dependent variable is volatility in specific index and independent variable includes GDP growth rate, Consumer price index and market interest rates. To estimate proportion of variance in volatility of Nkrishi index return that can be accounted by GDP growth rate, Consumer price index and market interest rates, a standard multiple regression analysis was performed. In combination, the selected independent variables account for significant 9.0 % of variability in volatility of Nkrishi ( $R^2 = 0.0907$ ,  $F = 2.462199$ ,  $p = 0.069154$ ). Unstandardized regression coefficients along with their significance test for each particular in regression model are reported in table 28. It can be seen that all selected macroeconomic variables namely GDP growth rate, Consumer price index and market interest rates are insignificant at 5% significance level. In combination, the selected independent variables account for significant 1.26 % of variability in volatility of MCX-Comdex ( $R^2 = 0.01026$ ,  $F = 0.265182$ ,  $p = 0.850287$ ). It can be seen that all selected macroeconomic variables namely GDP growth rate, Consumer price index and market interest rates are found to be insignificant at 5% significance level.

In combination, the selected independent variables account for significant 6.9 % of variability in volatility of MCX-Metal ( $R^2 = 0.069603$ ,  $F = 1.920136$ ,  $p = 0.133309$ ). Unstandardized regression coefficients along with their significance test for each particular in regression model are reported in the table. It can be seen that CPI is found to be significant at 5% significance level but same is not true for GDP growth rate and market interest rates. In combination, the selected independent variables account for significant 19.52 % of variability in volatility of MCX-Energy ( $R^2 = 0.195287$ ,  $F = 6.228443$ ,  $p = 0.000764$ ).

**Table 32: Impact of Macro Economic Variables on Volatility in Commodity Market Indices**

	Nkrishi		MCX Comdex		MCX Metal		MCX Energy		MCX Agri	
	<b>b</b>	<b>t (p value)</b>	<b>b</b>	<b>t (p value)</b>	<b>b</b>	<b>t (p value)</b>	<b>b</b>	<b>t (p value)</b>	<b>b</b>	<b>t (p value)</b>
Intercept	0.015276	3.647689 (0.0005)	0.010941	1.669241 (0.0991)	0.000971	0.126849 (0.8994)	0.023295	1.606146 (0.1123)	0.007878	1.014137 (0.3137)
CPI	-0.011190	-1.451575 (0.1508)	0.009169	0.415870 (0.6787)	0.025437	-0.948799 (0.0454)	0.100755	2.065369 (0.0423)	0.029719	2.340793 (0.0218)
GDP Growth rate	0.009354	0.648291 (0.5188)	- 0.006273	-0.585531 (0.5599)	- 0.024420	2.033 961 (0.3457)	-0.084575	-3.567936 (0.0006)	0.040310	1.542754 (0.1270)
Govt Bonds	-0.001002	-2.266195 (0.0264)	- 0.000413	-0.577200 (0.5655)	0.000869	1.040849	-0.001132	-0.715340 (0.4766)	- 0.000597	-0.704735 (0.4831)
f value	2.462199 (0.069154)		0.265182 (0.850287)		1.920136 (0.133309)		6.228443 (0.000764)		3.533278 (0.018614)	
R <sup>2</sup>	0.090759		0.010226		0.069603		0.195279		0.121003	

Unstandardized regression coefficients along with their significance test for each particular in regression model are reported in table states that both CPI and GDP growth rate is found to be significant at 5% significance level but same is not true for market interest rates. In combination, the selected independent variables account for significant 12.10% of variability in volatility of MCX-Energy ( $R^2=0.1210$ ,  $F= 3.533278$ ,  $p=0.018614$ ). Unstandardized regression coefficients along with their significance test for each particular in regression model are reported in table states that both CPI is found to be significant at 5% significance level but same is not true for market interest rates and GDP growth rate.

#### **4.4 Forecasting volatility in Indian Stock and Commodity Markets**

This section includes the results of forecasting volatility in stock and commodity market indices. Volatility has been forecasted using symmetric and asymmetric GARCH models namely GARCH (1, 1), GARCH-M, EGARCH and TGARCH models. The last 20% of the time till 31<sup>st</sup> December, 2018 was used for 'out of sample' forecasting for each of selected indices Before applying GARCH models the series was tested for Stationarity and ARCH effect. The asymmetric and symmetric models were selected on basis of AIC and SIC model selection criteria.

Table 33 depicts the out of the sample analysis of GARCH models on Nifty 50. In this, volatility of Nifty 50 index return has been tested using the symmetric and asymmetric GARCH models. The daily closing prices of Nifty 50 index for the time period November 1995 to December 2018 have been used and modeled using four different GARCH models that capture the volatility clustering and leverage effect for the study period. GARCH (1, 1), GARCH-M (1, 1), EGARCH (1, 1), and TGARCH (1, 1) models are employed in the study after confirming the unit root test, volatility clustering and ARCH effect. The asymmetric coefficient  $\gamma$  (0.965355) in the EGARCH model indicate that the Nifty 50 returns exhibit statistically significant asymmetric effects at one percent level. This signifies that negative shocks have larger effect on this market than the positive shocks. Similarly, the result of TGARCH(1,1) model reveal that asymmetric effect captured by the parameter estimate  $\delta$  (0.862076) is greater than zero signifying the occurrence of leverage effect, i.e. the volatility to negative innovations is larger than that of positive innovations.

Finally, to identify the best model among the different specifications of GARCH models, Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) have been used, which depicts that GARCH (1,1) model has been found to be the best model among all to capture the symmetric effect. Further, TGARCH (1, 1) model has been found to be the best model to capture the asymmetric volatility minimum AIC and SIC criterion. Overall, the TGARCH (1, 1) model seems to outperform the GARCH (1, 1) model in capturing the dynamic behavior of emerging stock market returns.

**Table 33: Volatility Model selection - Nifty 50**

	In sample				Out of sample			
	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH
<b>Mean Equation</b>								
C	0.000852 (0.00001)	0.000699 (0.0199)	0.000454 (0.0114)	0.000535 (0.0046)	0.000629 (0.0050)	0.000088 (0.8801)	0.000297 (0.2016)	0.000343 (0.01399)
ARCH	0.081840 (0.0001)	0.081996 (0.0001)	0.088376 (0.000)	0.089011 (0.000)	0.081657 (0.0162)	0.082186 (0.0162)	0.106312 (0.0013)	0.106218 (0.0022)
GARCH		0.887149 (0.5451)				8.871444 (0.3172)		
<b>Variance Equation</b>								
C	0.0000052 (0.0001)	0.000052 (0.0001)	-0.467044 (0.0001)	0.0000062 (0.0001)	0.000017 (0.0116)	0.0000018 (0.0110)	-0.620406 (0.0001)	0.000004 (0.0001)
ARCH	0.116608 (0.0001)	0.116819 (0.0001)	0.227294 (0.0001)	0.064399 (0.0001)	0.062219 (0.0001)	0.064785 (0.0001)	0.095872 (0.0002)	-0.010248 (0.3653)
GARCH	0.869219 (0.0001)	0.868924 (0.0001)	-0.081081 (0.0001)	0.108415 (0.0001)	0.916199 (0.0001)	0.911363 (0.0001)	-0.153330 (0.0001)	0.174134 (0.0001)
$\gamma$			0.965355 (0.0001)				0.943412 (0.0001)	
$\delta$		2.028161		0.862076 (0.0001)				0.871451 (0.0001)
AIC	-5.645891	-5.645555	-5.657063	-5.657213	-6.759140	-6.758390	-6.810104	-6.790007
SIC	-5.638910	-5.637178	-5.648686	-5.648836	-6.737256	-6.732128	-6.783843	-6.763745
Durbin Watson	2.029341		2.043505	2.044578	2.001713		2.050972	2.050914

The results of the out of the sample data shows that GARCH (1,1) model has been found to be the best model among all to capture the symmetric effect as per AIC and SIC criterion. Further, EGARCH (1,1) model has been found to be the best model to capture the asymmetric volatility based minimum AIC and SIC criterion. Overall, the EGARCH (1, 1) model seems to outperform the GARCH (1, 1) model in capturing the dynamic behavior of emerging stock market returns in out of the sample data. Concludingly in Nifty 50, GARCH (1, 1) model has been proved to be better model in both in sample and out of the sample data, but there was a conflict between models among asymmetric ones as TGARCH (1, 1) performed better in In sample data as compared to EGARCH(1,1) in out of sample data.

Table 34 depicts the out of the sample analysis of GARCH models on Nifty Midcap 50. The daily closing prices of Nifty Midcap 50 index for the time period January 2004 to December 2018 have been used and modeled using four different GARCH models that capture the volatility clustering and leverage effect for the study period. GARCH (1, 1), GARCH-M (1, 1), EGARCH (1, 1), and TGARCH (1, 1) models are employed in the study after confirming the unit root test, volatility clustering and arch effect. The asymmetric coefficient  $\gamma$  (0.952336) in the EGARCH model indicate that the Nifty Midcap 50 returns exhibit statistically significant asymmetric effects at one percent level. This signifies that negative shocks have larger effect on this market than the positive shocks. Similarly, the result of TGARCH(1,1) model reveal that asymmetric effect captured by the parameter estimate  $\delta$  (0.830743) is greater than zero signifying the occurrence of leverage effect, i.e. the volatility to negative innovations is larger than that of positive innovations.

Finally, to identify the best model among the different specifications of GARCH models, Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) have been used, which depicts that GARCH (1,1) model has been found to be the best model to capture the symmetric effect. Further, TGARCH (1,1) model has been found to be the best fitted model to capture the asymmetric volatility based on the highest log likelihood ratios and minimum AIC and SIC criterion. Overall, the TGARCH (1, 1) model seems to outperform the GARCH (1, 1) model in capturing the dynamic behavior of emerging stock market returns. The results of the out of the sample data shows that GARCH Mean (1,1) model has been found to be the best model among all to capture the symmetric effect. Further, EGARCH (1,1) model has been found to be the best fitted model to capture the asymmetric volatility based on the highest log likelihood ratios and minimum AIC and SIC criterion. Overall, the EGARCH (1, 1) model seems to outperform the GARCH Mean (1, 1) model in capturing the dynamic behavior of emerging stock market returns.

**Table 34: Volatility Model selection -Nifty Midcap 50**

	In sample				Out of sample			
	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH
<b>Mean Equation</b>								
C	0.000829 (0.0010)	0.000621 (0.1280)	0.000367 (0.1442)	0.000425 (0.1073)	0.000968 (0.0361)	-0.000793 (0.4204)	0.000402 (0.3884)	0.000430 (0.3631)
ARCH	0.156698 (0.0001)	0.157697 (0.0001)	0.163739 (0.0001)	0.170327 (0.0001)	0.072034 (0.0827)	0.077006 (0.0663)	0.085616 (0.0184)	0.082353 (0.0220)
GARCH		1.025282 (0.5268)				13.48263 (0.0414)		
<b>Variance Equation</b>								
C	0.0000093 (0.0001)	0.0000093 (0.0001)	-0.589801 (0.0001)	0.000011 (0.0001)	0.000015 (0.0005)	0.0000162 (0.0004)	-1.360584 (0.0001)	0.000014 (0.0001)
ARCH	0.143041 (0.0001)	0.143455 (0.0001)	0.253651 (0.0001)	0.075356 (0.0001)	0.126073 (0.0001)	0.137096 (0.0001)	0.080506 (0.0503)	-0.056241 (0.0050)
GARCH	0.83416 (0.0001)	0.833610 (0.0001)	-0.087971 (0.0001)	0.120262 (0.0001)	0.776365 (0.0001)	0.760377 (0.0001)	-0.249923 (0.0001)	0.253751 (0.0001)
$\gamma$			0.952336 (0.0001)				0.854510 (0.0001)	0.825395 (0.0001)
$\delta$				0.830743 (0.0001)				
AIC	-5.491813	-5.491315	-5.500674	-5.502779	-6.009846	-6.012415	-6.067540	-6.048848
SIC	-5.481741	-5.479228	-5.488587	-5.490692	-5.978753	-5.975104	-6.030228	-6.011536
Durbin Watson	2.014652	2.013886	2.029863	2.042568	2.035899	1.996539	2.065813	2.059371

Concludingly in Nifty Midcap 50, there was a conflict between models among symmetric and asymmetric models, GARCH (1, 1) model has been proved to be better model in sample and GARCH Mean (1, 1) model has been found to be better in out of the sample data, among asymmetric models TGARCH (1, 1) performed better in sample data as compared to EGARCH (1, 1) in out of sample data.

Table 35 depicts the out of the sample analysis of GARCH models on Nifty 500. The daily closing prices of Nifty 500 index for the time period June 1999 to December 2018 have been used and modeled using four different GARCH models that capture the volatility clustering and leverage effect for the study period. GARCH (1, 1), GARCH-M (1, 1), EGARCH (1, 1), and TGARCH (1, 1) models are employed in the study after confirming the unit root test, volatility clustering and arch effect. The asymmetric coefficient  $\gamma$  (0.963060) in the EGARCH model indicate that the Nifty Midcap 50 returns exhibit statistically significant asymmetric effects at one percent level. This signifies that negative shocks have larger effect on this market than the positive shocks. Similarly, the result of TGARCH(1,1) model reveal that asymmetric effect captured by the parameter estimate  $\delta$  (0.852945) is greater than zero signifying the occurrence of leverage effect, i.e. the volatility to negative innovations is larger than that of positive innovations.

Finally, to identify the best model among the different specifications of GARCH models, Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) have been used, which depict that GARCH-in-Mean (1,1) model has been found to be the best model to capture the symmetric effect. Further, EGARCH (1,1) model has been found to be the best fitted model to capture the asymmetric volatility based on the highest log likelihood ratios and minimum AIC and SIC criterion. Overall, the GARCH-in-Mean (1, 1) model seems to outperform the EGARCH (1, 1) model in capturing the dynamic behavior of emerging stock market returns. The results of the out of the sample data shows that EGARCH (1,1) model has been found to be the best model among all to capture the symmetric effect. Concludingly in Nifty 500, GARCH-in Mean (1, 1) model has been proved to be better model in both in sample and out of the sample data and among asymmetric ones EGARCH (1, 1) has been proved to be better model in in and out of sample data.

**Table 35: Volatility Model selection - Nifty 500**

	In sample				Out of sample			
	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH
<b>Mean Equation</b>								
C	0.000964 (0.0001)	-0.000793 (0.4204)	0.000669 (0.0002)	0.000655 (0.0005)	0.000596 (0.0237)	-0.000226 (0.7124)	-0.000009 (0.9709)	9.43E-05 (0.7109)
ARCH	0.124721 (0.0001)	0.077006 (0.0663)	0.141606 (0.0001)	0.138082 (0.0001)	0.096140 (0.0134)	0.099549 (0.0109)	0.141056 (0.0001)	0.132086 (0.0001)
GARCH		13.48263 (0.0414)				13.04006 (0.1408)		
<b>Variance Equation</b>								
C	0.0000047 (0.0001)	0.000016 (0.0004)	-0.514702 (0.0001)	0.0000056 (0.0001)	0.00000455 (0.0014)	0.00000495 (0.0012)	-1.043706 (0.0001)	0.0000054 (0.0001)
ARCH	0.130561 (0.0001)	0.137096 (0.0001)	0.255048 (0.0001)	0.069924 (0.0001)	0.109791 (0.0001)	0.117477 (0.0001)	0.033972 (0.29420)	-0.079306 (0.0001)
GARCH	0.854550 (0.0001)	0.760377 (0.0001)	-0.082427 (0.0001)	0.108601 (0.0001)	0.834822 (0.0001)	0.822299 (0.0001)	-0.291735 (0.0001)	0.320023 (0.0001)
$\gamma$			0.963060 (0.0001)				0.894373 (0.0001)	0.846878 (0.0001)
$\delta$				0.852945 (0.0001)				
AIC	-5.806760	-6.012415	-5.818596	-5.817720	-6.731328	-6.731959	-6.824962	-6.798903
SIC	-5.798716	-5.975104	-5.808944	-5.808067	-6.700269	-6.701888	-6.794892	-6.768833
Durbin Watson	1.987014	1.996539	2.021151	2.014406	2.028560	2.004935	2.119216	2.102668

Table 36 depicts the out of the sample analysis of GARCH models on Nifty Smallcap 50. The daily closing prices of Nifty Smallcap 50 index for the time period April 2005 to December 2018 have been used and modeled using four different GARCH models that capture the volatility clustering and leverage effect for the study period. GARCH (1, 1), GARCH-M (1, 1), EGARCH (1, 1), and TGARCH (1, 1) models are employed in the study after confirming the unit root test, volatility clustering and arch effect. The asymmetric coefficient  $\gamma$  (0.938167) in the EGARCH model indicate that the Nifty Midcap 50 returns exhibit statistically significant asymmetric effects at one percent level. This signifies that negative shocks have larger effect on this market than the positive shocks. Similarly, the result of TGARCH(1,1) model reveal that asymmetric effect captured by the parameter estimate  $\delta$  (0.836854) is greater than zero signifying the occurrence of leverage effect, i.e. the volatility to negative innovations is larger than that of positive innovations.

Finally, to identify the best model among the different specifications of GARCH models, Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) have been used, which depict that GARCH (1,1) model has been found to be the best model to capture the symmetric effect. Further, TGARCH (1,1) model has been found to be the best fitted model to capture the asymmetric volatility based on the highest log likelihood ratios and minimum AIC and SIC criterion. Overall, the TGARCH (1, 1) model seems to outperform the GARCH (1, 1) model in capturing the dynamic behavior of emerging stock market returns. Concludingly in Nifty Midcap 50, there was a conflict between models among symmetric and asymmetric models, GARCH (1, 1) model has been proved to be better model in in sample and GARCH-in- Mean (1, 1) model has been found to be better in out of the sample data, among asymmetric models EGARCH (1, 1) performed better in in sample data as compared to TGARCH (1, 1) in out of sample data.

Table 37 depicts the out of the sample analysis of GARCH models on Nkrishi. The daily closing prices of Nkrishi index for the time period October 2010 to December 2018 have been used and modeled using four different GARCH models that capture the volatility clustering and leverage effect for the study period. GARCH (1, 1), GARCH-M (1, 1), EGARCH (1, 1), and TGARCH (1, 1) models are employed in the study after confirming the unit root test, volatility clustering and ARCH effect. The asymmetric coefficient  $\gamma$  (0.974017) in the EGARCH model indicate that the Nifty Midcap 50 returns exhibit statistically significant asymmetric effects at one percent level. This signifies that negative shocks have larger effect on this market than the positive shocks. Similarly, the result of TGARCH(1,1) model reveal that asymmetric effect captured by the parameter estimate  $\delta$  (-0.246277) is greater than zero signifying the occurrence of leverage effect, i.e. the volatility to negative innovations is larger than that of positive innovations.

**Table 36: Volatility Model selection - Nifty Smallcap 50**

	In sample				Out of sample			
	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH
<b>Mean Equation</b>								
C	0.000748 (0.0048)	-0.000534 (0.5888)	0.000348 (0.1939)	0.000156 (0.7589)	0.000710 (0.1520)	-0.005787 (0.0057)	0.000069 (0.8946)	0.000156 (0.7589)
ARCH	0.189909 (0.0001)	0.192102 (0.0001)	0.204605 (0.0001)	0.180243 (0.0001)	0.132558 (0.0051)	0.156372 (0.0012)	0.171064 (0.0001)	0.180243 (0.0001)
GARCH		0.094424 (0.1767)				0.543460 (0.0018)		
<b>Variance Equation</b>								
C	0.0000123 (0.0001)	1.25E-05 (0.0001)	-0.732052 (0.0001)	0.0000181 (0.0001)	3.98E-05 (0.0001)	3.75E-05 (0.0001)	-1.276482 (0.0001)	0.0000181 (0.0001)
ARCH	0.153429 (0.0001)	0.154859 (0.0001)	0.282831 (0.0001)	-0.127930 (0.0001)	0.222559 (0.0001)	0.235496 (0.0001)	0.037527 (0.2824)	-0.127930 (0.0001)
GARCH	0.810765 (0.0001)	0.808634 (0.0001)	-0.092084 (0.0001)	0.326540 (0.0001)	0.562499 (0.0001)	0.563931 (0.0001)	-0.276391 (0.0001)	0.326540 (0.0001)
$\gamma$			0.938167 (0.0001)				0.858206 (0.0001)	0.836854 (0.0001)
$\delta$				0.836854 (0.0001)				
AIC	-5.531609	-5.531599	-5.542570	-5.932352	-5.876307	-5.886401	-5.942562	-5.932352
SIC	-5.520755	-5.518574	-5.529545	-5.892451	-5.843057	-5.846500	-5.902661	-5.892451
Durbin Watson	2.012933	2.007756	2.044213	2.078081	1.980805	1.901554	2.059776	2.078081

**Table 37: Volatility Model selection -Nkrishi**

	In sample				Out of sample			
	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH
<b>Mean Equation</b>								
C	0.000386 (0.0217)	-0.000277 (0.6187)	0.000443 (0.0087)	0.000186 (0.6301)	0.000154 (0.6684)	-211.3852 (0.7720)	0.000202 (0.6057)	0.000186 (0.6301)
ARCH	0.077646 (0.0020)	0.075883 (0.0026)	0.073906 (0.0029)	-0.046199 (0.3443)	-0.032041 (0.5361)	0.01294 1 (0.7685)	-0.039258 (0.4123)	-0.046199 (0.3443)
GARCH		12.70364 (0.2178)						
<b>Variance Equation</b>								
C	1.58E-06 (0.0019)	5.96E-05 (0.0001)	-0.341936 (0.0004)	7.39E-05 (0.0001)	1.17E-06 (0.0339)	5.96E-05 (0.0001)	-5.781057 (0.1407)	7.39E-05 (0.0001)
ARCH	0.05595 6 (0.000)	0.013654 (0.7643)	0.111743 (0.0001)	-0.071072 (0.1801)	0.019290 (0.1898)	0.01365 4 (0.7643)	-0.063609 (0.5312)	-0.071072 (0.1801)
GARCH	0.916828 (0.000)		0.021849 (0.0153)	0.199379 (0.0413)	0.963353 (0.0001)		-0.097705 (0.1387)	0.199379 (0.0413)
$\gamma$			0.97401 7 (0.0001)				0.400145 (0.3236)	-0.246277 (0.4099)
$\delta$				-0.246277 (0.4099)				
AIC	-6.985715	-6.859693	-6.993075	-6.861363	-6.872886	-6.859693	-6.856272	-6.861363
SIC	-6.970552	-6.823471	-6.974881	-6.806939	-6.827533	-6.823471	-6.801848	-6.806939
Durbin Watson	2.006957	2.058859	1.999316	1.967447	1.996031	2.058859	1.981447	1.967447

Finally, to identify the best model among the different specifications of GARCH models, Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) have been used, which depict that GARCH (1,1) model has been found to be the best model to capture the symmetric effect. Further, EGARCH (1,1) model has been found to be the best fitted model to capture the asymmetric volatility based on the highest log likelihood ratios and minimum AIC and SIC criterion. Overall, the EGARCH (1, 1) model seems to outperform the GARCH (1, 1) model in capturing the dynamic behavior of emerging stock market returns. The results of the out of the sample data shows that GARCH (1,1) model has been found to be the best model among all to capture the symmetric effect. Concludingly in Nkrishi, GARCH-in Mean (1, 1) model has been proved to be better model in both in sample and out of the sample data but there was a conflict between models among asymmetric ones as EGARCH (1, 1) performed better in sample data as compared to TGARCH(1,1) in out of sample data.

Table 38 depicts the out of the sample analysis of GARCH models on MCX Comdex. The daily closing prices of MCX Comdex index for the time period May 2006 to December 2018 have been used and modelled using four different GARCH models that capture the volatility clustering and leverage effect for the study period. GARCH (1, 1), GARCH-M (1, 1), EGARCH (1, 1), and TGARCH (1, 1) models are employed in the study after confirming the unit root test, volatility clustering and ARCH effect. The asymmetric coefficient  $\gamma$  (0.984452) in the EGARCH model indicate that the Nifty Midcap 50 returns exhibit statistically significant asymmetric effects at one percent level. This signifies that negative shocks have larger effect on this market than the positive shocks. Similarly, the result of TGARCH(1,1) model reveal that asymmetric effect captured by the parameter estimate  $\delta$  (0.968671) is greater than zero signifying the occurrence of leverage effect, i.e. the volatility to negative innovations is larger than that of positive innovations.

Finally, to identify the best model among the different specifications of GARCH models, Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) have been used, which depict that GARCH-in-mean (1,1) model has been found to be the best model to capture the symmetric effect. Further, EGARCH (1,1) model has been found to be the best fitted model to capture the asymmetric volatility based on the highest log likelihood ratios and minimum AIC and SIC criterion. Overall, the EGARCH (1, 1) model seems to outperform the GARCH (1, 1) model in capturing the dynamic behavior of emerging stock market returns. The results of the out of the sample data shows that GARCH (1,1) model has been found to be the best model among all to capture the symmetric effect. Concludingly in MCX Comdex, GARCH (1, 1) model has been found to be best model in both in sample and out of sample data and among symmetric ones EGARCH (1, 1) has been proved to be better model in both in sample and out of the sample data.

**Table 38: Volatility Model selection -MCX Comdex**

	In sample				Out of sample			
	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH
<b>Mean Equation</b>								
<b>C</b>	0.000107 (0.4867)	0.000184 (0.5263)	0.000106 (0.4887)	0.000361 (0.1870)	0.000392 (0.1491)	0.001887 (0.1332)	0.000386 (0.1583)	0.000361 (0.1870)
<b>ARCH</b>	0.04057 3 (0.0331)	0.040445 (0.0336)	0.037929 (0.0406)	-0.011291 (0.7718)	-0.009311 (0.8097)	-0.011610 (0.7668)	-0.014428 (0.7077)	-0.011291 (0.7718)
<b>GARCH</b>	-	-1.118224 (0.7485)				-28.87141 (0.2255)		
<b>Variance Equation</b>								
<b>C</b>	1.23E-06 (0.0001)	1.24E-06 (0.0001)	-0.247918 (0.0001)	6.63E-07 (0.1992)	7.89E-07 (0.2048)	1.60E-06 (0.1439)	-0.198593 (0.1102)	6.63E-07 (0.1992)
<b>ARCH</b>	0.061126 (0.0001)	0.061206 (0.1111)	0.136397 (0.0001)	0.013844 (0.2514)	0.022234 (0.0090)	0.029611 (0.0144)	0.043556 (0.0348)	0.013844 (0.2514)
<b>GARCH</b>	0.925911 (0.0001)	0.925797 (0.0001)	-0.012291 (0.0223)	0.009993 (0.4332)	0.96305 7 (0.0001)	0.940379 (0.0001)	-0.013027 (0.2335)	0.009993 (0.4332)
$\gamma$			0.984452 (0.0001)				0.983257 (0.0001)	0.968671 (0.0001)
$\delta$				0.968671 (0.0001)				
<b>AIC</b>	-6.606832	-6.606180	-6.602955	-7.003107	-7.005327	-7.003976	-7.000556	-7.003107
<b>SIC</b>	-6.596535	-6.593823	-6.590598	-6.965153	-6.973698	-6.966021	-6.962602	-6.965153
<b>Durbin Watson</b>	2.037041	2.027827	2.031558	2.026063	2.030090	2.027827	2.019237	2.026063

Table 39 depicts the out of the sample analysis of GARCH models on MCX Metal. The daily closing prices of MCX Metal index for the time period May 2006 to December 2018 have been used and modeled using four different GARCH models that capture the volatility clustering and leverage effect for the study period. GARCH (1, 1), GARCH-M (1, 1), EGARCH (1, 1), and TGARCH (1, 1) models are employed in the study after confirming the unit root test, volatility clustering and ARCH effect. The asymmetric coefficient  $\gamma$  (0.984452) in the EGARCH model indicate that the Nifty Midcap 50 returns exhibit statistically significant asymmetric effects at one percent level. This signifies that negative shocks have larger effect on this market than the positive shocks. Similarly, the result of TGARCH(1,1) model reveal that asymmetric effect captured by the parameter estimate  $\delta$  (0.968671) is greater than zero signifying the occurrence of leverage effect, i.e. the volatility to negative innovations is larger than that of positive innovations.

Finally, to identify the best model among the different specifications of GARCH models, Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) have been used, which depict that GARCH (1,1) model has been found to be the best model to capture the symmetric effect. Further, TGARCH (1,1) model has been found to be the best fitted model to capture the asymmetric volatility based on the highest log likelihood ratios and minimum AIC and SIC criterion. Overall, the TGARCH (1, 1) model seems to outperform the GARCH (1, 1) model in capturing the dynamic behavior of emerging stock market returns. The results of the out of the sample data shows that TGARCH (1,1) model has been found to be the best model among all to capture the symmetric effect. Concludingly in MCX Metal, GARCH (1, 1) model has been found to be best model in both in sample and out of sample data and among symmetric ones TGARCH (1, 1) has been proved to be better model in both in sample and out of the sample data.

Table 39: Volatility Model selection - MCX Metal

	In sample				Out of sample			
	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH
<b>Mean Equation</b>								
<b>C</b>	0.000211 (0.4224)	0.000107 (0.7382)	0.000182 (0.4923)	0.000145 (0.5791)	0.000174 (0.5084)	-0.000398 (0.9035)	0.000182 (0.4923)	0.000145 (0.5791)
<b>ARCH</b>	-0.021131 (0.5580)	-0.016948 (0.3554)	-0.009601 (0.8117)	-0.011062 (0.7676)	-0.020437 (0.5705)	-0.023542 (0.5125)	-0.009601 (0.8117)	-0.011062 (0.7676)
<b>GARCH</b>		0.672956 (0.8357)				11.3963 (0.8614)		
<b>Variance Equation</b>								
<b>C</b>	3.70E-05 (0.1734)	1.86E-06 (0.0001)	-0.908729 (0.1050)	5.16E-06 (0.0076)	8.11E-05 (0.0001)	4.31E-05 (0.1986)	-0.908729 (0.1050)	5.16E-06 (0.0076)
<b>ARCH</b>	-0.041628 (0.0590)	0.063106 (0.0001)	0.025008 (0.4758)	0.036933 (0.0951)	-0.040746 (0.0714)	-0.043035 (0.0705)	0.025008 (0.4758)	0.036933 (0.0951)
<b>GARCH</b>	0.308861 (0.5622)	0.920662 (0.0001)	0.051995 (0.0411)	-0.091509 (0.0014)	-0.572428 (0.0666)	0.18686(0.7 778)	0.051995 (0.0411)	-0.091509 (0.0014)
$\gamma$			0.910330 (0.0001)				0.910330 (0.0001)	0.904590 (0.0001)
$\delta$				0.904590 (0.0001)				
<b>AIC</b>	-7.044380	-6.518872	-7.049133	-7.058682	-7.048404	-7.045568	-7.049133	-7.058682
<b>SIC</b>	-7.012785	-6.508619	-7.011220	-7.020769	-7.016776	-7.007614	-7.011220	-7.020769
<b>Durbin Watson</b>	1.981213	2.029454	2.005171	2.002013		1.979823	2.005171	2.002013

Table 40 depicts the out of the sample analysis of GARCH models on MCX Energy. The daily closing prices of MCX Metal index for the time period May 2006 to December 2018 have been used and modeled using four different GARCH models that capture the volatility clustering and leverage effect for the study period. GARCH (1, 1), GARCH-M (1, 1), EGARCH (1, 1), and TGARCH (1, 1) models are employed in the study after confirming the unit root test, volatility clustering and ARCH effect. The asymmetric coefficient  $\gamma$  (0.990348) in the EGARCH model indicate that the Nifty Midcap 50 returns exhibit statistically significant asymmetric effects at one percent level. This signifies that negative shocks have larger effect on this market than the positive shocks. Similarly, the result of TGARCH(1,1) model reveal that asymmetric effect captured by the parameter estimate  $\delta$  (0.947611) is greater than zero signifying the occurrence of leverage effect, i.e. the volatility to negative innovations is larger than that of positive innovations.

Finally, to identify the best model among the different specifications of GARCH models, Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) have been used, which depict that GARCH (1,1) model has been found to be the best model to capture the symmetric effect. Further, TGARCH (1,1) model has been found to be the best fitted model to capture the asymmetric volatility based on the highest log likelihood ratios and minimum AIC and SIC criterion. Overall, the TGARCH (1, 1) model seems to outperform the GARCH (1, 1) model in capturing the dynamic behavior of emerging stock market returns. The results of the out of the sample data shows that TGARCH (1,1) model has been found to be the best model among all to capture the symmetric effect. Concludingly in MCX Energy, GARCH (1, 1) model has been found to be best model in both in sample and out of sample data but there was a conflict between models among asymmetric ones as TGARCH (1, 1) performed better in sample data as compared to EGARCH(1,1) in out of sample data.

**Table 40: Volatility Model selection - MCX Energy**

	In sample				Out of sample			
	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH	GARCH (1,1)	GARCH Mean	EGARCH	TGARCH
<b>Mean Equation</b>								
C	0.000123 (0.6133)	0.000234 (0.5739)	-2.64E-05 (0.9122)	2.98E-05 (0.9039)	-0.007517 (0.0740)	-0.000273 (0.8634)	0.000509 (0.3764)	0.000599 (0.3049)
ARCH	0.065436 (0.0004)	0.065409 (0.0004)	0.061276 (0.0008)	0.062656 (0.0007)	0.005598 (0.8941)	0.013790 (0.7384)	0.008199 (0.8332)	0.009266 (0.8173)
GARCH		-0.632630 (0.7388)				4.251602(0.4 919)		
<b>Variance Equation</b>								
C	1.56E-06 (0.0001)	1.57E-06	-0.162127 (0.0001)	1.56E-06 (0.0001)	0.000234 (0.0001)	0.000236 (0.0001)	-0.316101 (0.0065)	7.91E-06 (0.0287)
ARCH	0.04930 0 (0.0001)	0.049380	0.108144 (0.0001)	0.035154 (0.0001)	0.134079 (0.0007)	0.130713 (0.0001)	0.099379 (0.0008)	0.024492 (0.1406)
GARCH	0.945774 (0.0001)	0.945668	-0.023935 (0.0001)	0.023703 (0.0008)			-0.058716 (0.0025)	0.061602 (0.0164)
$\gamma$			0.990348 (0.0001)				0.971055 (0.0001)	0.914397 (0.0001)
$\delta$				0.947611 (0.0001)				
AIC	-5.619955	-5.619303	-5.618732	-5.621528	-5.382141	-5.381379	-5.436078	-5.431526
SIC	-5.609658	-5.606946	-5.606375	-5.609172	-5.350512	-5.356103	-5.398123	-5.393572
Durbin Watson	2.018376	2.019451	2.010215	2.012944	2.048160	2.038325	2.072791	2.075063

#### 4.5 Perception of market participants regarding volatility in Indian stock and commodity markets

This section includes the results of the perception of market participants namely stock and commodity brokers and traders regarding volatility in stock and commodity markets. Perception of the market participants has been observed using the primary data.

Table 41 depicts the demographic profile of the Stock brokers. It can be seen from the table that out of the sample of 50 stock brokers, 17 brokers (34%) belonged to age group of 30-40 years, followed by 16 (32%) investors in the age group of 40-50 years. Therefore approximately (66 %) of the stock brokers belonged to age group 30-50. The proportion of the brokers either belonging to the age group of greater than 50 years is 8%. In the sample of stock brokers there were 42(84%) males and 8 (16%) females. With respect to marital status 40 (80%) respondents were married and 10 (20%) were unmarried. As far as educational qualification is concerned out of sample of 50 respondents, 28 (56%) were graduate, 16 (32%) were post graduate and 2(4%) were professional. Whereas 4 (8%) were senior secondary. As per the sample characteristics, it can be inferred that most of the stock brokers were males, mature (in the age group of 30-40), majority were graduates, and married.

**Table 41: Demographic Characteristics of Stock Brokers (n=50)**

Demographic Parameters	Class	Frequency	Cumulative Frequency	Percent
Age (in Years)	20-Less than 30	13	13	26
	30-Less than 40	17	30	34
	40- Less than 50	16	46	50
	50-Less than 60	4		8
Gender	Male	42	42	84
	Female	8	50	16
Marital Status	Married	40	40	80
	Unmarried	10	50	20
Highest Educational Qualification	Senior Secondary	4	4	8
	Graduate	28	32	56
	Post Graduate	16	48	32
	Professional	2	50	4
Family Size	3	07	07	14
	4	20	27	40
	5	14	41	28
	6	9	50	18

Table 42 depicts economic profile of the stock brokers. Majority of the brokers 46% under survey reported income less than 50000, followed by 20% brokers with income 50,000 - less than1,00,000. There were 10% brokers who reported income of 200000 & above. There were only 10% traders who reported their income between 150000 -<200000. Out of the total sample under survey 80% of brokers reported less than Rs.150000 monthly income. There were 20% brokers who reported more than Rs Rs.150000 as their monthly income.

**Table 42: Economic Profile of Stock Brokers (n=50)**

<b>Economic Parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative Frequency</b>	<b>Percent</b>
Monthly Income (in INR)	Less than 50,000	23	23	46
	50,000 - less than1,00,000	10	33	20
	1,00,000- Less than 1,50,000	7	40	14
	More than 2,00,000	5	45	10
	200000 Above	5	50	10
Starting year of brokerage business	1996-2000	2	2	4
	2001-2005	5	7	10
	2006-2010	13	20	26
	2011-2015	18	38	36
	2016-2019	12	50	24

Table 43 depicts the Business characteristics of the stock brokers. Majority of the stock brokers (64%) were not having broking as their inherited business. Out of the total sample 54% of the brokers were found to be involved in both self trading and servicing clients. It was found that 58% of the stock brokers provide service in commodity also. Majority of the stock brokers deals in both online and offline trading. About 50% of the respondents operate in both primary and secondary markets followed by 42% who only operates in secondary markets. 28% of the stock brokers were found to believe that day trading best describes trader's personality followed by 20% stock brokers who believes positional traders best describes investor's investing or trader's personality. Majority of the brokers (42%) were having clients less than 50 followed by 32% having clients between 50-100. Only 14% of brokers were having clients between 150-200. Day traders were found to be the best clients in terms of value (40%) and in terms of no. of trades (50%). From investing objective as per stock brokers long term wealth maximization is the major objective of client (54%) followed by capital appreciation (26%) and dividend (20%). In terms of risk tolerance according to respondents majority of clients are moderate risk taker (64%) followed by low risk (20%) and high risk (16%).

**Table 43: Business Characteristics of Stock Brokers (n=50)**

<b>Business Parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative frequency</b>	<b>Percent</b>
Inherited Business	Yes	13	13	26
	No	37	50	64
Involved in	Self Trading	8	8	16
	Servicing Clients	15	23	30
	Both	27	50	54
Provide Service in Commodity Also	Yes	29	29	58
	No	21	50	42
Kind of trading offered	Online	16	16	32
	Offline	4	20	8
	Both	30	50	60
Market in which broker is dealing	Primary	4	4	8
	Secondary	21	25	42
	Both	25	50	50
What best describe investor's investing/ trading personality	Positional trader	10	10	20
	Day Trader	14	24	28
	Long Term Investor	11	35	22
No. of Clients	0- Less than50	21	21	42
	50- Less than100	16	37	32
	100- Less than 150	6	43	12
	150- Less Than 200	7	50	14
Top 10 clients in terms of value	Positional Traders	15	15	30
	Day Traders	20	35	40
	Long term Investors	15	50	30
Top 10 clients in terms of number of trades	Positional Traders	15	15	30
	Day Traders	25	40	50
	Long term Investors	10	50	20
Major objective of clients	Capital appreciation	13	13	26
	Long term wealth	27	40	54
	Dividend	10	50	20
Risk Tolerance of client	Low	10	10	20
	Moderate	32	42	64
	High	8	50	16

Table 44 depicts the importance of source of information for stock brokers. Sources of information play a dominant role in stock selection criteria, as not only they provide information regarding the other factors influencing the stock selection, but also they themselves act as stock selection criteria. From the various sources of trading information Company announcements was found to be most important source of information by the stock brokers (Mean=4.62, S.D = 0.567). The second important source of information was stock exchange announcements (Mean= 4.48, S.D= 0.762) followed by commodity exchange announcements (Mean=4.04, S.D. =0.875). The source of information which was least in importance is others (Friends and relatives) (Mean=2.68, S.D=1.115).

**Table 44: Importance of source of Information for stock Brokers**

S. No.	Source of Information	Mean	S.D	t value	p value
1	Newspaper	4.36	.898	10.708	.001
2	Journals and Magazines	3.82	.941	6.162	.001
3	TV Channels	4.36	1.025	9.379	.001
4	Investments related websites	4.02	.937	7.701	.001
5	Brokers / analysts forecast	4.12	.918	8.628	.001
6	Investor forum	3.48	1.074	3.161	.003
7	Technical analysis	4.40	.728	13.590	.001
8	Company announcements	4.62	.567	20.186	.001
9	Stock exchange announcements	4.48	.762	13.727	.001
10	Others (Friends, relatives etc)	2.68	1.115	-2.030	.048
11	Investment blogs	3.28	1.356	1.460	.151

Table 45 depicts the perception of stock brokers regarding volatility in stock markets. From the given statements regarding volatility the statement ‘volatility has been rising in the stock market’ was found to be highly perceived statement (Mean= 4.54, S.D.= 0.646) followed by the statement ‘Volatility offers good opportunities for traders’. The least perceived statement was found to be “There is more volatility in stock market as compared to commodity markets’ (Mean= 3.38, S.D. 1.176).

**Table 45: Perception of stock brokers regarding volatility in stock markets (n=50)**

S.No	Statement	Mean	S.D	t value	p Value
1	Volatility has been rising in stock market	4.54	.646	16.868	.001
2	Overall markets are calm in nature but there are incidences of high volatility	3.78	.910	6.061	.001
3	Volatility affects future returns	3.96	.727	9.333	.001
4	Volatility offers good opportunities for traders	4.22	.840	10.269	.001
5	Technical analyst can make use of this volatility in generating good returns	3.90	.974	6.533	.001
6	There is more volatility in stock market as compared to commodity markets.	3.38	1.176	2.285	.027
7	With increasing technical innovations in stock market, volatility is rising	4.18	.720	11.594	.001
8	New methods of trading like algorithmic trading, increases volatility	3.78	.910	6.061	.001
9	Volatility is not good for long term investors	3.46	1.182	2.753	.008
10	Volatility is rightly captured in Indian VIX	3.86	.904	6.729	.001
11	Derivatives help in generating good return due to volatility	3.84	.912	6.516	.001
12	Largely on an average my clients have earned good returns due to increasing volatility	3.68	1.039	4.629	.001
13	I feel that this volatility will increase more in future	4.16	.842	9.744	.001
14	I desire that regulators should devise more measures to contain volatility	3.88	1.023	6.083	.001

Table 46 depicts the Demographic Characteristics of Stock traders. It can be seen from the table that out of the sample of 100 stock traders, 42% of the traders belonged to age group of 30-40 years, followed by 23% traders in the age group of 40-50 years. Therefore approximately (61%) of the stock traders belonged to age group 30-50. The proportion of the traders either belonging to the age group of greater than 50 years is 16%.

In the sample of stock traders there were 75% male and 25% female respondents. With respect to marital status 79% respondents were married and 21% were unmarried. As far as educational qualification is concerned out of sample of 100 respondents, 58% were graduate, 20% were post graduate and 17% were professional, whereas 5% were senior secondary. Out of the total sample 85% respondents were found to have their own house and 15% were found to have rented house.

**Table 46: Demographic Characteristics of Stock traders (n=100)**

<b>Demographic Parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative frequency</b>	<b>Percent</b>
Age (in Years)	20- Less than30	19	19	19
	30- Less than 40	42	61	42
	40- Less than 50	23	84	23
	50- Less than 60	16	100	16
Gender	Male	75	75	75
	Female	25	100	25
Marital Status	Married	79	79	79
	Unmarried	21	100	21
Highest Educational Qualification	Senior Secondary	5	5	5
	Graduate	58	63	58
	Post Graduate	20	83	20
	Professional	17	100	17
Family Size	4	43	43	43
	5	43	86	43
	6	14	100	14
House ownership	Own	85	85	85
	Rented	15	100	15

Table 47 depicts the economic characteristics of the stock traders. Out of the total sample 34% respondents under survey reported income between 50,000- Less than1, 00,000, followed by 30% traders with income less than 50,000. There were 16% traders who reported income of 1, 50,000 – Less than 2,00,000. There were only 8% traders who reported their income above 2, 00,000. Out of the total sample under survey 76% of brokers reported less than Rs.150000 monthly income. There were 24% brokers who reported more than Rs.150000 as their monthly income.

**Table 47: Economic characteristics of the stock traders (n=100)**

<b>Economic Parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative frequency</b>	<b>Percent</b>
Monthly Income (in Rs.)	Less than 50,000	30	30	30
	50,000- Less than1,00,000	34	64	34
	1,00,000- Less than1,50,000	12	76	12
	150000- Less than 2,00,000	16	92	16
	Above 2,00,000	8	100	8

Table 48 depicts the business characteristics of the stock traders. Majority of the commodity traders (47%) describes themselves as Day traders. Out of the total sample 35% of the traders were positional traders and 18% of traders were program traders. The respondents were asked about their trading experience. Majority of the traders were having trading experience of 3 to 5 years. Out of the total sample 46% of the traders were having trade experience between 3-5 years followed by 40% of the traders having experience of experience of more than 5 years. There were 14% traders who were experts having experience of less than 3 years. Out of the total sample 60% of the respondents do every day trading 20% traders who do trading at multiple times and every week. Majority of the respondents (67%) use their own money as a source of finance.

Out of the total sample Majority (44%) of the traders do trading as a source of additional income and to earn additional income. There were 28% traders who opted trading as profession, followed by 24% traders who do trading for knowledge gaining and only 4% of the traders do trading for other objectives like time pass. Out of the total sample the goal of majority (37%) of the traders is to grow significantly, followed by 26% whose goal of trading is to have aggressive wealth creation. There were 23% of the traders who aims to grow with caution, 14% aim to grow moderately. Out of the total sample majority (52%) of the investor's trades in 10- less than 20 companies, followed by 28% traders who trade in less than 10 companies and 20% traders were dealing in more than 20 companies.

The respondents were asked about their risk return profile. Out of the total sample 61% of the respondents were interested in moderate risk and moderate return followed by 23% traders who were interested in high risk and high return investments and 16% traders were such who were interested in investments with low risk and low return. Out of the sample 71% of the respondents use online mode of trading followed by 29% respondents who use both online and offline mode of trading for trading purpose. Traders were asked about their trading volume in a day. Out of the sample majority (43%) of the traders have trading volume of 5 lakh- 10 lakh a day followed by 38% traders with trading volume of less than 5 lakh per day. There were 16% traders who were having trading volume of 10-15 lakh. Only 3% of the traders were having trading volume of more than 20 lakh per day.

Traders in the market are having different expectations from their trading activities. Majority of the traders (28%) out of the total sample want to To generally keep pace with the stock market, followed by 24% of the traders who want to To slightly trail the stock market, but make a good profit and 22% who want to trail the stock market, but make a moderate profit. Out of the total sample most of the traders (75%) expect 12-24% return on their investment. There were 19% traders who expect To trail the stock market, but make a moderate profit followed by 6 % traders who expect less than 12% on their investments.

Traders were also asked about the reasons behind choosing a particular exchange for their trading activities. Most of the traders (48%) make their decision on the basis of transparency provided by the exchanges, followed by those who More liquid market (27%). There were 18% traders who make decision of exchange on the basis of Better broker services. Out of total sample 7% of the traders prefer exchanges with long trading hours.

**Table 48: Business Characteristics of Stock Traders (n=100)**

<b>Business Parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative Percent</b>	<b>Percent</b>
Description of stock trader	Positional trader	35	35	35
	Day trader	47	82	47
	Program trader	18	100	18
Trading Experience	Less than 3 years	14	14	14
	3-5 years	46	60	46
	5 years & above	40	100	40
Frequency of trading	Multiplies times in a day	20	20	20
	Everyday	60	80	60
	Every week	20	100	20
Source of Finance For Trading	Own Money	67	67	67
	Margin Money	33	100	33
Trading Motivation	Profession	28	28	28
	Additional Income	44	72	44
	Knowledge Gaining	24	96	24
	Other Objective	04	100	04
Goal for stock trading	Aggressive wealth creation	26	26	26
	to grow significantly	37	63	37
	to grow moderately	14	77	14
	to grow with caution	23	100	23
Number of companies in which trading is carried out	Less than 10	28	28	28
	10- less than 20	52	80	52
	20 & above	20	100	20
Risk return Profile	High risk High return	23	23	23
	Moderate risk moderate return	61	84	61
	Low risk Low Return	16	100	16
Most Frequent Mode of Trading	Online	71	71	71
	Offline	29	100	29

<b>Business Parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative Percent</b>	<b>Percent</b>
Trading Volume Per day (in Rs.)	Less than 5 lakh	38	38	38
	5-Less than10 Lakh	43	81	43
	10- Less than15 Lakh	16	97	16
	20Lakh and above	03	100	03
Assuming Normal market condition expectation from trading over time	To outperform the market	10	10	10
	To generally keep pace with the stock market	28	38	28
	To slightly trail the stock market, but make a good profit	24	62	24
	To trail the stock market, but make a moderate profit	22	74	22
	To have some stability, but make modest profits	16	100	16
Expected Rate of return Per annum	Less than 12%	06	06	06
	12%-24%	75	81	75
	24%-36%	19	100	19
Reasons for choosing Particular stock exchange	More liquid market	27	27	27
	Transparent market	48	75	48
	Longer trading hours	07	82	07
	Better broker services	17	100	18

Table 49 depicts the stock trader's preference for financial asset. Out of the total sample 27.1% of the stock traders prefer stock as an asset, followed by stock option (20.8%), Index futures (20.1%). Around 16 % of the stock traders prefer stock future and index options for investment. So we found mixed results about the preference for a particular financial asset.

**Table 49: Preference of stock traders for financial asset (n=100)**

<b>Financial Asset</b>	<b>Response No.</b>	<b>Response %</b>	<b>Cumulative Frequency</b>
Stock	73	27.1	73
Stock options	56	20.8	56
Stock futures	42	16.6	42
Index futures	54	20.1	54
Index options	44	16.4	44

Table 50 depicts the importance of source of information for stock traders. From the various sources of trading information company announcement was treated as most important source of information by the stock traders (Mean=4.50, S.D = 0.595). The second important source of information was Stock Exchange Announcements (Mean= 4.42, S.D= 0.755) followed by newspaper (Mean=4.20, S.D.=0.711). The source of information which was least in importance is others (Friends and relatives) (Mean=2.50, S.D=1.078).

**Table 50: Importance of source of Information for stock traders (n=100)**

S. No.	Source of Information	Mean	S.D	t value	p Value
1	Newspaper	4.20	0.711	16.885	0.001
2	Journals & Magazines	3.25	1.067	2.343	0.021
3	TV Channels	3.81	1.022	7.926	0.001
4	Investments Related Websites	3.92	.939	9.794	0.001
5	Brokers / Analysts Forecast	3.94	.941	9.991	0.001
6	Investor Forum	3.70	.937	7.467	0.001
7	Technical Analysis	4.15	.869	13.235	0.001
8	Company Announcements	4.50	.595	25.228	0.001
9	Stock Exchange Announcements	4.42	.755	18.820	0.001
10	Others (Friends, Relatives etc)	2.50	1.078	-4.639	0.001
11	Investment Blogs	3.07	1.085	.645	0.520
12	Macroeconomic News	3.87	0.837	10.398	0.001
13	Industry News	4.12	0.820	13.659	0.001

Table 51 depicts the perception of stock traders regarding volatility in stock markets. From the given statements regarding volatility the statement ‘volatility has been rising in the stock market’ was found to be highly perceived statement (Mean= 4.23, S.D.= 0.566) followed by the statement ‘Volatility affects future returns’ (Mean= 3.97, S.D.= 0.703). The least perceived statement was found to be “There is more volatility in stock market as compared to commodity markets’ (Mean = 3.47, S.D. = 0.969).

**Table 51: Perception of stock traders regarding volatility in stock market**

S.No	Statement	Mean	S.D	t value	p Value
1	Volatility has been rising in stock market	4.23	0.566	21.733	.001
2	Overall markets are calm in nature but there are incidences of high volatility	3.74	0.906	8.169	.001
3	Volatility affects future returns	3.97	0.703	13.800	.001
4	Volatility offers good opportunities for traders	3.84	0.950	8.838	.001
5	Technical analyst can make use of this volatility in generating good returns	3.82	0.857	9.565	.001
6	There is more volatility in stock market as compared to commodity markets.	3.47	0.969	4.852	.001
7	With increasing technical innovations in stock market, volatility is rising	3.77	0.930	8.275	.001
8	New methods of trading like algorithmic trading, increases volatility	3.78	0.705	11.069	.001
9	Volatility is not good for Long term investors	3.70	0.870	8.042	.001
10	Volatility is rightly captured in Indian VIX	3.61	0.875	6.972	.001
11	Derivatives help in generating good return due to volatility	3.76	0.740	10.268	.001
12	Largely on an average my clients have earned good returns due to increasing volatility	3.56	0.868	6.449	.001
13	I feel that this volatility will increase more in future	3.84	0.735	11.433	.001
14	I desire that regulators should devise more measures to contain volatility	3.74	0.824	8.979	.001

Table 52 depicts the reliance of stock traders on the type of analysis. The stock brokers consider company analysis to be more reliable type of analysis (Mean= 4.09, S.D. = 0.780) followed by technical analysis (Mean= 4.21, S.D. = 0.820). The least reliable analysis from the selected analysis was Behavioral Theories (Mean= 3.25, S.D. = 1.209)

**Table 52: Extent of reliance of stock traders on the type of analysis (n=100)**

S. No	Type of Analysis	Mean value of extent	S.D	t value	p Value
1	Company Analysis	4.09	0.780	13.979	0.001
2	Industry analysis	3.91	0.944	9.642	0.001
3	Macro economic analysis	3.82	0.869	9.436	0.001
4	Technical analysis	4.21	0.820	14.754	0.001
5	Behavioral Theories	3.25	1.209	2.068	0.041

Table 53 depicts the agreement of the stock traders regarding their trading approach. Out of the total sample majority of the stock traders follows the approach that a diversified portfolio reduces risk (Mean= 4.06, S.D. = 0.814), followed by the statement my approach is to be cautious and avoid all risky investment (Mean= 3.98, S.D. = 0.696).

**Table 53: Agreement of traders regarding their trading approach**

S.No	Statement	Mean	S.D	t value	p value
1	My approach is to be cautious and avoid all risky investment	3.98	0.696	14.080	0.000
2	Any trading activity that involves a great deal of risk is not really investments but it is gambling	3.90	0.847	10.627	0.000
3	The more money one has, the more trading risk one can take.	3.58	1.130	5.134	0.001
4	My broker decides the best trading levels for me	3.54	1.114	4.848	0.001
5	The more familiar a trading opportunity is, the less risky it is	3.57	0.998	5.714	0.001
6	A diversified portfolio reduces risk	4.06	0.814	13.018	0.001
7	The older people take lesser trading risk	3.58	0.976	5.941	0.001
8	The need to liquidate quickly prohibits me from considering trading in riskier products'	3.54	0.797	6.778	0.001
9	The higher the trading yield or rate of return, the greater is its associated risk	3.61	0.723	8.434	0.001

Table 54 depicts the demographic profile of the commodity brokers. It can be seen from the table that out of the sample of 50 commodity brokers, 23 brokers (46%) belonged to age group of 40-less than 50 years, followed by 14 (28%) investors in the age group of 30-less than 40 years. Therefore approximately (74%) of the commodity brokers belonged to age group 30-50. The proportion of the brokers either belonging to the age group of greater than 50 years is 8%.

In the sample of commodity brokers there were 45(90%) males and 5 (10%) females. With respect to marital status 38 (76%) respondents were married and 12 (24%) were unmarried. As far as educational qualification is concerned out of sample of 50 respondents, 23 (46%) were graduate, 18 (36%) were post graduate and 6(12%) were professional. Whereas 3 (6%) were senior secondary. As per the sample characteristics, it can be inferred that most of the stock brokers were males, mature (in the age group of 30-40), majority were graduates, and married.

**Table 54: Demographic Characteristics of Commodity Brokers (n=50)**

<b>Demographic Parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative Frequency</b>	<b>Percent</b>
Age (in Years)	30- Less than40	14	14	28
	40- Less than50	23	37	46
	50- Less than60	9	46	18
	60 and above	4	50	8
Gender	Male	45	45	90
	Female	5	50	10
Marital Status	Married	38	38	76
	Unmarried	12	50	24
Highest Educational Qualification	Senior Secondary	3	3	6
	Graduate	23	26	46
	Post Graduate	18	44	36
	Professional	6	50	12
Family Size	3	6	6	12
	4	21	27	42
	5	15	42	30
	6	8	50	16
House Ownership	Own	75	75	75
	Rented	25	100	25

Table 55 depicts the economic profile of the commodity brokers. Majority of the brokers 38% under survey reported income 50000 - less than 100000, followed by 36% brokers with income less than 50,000. There were 10% brokers who reported income of 200000 & above. There were only 4% traders who reported their income between 150000 -< 200000. Out of the total sample under survey 86% of brokers reported less than Rs.150000 monthly income. There were 14% brokers who reported more than Rs Rs.150000 as their monthly income.

**Table 55: Economic profile of the commodity brokers**

<b>Economic Parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative Frequency</b>	<b>Percent</b>
Monthly Income	>50000	18	18	36
	50000-<100000	19	37	38
	100000-<150000	6	43	12
	150000-<200000	2	45	4
	200000 Above	5	50	10

Table 56 depicts the Business Characteristics of Commodity brokers. Majority of the stock brokers (74%) were not having broking as their inherited business. Out of the total sample 68% of the brokers were found to be involved in both self trading and servicing clients. It was found that 66% of the commodity brokers provide service in stock also. Majority of the commodity brokers (74%) deals in both online and offline trading. About 48% of the respondents operate in both primary and secondary markets followed by 44% who only operates in secondary markets. Out of the total 58% of the commodity brokers were found to believe that day trading best describes trader's personality followed by 30% commodity brokers who believes positional traders best describes investor's investing or trader's personality. Majority of the brokers (40%) were having clients less than 50 followed by 28% having clients between 50- 100. Only 8% of brokers were having clients between 150-200. Day traders were found to be the best clients in terms of value (44%) and in terms of no. of trades (52%). From investing objective as per stock brokers capital appreciation is the major objective of client (44%) followed by long term wealth maximization (30%). In terms of risk tolerance according to respondents majority of clients are moderate risk taker (50%) followed by low risk (34%) and high risk (16%).

**Table 56: Business Characteristics of Commodity Brokers (n=50)**

<b>Business Parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative Frequency</b>	<b>Percent</b>
Is this inherited business	Yes	13	13	26
	No	37	50	74
Are you involved in	Self	6	6	12
	Servicing clients	10	16	20
	Both	34	50	68
Do you provide service in stock trading	Yes	33	33	66
	No	17	50	34
what kind of trading do you offer	Online	13	13	26
	Both	37	50	74
In what kind of market do you operate?	Primary Market	4	4	8
	Secondary Market	22	26	44
	Both	24	50	48
If you are involved in trading	Positional Trader	15	15	30
	Day Trader	29	44	38
	Long term Investor	6	50	12
How many clients do you serve	0 - Less than 50	20	20	40
	50 - Less than100	14	34	28
	100-Less than150	8	42	16
	150- Less than 200	4	46	8
	200 & above	4	50	8
what best describes top 10 clients (in terms of value)	Positional Trader	22	22	44
	Day Trader	22	44	44
	Long term Investor	6	50	12
what best describes top 10 clients (in terms of No. of trades)	Positional Trader	20	20	40
	Day Trader	27	47	52
	Long term Investor	3	50	6
Major objective of clients	Capital appreciation	22	22	44
	Long term wealth	15	37	30
	Use commodity market as an alternate investment	13	50	26
Risk tolerance of clients	High	17	17	34
	Moderate	25	42	50
	Low	8	50	16

Table 57 depicts the importance of source of Information for commodity brokers. From the various sources of trading information Technical analysis was treated as most important source of information by the commodity brokers (Mean=4.42, S.D = 0.642). The second important source of information was company announcements (Mean= 4.30, S.D= 0.763) followed by stock exchange announcements (Mean=4.18, S.D. =0.873). The source of information which was least in importance is others (Friends and relatives) (Mean=2.94, S.D=1.42).

**Table 57: Importance of source of Information for Commodity Brokers (n=50)**

S. No	Source of Information	Mean Value	S.D	t value	p value
1	Newspaper	3.9400	1.236	5.379	0.001
2	Journals & Magazines	3.5000	1.182	2.990	0.004
3	TV Channels	4.0400	1.245	5.908	0.001
4	Investments Related Websites	3.9400	0.818	8.122	0.001
5	Brokers / Analysts Forecast	4.0800	0.877	8.709	0.001
6	Investor Forum	3.3000	1.165	1.821	0.075
7	Technical Analysis	4.4200	0.642	15.646	0.001
8	Company Announcements	4.3000	0.763	12.053	0.001
9	Stock Exchange Announcements	4.1800	0.873	9.553	0.001
10	Others (Friends, Relatives etc)	2.9400	1.420	-0.299	0.766

Table 58 depicts the perception of commodity brokers regarding volatility in Commodity market depicts the perception of stock traders regarding volatility in stock markets. From the given statements regarding volatility the statement ‘volatility has been rising in the stock market’ was found to be highly perceived statement (Mean= 4.48, S.D.= 0.646) followed by the statement ‘There is more volatility in stock market as compared to commodity markets’ (Mean= 4.08, S.D.= 0.804). The least perceived statement was found to be “Volatility is not good for Long term investors (Mean= 3.38, S.D. = 1.123).

Demographic profile of commodity traders includes age in years, gender, marital status, highest educational qualification, family size and house ownership. In the questionnaire the respondents were provided with options to get their opinion. Demographic profile details of the commodity traders are discussed in the following section

**Table 58: Perception of Commodity brokers regarding volatility in Commodity market (n=50)**

S. No	Statement	Mean Value	S.D	t value	p Value
1	Volatility has been rising in stock market	4.4800	0.646	16.188	0.001
2	Overall markets are calm in nature but there are incidences of high volatility	3.9800	0.845	8.202	0.001
3	Volatility affects future returns	3.9400	0.867	7.668	0.001
4	Volatility offers good opportunities for traders	4.1000	0.647	12.025	0.001
5	Technical analyst can make use of this volatility in generating good returns	3.9800	0.915	7.577	0.001
6	There is more volatility in stock market as compared to commodity markets.	4.0800	0.804	9.498	0.001
7	With increasing technical innovations in stock market, volatility is rising	3.8600	0.700	8.686	0.001
8	New methods of trading like algorithmic trading, increases volatility	3.4400	1.091	2.852	0.06
9	Volatility is not good for Long term investors	3.3800	1.123	2.393	0.021
10	Volatility is rightly captured in Indian VIX	3.7200	0.948	5.368	0.001
11	Derivatives help in generating good return due to volatility	3.6327	0.830	5.310	0.001
12	Largely on an average my clients have earned good returns due to increasing volatility	3.8800	0.961	6.473	0.001
13	I feel that this volatility will increase more in future	3.7200	0.927	5.494	0.001

Table 59 depicts the demographic profile of the commodity traders. It can be seen from the table that 51 traders (51%) belonged to age group of 30-40 years, followed by 22 investors in the age group of 40-50 years. Therefore approximately (76 %) of the retail mutual fund investors belonged to age group 30-50. The proportion of the investor either belonging to the age group of greater than 50 years is negligible. In the sample of commodity traders there were 83(83%) males and 17 (17%) females. With respect to marital status 83(83%) respondents were married and 17 (17%) were unmarried. As far as educational qualification is concerned out of sample of 100 respondents 59 (59%) were graduate, 22 (22%) were post graduate and 13(13%) were professional. Whereas only 5(5%) were senior secondary and

1(1%) was matriculate. Out of the sample of 100 respondents 75% of the traders were those with own house ownership and 25% respondents were having rented house. As per the sample characteristics, it can be inferred that most of the commodity traders were males, mature (in the age group of 30-40), majority were graduates, married and own their own house.

**Table 59: Demographic Characteristics of Commodity Traders (n=100)**

<b>Demographic Parameter</b>	<b>Category</b>	<b>Frequency</b>	<b>Cumulative Frequency</b>	<b>Percentage</b>
Age (in Years)	20-Less than30	18	18	18
	30- Less than 40	51	69	51
	40- Less than50	22	91	22
	50- Less than60	9	100	9
Gender	Male	85	85	85
	Female	15	100	15
Marital Status	Married	78	78	78
	Unmarried	22	100	22
Highest Educational Qualification	Senior Secondary	6	6	6
	Graduate	59	65	59
	Post Graduate	35	100	35
Family Size	2	2	2	2
	3	3	5	3
	4	33	38	33
	5	32	70	32
	6	24	94	24
	7	6	100	6
House Ownership	Own	75	75	75
	Rented	25	100	25

Table 60 depicts the economic profile of commodity traders. The study aims to assess the economic profile of the commodity traders. The economic profile mainly includes Individual monthly income from less than Rs. 50000 to more than Rs. 200,000. Majority of the investors 38% under survey reported income between 50000- <100000, followed by 23% traders with income >50000. There were 21% traders who reported income of 200000 & above. There were only 6 (6%) traders who reported their income between 150000-<200000. Out of the total sample under survey 73% of traders reported less than Rs.150000 monthly income. There were 27% traders who reported more than Rs Rs.150000 as their monthly income.

**Table 60: Economic Profile of Commodity traders**

<b>Economic Parameter</b>	<b>Category</b>	<b>Frequency</b>	<b>Cumulative Frequency</b>	<b>Percentage</b>
Monthly Income	Less than 50000	23	23	23
	50000- Less than 100000	38	61	38
	100000- Less than 150000	12	73	12
	150000- Less than 200000	6	79	6
	200000 and Above	21	100	21

Table 61 depicts that majority of the commodity traders describes themselves as positional traders. Out of the total sample 67% of the traders were positional traders and 33% of traders were day traders. The respondents were asked about their trading experience. Majority of the traders were having trading experience of 3 to 5 years. Out of the total sample 55% of the traders were having trade experience between 3-5 years followed by 24% of the traders having experience of less than 3 years. There were 21(21%) traders who were experts having experience of more than 5 years.

As per the data collected from the respondents Bullion is the most traded commodity. Out of the total sample 33% of the respondents trade most in bullion followed by 26% traders who traded in energy. Out of total sample 24% traders trades in metals and 17% in agricultural commodities. Out of the total sample majority of the traders (53%) were day traders who do trading on daily basis, followed by 30% traders who do trading multiple times in a day. There were 17 (17%) traders who do trading on weekly basis. Majority of the respondents uses their own money for trading purpose. Out of total sample 59% respondents use their own money for trading purpose followed by 30% traders who uses margin money for trading purpose and only 11% of the respondents who uses borrowed money for trading purpose.

Out of the total sample Majority (52%) of the traders do trading as a source of additional income and to earn additional income. There were 31(31%) traders who opted trading as profession, followed by 16% traders who do trading for knowledge gaining and only 1% of the traders do trading for other objectives like time pass. Out of the total sample the goal of majority (31%) of the traders is to avoid losing money, followed by 30% whose goal of trading is to avoid losing money. There were 21% of the traders who aims to grow significantly in trading, 14% aim to grow with caution and only 4% traders were there with aim of growing aggressively. Out of the total sample majority (68%) of the investors trades in limited number of commodities i.e less than 5, followed by 27% traders who trades in commodities ranging between 5-less than 10 and only 5% traders were dealing in more than 10 commodities.

The respondents were asked about their risk return profile. Out of the total sample 55% of the respondents were interested in moderate risk and moderate return followed by 26% traders who were interested in high risk and high return investments and 19% traders were such who were interested in investments with low risk and low return. Out of the sample 63% of the respondents use online mode of trading followed by 38% respondents who use both online and offline mode of trading for trading purpose. Only 9% of respondents use offline mode of trading. Traders were asked about their trading volume in a day. Out of the sample majority (44%) of the traders have trading volume of less than 5 lakh a day followed by 33% traders with trading volume of 5-10 lakh per day. There were 16% traders who were having trading volume of 10-15 lakh. Only 7% of the traders were having trading volume of more than 20 lakh per day.

Traders in the market are having different expectations from their trading activities. Majority of the traders (33%) out of the total sample want to slightly trail the market but to make good profits, followed by 21% of the traders who want to outperform the market and 20% who want to keep their pace with the commodity market. Out of the total sample most of the traders (70%) expect 12-24% return on their investment. There were 18% traders who expect less than 12% return followed by 12 % traders who expect more returns (24% - 36%) on their investments.

Traders were also asked about the reasons behind choosing a particular exchange for their trading activities. Most of the traders (39%) make their decision on the basis of transparency provided by the exchanges, followed by those who prefer better broker services (25%). There were 20% traders who make decision of exchange on the basis of liquidity of the market. Out of total sample 14% of the traders prefer exchanges with long trading hours and only 2% of the traders make their decisions based on the other factors besides mentioned above.

**Table 61: Business Characteristics of Commodity Traders (N=100)**

<b>Business parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative Frequency</b>	<b>Percent</b>
What best describes you	Positional trader	67	67	67
	Day Trader	33	100	33
Most Traded commodity	Metals	24	24	24
	Energy	26	50	26
	Bullion	33	83	33
	Agricultural	17	100	17

<b>Business parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative Frequency</b>	<b>Percent</b>
Trading Experience	Less than 3 years	24	24	24
	3-Less than 5 years	55	79	55
	5years & Above	21	100	21
Frequency of Trading	Multiple times in a day	30	30	30
	Every Day	53	83	53
	Every Week	17	100	17
Source of Finance for Trading	Own Money	59	59	59
	Borrowed Money	11	70	11
	Margin Money	30	100	30
Trading Motivation	Profession	31	31	31
	Additional Income	52	83	52
	Knowledge Gaining	17	100	17
Goal for Commodity Trading	To grow aggressively	21	21	21
	To grow significantly	31	52	31
	To grow moderately	14	66	14
	To grow with caution	30	96	30
	To avoid losing money	04	100	04
No. of Commodities for Trading	Less than 5	68	68	68
	5-less than 10	27	95	27
	10 & above	5	100	5
Risk and Return Profile of traders	High risk high return	26	26	26
	Moderate risk moderate return	55	81	55
	Low risk low return	19	100	19
Most Frequent Mode of Trading	Online	63	63	63
	Offline	9	72	9
	Both	28	100	28
Trading Volume Per Day	Less than 5 lakh	44	44	44
	5- Less than 10 lakh	33	77	33
	10- Less than 15 lakh	23	100	23
Traders' expectation from trading over time	To outperform the market	21	21	21
	To generally keep pace with the commodity market	20	41	20
	To slightly trail the commodity market, but make a good profit	31	72	31
	To trail the commodity market, but make a moderate profit	13	85	13

<b>Business parameters</b>	<b>Class</b>	<b>Frequency</b>	<b>Cumulative Frequency</b>	<b>Percent</b>
	To have some stability, but make modest profits	11	96	11
	To have a high degree of stability, but make small profits	4	100	4
Expected rate of return (ROR) per annum from commodity trading activities	Less than 12%	18	18	18
	12% - 24%	70	88	70
	24% - 36%	12	100	12
Reasons for choosing particular Commodity Exchange	More liquid market	20	20	20
	Transparent market	39	59	39
	Longer trading hours	14	73	14
	Better broker services	27	100	27
Commodity group price for which volatility is higher	Metals	34	34	34
	Energy	34	68	34
	Bullion	12	80	12
	Agricultural	20	100	20

Table 62 depicts the preference of stock traders for financial assets. It has been found that out of the total sample majority of the traders believes that volatility in Bullion is more (31.2%) followed by traders who believe that volatility is more in Energy and metal commodities. Only 20% of the investors believe that volatility is more in Agricultural commodity group.

**Table 62: Preference of commodity traders for financial asset (n=100)**

<b>Financial Asset</b>	<b>Response No.</b>	<b>Percent</b>	<b>Response percent</b>
Metals	58	24.5	58
Energy	57	24.1	57
Bullion	74	31.2	74
Agricultural	48	20.3	48

Table 63 shows the importance of sources of information for commodity traders. Sources of information play a dominant role in commodity selection criteria, as not only they provide information regarding the other factors influencing the commodity selection, but also they themselves act as commodity selection criteria. From the various sources of trading information Technical analysis was treated as most important source of information by the

commodity traders (Mean=4.37, S.D = 0.691). The second important source of information was company announcements (Mean= 4.33, S.D= 0.817) followed by commodity exchange announcements (Mean=4.04, S.D.=0.875). The source of information which was least in importance is others (Friends and relatives) (Mean=2.38, S.D=1.221).

**Table 63: Importance of source of Information for commodity Traders (n=100)**

S. No	Source of Information	Mean Value	S.D	t value	P value
1	Newspaper	3.41	0.986	4.159	0.001
2	Journals & Magazines	2.97	1.201	-0.250	0.803
3	TV Channels	3.38	1.324	2.870	0.005
4	Investments Related Websites	3.86	0.779	11.043	0.001
5	Traders / Analysts Forecast	4.01	0.611	16.523	0.001
6	Investor Forum	3.73	0.863	8.460	0.001
7	Technical Analysis	4.37	0.691	19.818	0.001
8	Company Announcements	4.33	0.817	16.276	0.001
9	Commodity Exchange Announcements	4.04	0.875	11.882	0.001
10	Others (Friends, Relatives etc)	2.38	1.221	-5.078	0.001
11	Investment Blogs	2.68	1.127	-2.839	0.005

Table 64 shows the reliance of stock traders on the type of analysis. The commodity traders consider company analysis to be more reliable type of analysis (Mean=3.12, S.D. = 0.856) followed by technical analysis (Mean= 3.08, S.D. = 0.981). The least reliable analysis from the selected analysis was Macroeconomic analysis (Mean= 2.64, S.D. = 0.969)

**Table 64: Extent of reliance on type of analysis (n=100)**

S. No	Type of Analysis	Mean value of extent	S.D	t value	p Value
1	Company Analysis	3.12	0.856	36.444	0.001
2	Macro economic analysis	2.64	0.969	27.232	0.001
3	Technical analysis	3.08	0.981	31.382	0.001

Table 65 depicts the agreement of the stock traders regarding their trading approach. Out of the total sample majority of the commodity traders follows the approach to be cautious and avoid all risky investment (Mean= 4.14, S.D. = 0.667), followed by the statement that a diversified portfolio reduces risk (Mean= 4.02, S.D. = 0.791).

**Table 65: Agreement of traders regarding their trading approach (n=100)**

S. No	Statement	Mean	S.D	t value	p value
1	My approach is to be cautious and avoid all risky investment	4.14	0.667	62.072	0.001
2	Any trading activity that involves a great deal of risk is not really investments but it is gambling	4.00	0.876	45.653	0.001
3	The more money one has, the more trading risk one can take.	3.79	1.085	34.924	0.001
4	My broker decides the best trading levels for me	3.47	0.979	35.440	0.001
5	The more familiar a trading opportunity is, the less risky it is	3.69	0.775	47.642	0.001
6	A diversified portfolio reduces risk	4.02	0.791	50.815	0.001
7	The older people take lesser trading risk	3.94	0.874	45.075	0.001
8	The need to liquidate quickly prohibits me from considering trading in riskier products'	3.72	0.780	47.721	0.001
9	The higher the trading yield or rate of return, the greater is its associated risk	3.74	0.691	54.142	0.001

Table 66 depicts the Importance of source of information for stock brokers. The stock brokers were inquired about 11 different sources namely Newspaper, Journals & Magazines, TV Channels, Commodity Related Announcements, Brokers / Analysts Forecast, Investor Forum, Technical Analysis, Commodity news, Commodity Exchange Announcements, Others (Friends, Relatives etc), Investment blogs.

In terms of inherited business all the sources of information were found out to be statistically insignificant as the p value for all the sources came out to be more than 0.05. The most important significant source of information for those who are involved in self trading (Mean=4.38 S.D.=0.74) or are in servicing clients (Mean=4.40 S.D.=0.51) or in both (Mean=4.29, S.D.=0.76) is found to be Company Announcements. It was found to be statistically significant at 5% level of significance with  $p= 0.028$ . The least important significant source of information was found to be Stock Exchange announcements for investors who deals in self trading only as compared to the traders who deals in servicing clients (Mean=3.47, S.D.=1.25) and both self trading and servicing clients (Mean=4.44, S.D.=0.58) for whom the least important source was found to be Brokers / Analysts Forecast.

**Table 66: Significant important Source of Information for various Categories of Stock brokers (n=50)**

Parameters	Category	Significant Source of information	Mean (S.D)			Test statistics (p value)
Involved in	Self trading Servicing clients both	Brokers / Analysts Forecast	4.25 (0.46)	3.47 (1.25)	4.44 (0.58)	F =6.910, (0.002)
		Company Announcements	4.38 (0.74)	4.40 (0.51)	4.81 (0.48)	F =3.869, (0.028)
		Stock Exchange announcements	4.00 (0.54)	4.33 (0.62)	4.70 (0.82)	F =3.311, (0.045)
Kind of trading offered	Online Offline Both	Newspaper	3.88 (1.20)	4.25 (0.50)	4.63 (0.62)	F =4.251, (0.020)
Kind of market operated	Primary Market	Investor Forum	3.00 (1.41)	3.14 (1.20)	3.84 (0.80)	F =3.082, (0. 0.055)
	Secondary Market Both	Others (Friends, Relatives etc)	3.75 (0.96)	2.19 (1.17)	2.92 (0.91)	F=5.212, (0.009)

The most important significant source of information in terms of kind of trading offered is found to be Newspaper for those who do both online and offline trading (Mean=4.63, S.D.=0.62), followed by those who do offline trading (Mean=4.25, S.D.=0.50) and those who do online trading (Mean=3.88, S.D.=1.20). It was found to be significant at 5% level of significance with  $p=0.020$  which is less than 0.05. In terms of kinds of market operated the most important source of information was found to be other (friends & relatives) for those who deals in primary market (Mean=3.75 S.D.=0.96) as compared to investor's forum for those who deals in secondary market (Mean=3.14 S.D.=1.20) and in both primary and secondary market (Mean=3.84 S.D.=0.80). The least important source of information for those who deal in primary market (Mean=3.00 S.D.=1.41) is Investor Forum as compared to those who deals in secondary (Mean=2.19, S.D.=1.17) and both primary and secondary market (Mean=2.92 S.D.=0.91). In terms of type of trader all the sources of information were found out to be statistically insignificant as the p value for all the sources came out to be more than 0.05.

Table 67 represents the importance of source of information for stock traders. The traders were inquired about 13 different sources namely Newspaper, Journals & Magazines, TV Channels, Investment Related Websites, Brokers /Analysts Forecast, Investor Forum, Own Technical Analysis, Company Announcements, Stock Exchange Announcements, Others (Friends, Relatives etc), Investment Blogs, Macroeconomic News, Industry News. The most important significant source of information in terms of Source of finance was found to be the TV channels for brokers with margin money (Mean=3.88 S.D.=0.74)and own money (Mean=3.78, S.D.=1.14) It was found to be significantly different from neutral value 3 with P value 0.009 which is less than 0.05. The least important significant source of information in terms of source of finance was found to be the Others (Friends, Relatives etc) for brokers with own money (Mean=2.55, S.D.=1.19)and margin money (Mean= 2.39, S.D.=0.78). It was found to be significantly different from neutral value 3 with P value 0.000 which is less than 0.05. Further Investor Forum were also found to be significant source of information for stock traders who use margin money (Mean=3.85, S.D. =0.62) followed by traders who use their own money (Mean=3.63, S.D.=1.06) for trading purpose. It was also found to be significant at 5% level of significance with  $p=0.002$  which is less than 0.05.

In terms of expected rate of return all the sources of information were found out to be statistically insignificant as the p value for all the sources came out to be more than 0.05. In terms of types of traders the most important significant source of information was found to be industry news for both positional (Mean=4.26, S.D.=0.85) and day traders (Mean=4.21, S.D.=0.69) as compared to Brokers / Analysts Forecast for program traders (Mean=4.22, S.D.=0.65).

**Table 67: Significant important Source of Information for various Categories of Stock Traders (n=100)**

Parameters	Categories	Significant Source of information	Mean (S.D)			Test Statistics p value
Source of finance for Trading	Own money Margin money	TV Channels	3.78 (1.14)		3.88 (0.74)	t=7.016, (0.009)
		Investor Forum	3.63 (1.06)		3.85 (0.62)	t=10.511, (0.002)
		Others (Friends, Relatives etc)	2.55 (1.19)		2.39 (0.78)	t=15.806, (0.000)
Types of trader	Positional trader Day trader Program Trader	Journals & Magazines	3.51 (1.10)	0.23 (1.09)	2.78 (0.81)	F =2.95, (0.06)
		Brokers / Analysts Forecast	4.14 (0.85)	3.68 (1.05)	4.22 (0.65)	F =3.58, (0.03)
		Others (Friends, Relatives etc)	2.97 (1.07)	2.30 (1.00)	2.11 (1.02)	F =5.87, (0.00)
		Investment Blogs	3.37 (1.00)	3.19 (1.01)	2.17 (0.99)	F =9.19, (0.00)
		Industry News	4.26 (0.85)	4.21 (0.69)	3.61 (0.920)	F =4.56, (0.01)
Trading Experience in Market	Less than 3 Years 3-5 Years 5 years and above	Investments Related Websites	3.36 (1.15)	3.91 (0.96)	4.13 (0.76)	F =4.56, (0.01)
		Own Technical Analysis	3.50 (1.29)	4.24 (0.77)	4.28 (0.72)	F =4.936, (0.009)
		Stock Exchange Announcements	4.57 (0.65)	4.61 (0.54)	4.15 (0.92)	F =4.592, (0.012)
		Investment Blogs	3.50 (0.76)	2.78 (1.13)	3.25 (1.06)	F =3.424, (0.037)
		Macroeconomic News	4.36 (0.63)	3.91 (0.76)	3.65 (0.92)	F =4.052, (0.020)
Risk return Profile	High risk High Return Moderate risk moderate Return Low risk Low return	TV Channels	3.52 (0.90)	4.07 (1.00)	3.25 (1.00)	F =5.723, (0.004)
		Others (Friends, Relatives etc)	2.04 (1.02)	2.52 (1.06)	3.06 (1.00)	F =4.565, (0.013)
		Macroeconomic News	3.87 (1.01)	4.00 (0.78)	3.38 (0.62)	F =3.731, (0.027)

The least important significant source of information was found to be Others (Friends, Relatives etc) for all three types of traders for positional traders (Mean=2.97, S.D.=1.07) followed by day traders (Mean=2.30, S.D.=1.00) and program traders (Mean=2.11, S.D.=1.02). It was found to be significant at 5% level of significance.

In terms of trading experience in market stock exchange announcements was found to be an important and significant source of information for traders with less than 3 years experience (Mean=4.57 S.D.=0.65) and 3-5 years experience (Mean=4.61, S.D.=0.54) as compared to traders with more than 5 years of experience (Mean=4.28 S.D.=0.72) who found own technical analysis to be significant source of information. The least important source of information was found to be Investments Related Websites for investors with less than 3 years experience (Mean=3.36 S.D.=1.15) as compared to Investment Blogs for traders with 3-5 years experience (Mean=2.78, S.D.=1.13) traders with more than 5 years of experience (Mean=3.25, S.D.=1.06). In terms of frequency of trading all the sources of information were found out to be statistically insignificant as the p value for all the sources came out to be more than 0.05.

In terms of risk return profile Macroeconomic news were found to be an important and significant source of information for traders with High risk and high return profile (Mean=3.87, S.D.=1.01) and low risk low return profile (Mean=3.38, S.D.=0.62) as compared to traders with medium risk medium return profile (Mean=4.07, S.D.=1.00) who found TV channels to be significant source of information. The least important source of information was found to be Others (Friends, Relatives etc) for all three traders with high risk high return profile (Mean=2.04, S.D.=1.02) medium risk medium return profile (Mean=2.52, S.D.=1.06) low risk low return profile (Mean=3.06 S.D.=1.00). It was found to be significant with at 5% level of significance with  $p=0.013$  which is less than 0.05. In terms of trading volume all the sources of information were found out to be statistically insignificant as the p value for all the sources came out to be more than 0.05.

Table 68 depicts the Importance of source of information for commodity brokers. The commodity brokers were inquired about 10 different sources of information namely Newspaper, Journals & Magazines, TV Channels, Commodity Related Announcements, Brokers / Analysts Forecast, Investor Forum, Technical Analysis, Commodity news, Commodity Exchange Announcements, Others (Friends, Relatives etc).

The most important significant source of information for those who are in inherited trading business is found to be commodity related websites (Mean=4.38, S.D. =0.65), followed by those with non inherited business (Mean=3.78, S.D=0.82). It was found to be

statistically significant at 5% level of significance with  $p= 0.021$ . In terms of trading services the most significant source of information was found to broker/analyst forecast for all three types of brokers who do self trading (Mean=3.67, S.D=1.03), servicing clients (Mean=3.60, S.D.=0.96) and those who provide both these services (Mean=4.29, S.D.=0.76). It was found to be significant at 5% level of significance with  $p=0.038$

In terms of trading services in stock and commodity markets the most important significant source of information was found to be commodity exchange announcements for those who deals only in commodity markets (Mean=4.00, S.D.=0.94) and brokers who deals in both commodity and stock market (Mean=4.53, S.D.=0.63). It was found to be significant at 5% level of significance with  $p=0.041$ . In terms of Kind of trading services offered in commodity markets the most important significant source of information for brokers was found to be commodity exchange announcements for those who provide online services (Mean=4.00, S.D.=0.93)and those who provide both online and offline services (Mean=4.53, S.D=0.63). It was found to be significant at 5% level of significance with  $p=0.041$ .

In terms of number of clients served the most important source of information was found to be Newspaper for the brokers who deals with less than 50 clients (Mean=4.70, S.D.=0.57)as compared to brokers who deals with 50 – less than 100 clients(Mean=3.93, S.D.=1.33), 100 – less than 150 (Mean=3.13, S.D=1.55), 150 – less than 200 (Mean=4.00, S.D.=0.82) clients for whom TV channels are considered as most important source of information. For brokers who deal with more than 200 clients both Newspaper and TV channels are equally important significant source of information (Mean= 3.25, S.D. =1.50). In terms of top 10 clients in terms of Value the most important source of information was found to be Broker/ Analyst forecast for positional traders (Mean=4.23,S.D.=0.75), followed by day traders (Mean=4.32, S.D.=0.65) and long term investors (Mean=2.67, S.D.=0.82). It was found to be significant at 5% level of significance with  $p=0.021$ .

In terms of top 10 clients in terms of number of trades the most important source of information was found to be Broker/ Analyst forecast for positional traders (Mean=4.35, S.D.=0.59), followed by day traders (Mean=4.11, S.D.=0.80) and long term investors (Mean=2.00, S.D.=0.00). It was found to be significant at 5% level of significance with  $p=0.021$ . In terms of objective of clients the most important source of information was found to be Technical analysis for clients with three different objectives namely Use commodity as an alternate investment (Mean=4.62, S.D. =0.51), followed by Capital Appreciation (Mean=4.55, S.D. =0.51) and long term wealth (Mean=4.07, S.D. =0.80). It was found to be significant at 5% level of significance with  $p=0.034$ .

**Table 68: Significant important Source of Information for various Categories of Commodity brokers (n=50)**

Parameters	Categories	Significant Source of information	Mean (S.D)			Test statistics p value
Is this inherited Business	Yes	Commodity related websites	4.38	3.78		t=2.383, (0.021)
	No		(0.65)	(0.82)		
Traders with different services	Self trading	Brokers / Analysts Forecast	3.67	3.60	4.29	F=3.503, (0.038)
	Servicing clients		(1.03)	(0.96)	(0.76)	
	Both					
do you provide stock trading also	Yes	Commodity Exchange announcements	4.00	4.53	-	t value=-2.100, (0.041)
	No		(0.94)	(0.63)		
Kind of Trading offered	online	Commodity Exchange announcements	4.00	4.53		t value =-2.100, (0.041)
	Both online and offline		(0.93)	(0.63)		

The least important source of information was found to be Others (Friends, Relatives etc) for clients with three different objectives namely Use commodity as an alternate investment (Mean=3.38, S.D. =1.26), followed by Capital Appreciation (Mean=3.18, S.D. =1.56) and long term wealth (Mean=2.20, S.D. =1.08). It was found to be significant at 5% level of significance with  $p=0.047$ . Further Newspaper was also found to be an important source of information for clients with three different objectives namely Use commodity as an alternate investment (Mean=4.54, S.D. =0.66), followed by Capital Appreciation (Mean=3.95, S.D. =1.36) and long term wealth (Mean=3.40, S.D.=1.24). It was found to be significant at 5% level of significance with  $p=0.049$ . Brokers / Analysts Forecast was also found to be an important significant source of information for clients with three different objectives namely Capital Appreciation (Mean=4.32, S.D. =0.78), followed by use commodity as an alternate investment (Mean=4.31, S.D. =0.86 and long term wealth (Mean=3.53, S.D. =0.83). It was found to be significant at 5% level of significance with  $p=0.049$ . In terms of risk tolerance the most important source of information was found to be Commodity related announcements for brokers with high risk tolerance (Mean=4.65, S.D. =0.61), followed by medium risk tolerance (Mean=4.20, S.D. =0.87) and low risk tolerance (Mean=3.88, S.D. =0.35). It was found to be significant at 5% level of significance with  $p=0.037$ .

Table 69 depicts the importance of source of information for commodity traders. The most important significant source of information in terms of trading experience was found to be the Commodity investment forum for all three types of traders for least experienced traders (mean 4.04, S.D. = 0.624), for medium experienced traders (Mean=3.78 S.D.=0.686) and for more experienced traders (Mean=3.24, S.D=1.261). It was found to be significantly different from neutral value 3 with P value 0.005 which is less than 0.05. The least important significant source of information in terms of trading experience was found to be the News paper for all three types of traders for least experienced traders (Mean= 3.58, S.D.= 0.881), for medium experienced traders (Mean=3.56 S.D. = 0.834) and more experienced traders (Mean=2.81, S.D.=1.250). It was found to be significantly different from neutral value 3 with P value 0.006 which is less than 0.05. In terms of positional and day traders all the sources of information were found out to be statistically insignificant as the p value for all the sources came out to be more than 0.05.

The most important significant source of information in terms of Frequency of trading was found to be the Analysts Forecast for all three types of traders, for traders who do trading multiples times in a week (mean 4.07, S.D. = 0.64), traders who deals ones in a day (Mean= 4.09 S.D. = 0.53) and those who do weekly trading (Mean=3.65 S.D. = 0.70). It was found to

be significantly different from neutral value 3 with P value 0.025 which is less than 0.05. The least important significant source of information in terms of Frequency of trading was found to be the TV Channels for all three types of traders (Mean=3.23, S.D. = 1.33) for traders who do trading multiples times in a week, who deals ones in a day (Mean=3.75 S.D. = 1.27) and those who do weekly trading 2.47 (1.01). It was found to be significantly different from neutral value 3 with P value 0.005 which is less than 0.05.

The most important significant source of information in terms of Source of finance for trading was found to be the Technical Analysis for both type of traders who do trading with their own money (mean 4.54, S.D. = 0.57) and those who use margin money for trading purpose (Mean=4.20 S.D. = 0.76) as compared to Commodity Related Websites for traders who use borrowed money (Mean= 3.91 S.D. = 0.83). The least important significant source of information in terms of Source of finance for trading was found to be the Others (Friends, Relatives etc) for all three types of traders, for traders who do trading with their own money (Mean 2.14, S.D. = 1.21), those who use borrowed money for trading purpose (Mean=3.36 S.D. = 1.43) and those who use margin money for trading purpose (Mean=2.50 S.D. = 0.97). It was found to be significantly different from neutral value 3 with P value 0.005 which is less than 0.05. Further Commodity Related Websites was also found to be significant source of information for traders who use borrowed money (Mean=4.55, S.D. =0.52) followed by those who use their own money (Mean=3.73, S.D. =0.85) and those who use margin money (Mean=3.87, S.D. =0.57). It was found to be significantly more than neutral value 3 with P value 0.005 which is less than 0.05. Analysts Forecast was also found to be significant source of information for traders who use borrowed money (Mean=4.45, S.D. =0.68) followed by those who use their own money (Mean=4.05, S.D. =0.63) and those who use margin money (Mean=3.77, S.D. =0.43). It was found to be significantly more than neutral value 3 with P value 0.029 which is less than 0.05. Commodity Investor Forum was also found to be significant source of information for traders who use borrowed money (Mean=4.09, S.D. =0.83) followed by those who use margin money (Mean=3.97, S.D. =0.55) and those who use their own money (Mean=3.54, S.D. =0.95). It was found to be significantly more than neutral value 3 with P value 0.029 which is less than 0.05. TV Channels were also found to be significant source of information for traders who use borrowed money (Mean=4.45, S.D. =0.68) followed by those who use their own money (Mean=3.46, S.D. =1.36) and those who use margin money (Mean=2.83, S.D. =1.18). It was found to be significantly more than neutral value 3 with P value 0.029 which is less than 0.05. News papers were also found to be significant source of information for traders who use borrowed money (Mean=4.36 S.D. = 0.50) followed by those who use their Margin money (Mean=3.67, S.D. = 0.84) and those

who use Own money (Mean=2.50, S.D=0.97). It was found to be significantly more than neutral value 3 with P value 0.001 which is less than 0.05. Journals & Magazines were also found to be significant source of information for traders who use borrowed money (Mean=4.36, S.D=0.67) followed by those who use their Margin money (Mean= 3.20, S.D=0.99) and those who use Own money (Mean=2.59, S.D=1.16). It was found to be significantly more than neutral value 3 with P value 0.000 which is less than 0.05

The most important significant source of information in terms of Risk return profiles was found to be the Commodity Analysts Forecast for both type of traders for those who can bear high risk for high returns (Mean= 4.27S.D=0.45) and those who can bear moderate risk for moderate returns (Mean=3.85, S.D=0.65) as compared to Commodity exchange announcements for traders who are satisfied with Low risk and low return (Mean=4.11, S.D=0.57). The least important significant source of information in terms of Risk return profiles was found to be the Others (Friends, Relatives etc) for all three types of traders for traders who can bear moderate risk for moderate returns (Mean 2.69, S.D. =1.10), those who can bear risk for high returns (Mean=2.19, S.D=1.47) and those who are satisfied with Low risk and low return (Mean=1.74, S.D. =0.87). It was found to be significantly different from neutral value 3 with P value 0.005 which is less than 0.05. Further Commodity Exchange Announcements were also found to be significant source of information for traders who can bear moderate risk for moderate returns (Mean= 4.22, S.D=0.83) followed by those who can bear risk for high returns (Mean=4.04, S.D=0.96) and those who are satisfied with Low risk and low return (Mean=3.53, S.D=0.69). It was found to be significantly more than neutral value 3 with P value 0.000 which is less than 0.05. Investor Forum was also found to be significant source of information for traders who can bear moderate risk for moderate returns (Mean= 3.95 S.D. =0.75) followed by those who are satisfied with Low risk and low return (Mean=3.53, S.D=0.51) and those who can bear risk for high returns (Mean=3.42, S.D. =1.14). It was found to be significantly more than neutral value 3 with P value 0.000 which is less than 0.05. Newspaper was also found to be significant source of information for traders who can bear moderate risk for moderate returns (Mean= 3.65, S.D. =0.75) followed by those who are satisfied with Low risk and low return (Mean=3.16, S.D. =1.01)) and those who can bear risk for high returns (Mean=3.08, S.D=1.26)). It was found to be significantly more than neutral value 3 with P value 0.002 which is less than 0.05. Journals & Magazines was also found to be significant source of information for traders who can bear moderate risk for moderate returns (Mean= 3.33, S.D=0.96) followed by those who can bear risk for high returns (Mean=2.65, S.D=1.38) and those who are satisfied with Low risk and low return

(Mean=2.37, S.D. =1.26). It was found to be significantly more than neutral value 3 with P value 0.000 which is less than 0.05.

The most important significant source of information in terms of Mode of Trading for trading was found to be the Commodity Investor Forum for both types of traders who do offline trading (Mean=4.00, S.D.=0.62) and traders who do online trading (Mean=3.57(0.95). It was found to be significantly less than the neutral value with P value 0.016 which is less than 0.05. The least important significant source of information in terms of Mode of Trading for trading was found to be the Journals and Magazines for traders who do online trading (Mean= 2.76, S.D.=1.304) as compared to Investment blogs for traders who do offline trading (Mean=2.38, S.D=1.01)

The most important significant source of information in terms of Volume of trading per day for trading was found to be the Technical Analysis for both type of traders who trade between 5 to 10 lakh (Mean =4.64, S.D=0.55) and traders who do trading of more than 10 lakh (Mean=4.26, S.D=0.81) as compared to Commodity News for traders who do trading of less than 5 lakh (Mean=4.32, S.D=0.71) The least important significant source of information in terms of Volume of trading per day for trading was found to be the Others (Friends, Relatives etc) for traders who trade of less than 5 lakh (Mean=2.84, S.D=1.14), followed by traders who do trading between 5 lakh-10 Lakh (Mean=2.21, S.D=1.36) and who do trading of more than 10 lakh (Mean=1.36, S.D=0.752). It was found to be significantly more than the neutral value with P value 0.001 which is less than 0.05. Commodity Investor Forum were also found to be significant source of information in terms of Volume of trading per day for traders who do trading of less than 5 lakh (Mean =4.07, S.D.=0.54), followed by traders who trade between 5 to 10 lakh (Mean=3.76, S.D.=0.94) and who do trading of more than 10 lakh (Mean=3.04, S.D.=0.88). It was found to be significantly more than the neutral value with P value 0.001 which is less than 0.05. It was found to be significantly more than the neutral value with P value 0.024 which is less than 0.05. Commodity Exchange Announcements was also found to be significant source of information in terms of Volume of trading per day for traders who do trading of less than 5 lakh (Mean =4.25(0.72), followed by traders who trade between 5 to 10 lakh (Mean=4.03, S.D.=0.81) and who do trading of more than 10 lakh (Mean=3.65, S.D=1.11). It was found to be significantly more than the neutral value with P value 0.028 which is less than 0.05.

The most important significant source of information in terms of Expected rate of return was found to be the Commodity Investor Forum for all three types of traders who expect rate of return of less than 12% (Mean=4.17, S.D. =0.38), traders who expect rate of

**Table 69: Significant important Source of Information for various Categories of Commodity traders (n=100)**

Parameters	Categories	Significant Source of information	Mean (S.D)			Test Statistics p value
Trading Experience	Less Experience	News paper	3.58 (0.881)	3.56 (0.834)	2.81 (1.250)	F=5.372 (0.006)
	Medium experience More experience	Commodity investment forum	4.04 (0.624)	3.78 (0.686)	3.24 (1.261)	F=5.543 (0.005)
frequency of trading	Multiple times in a day	TV Channels	3.23 (1.33)	3.75 (1.27)	2.47 (1.01)	F=5.543 (0.005)
	Once in a day Once in a week	Analysts Forecast	4.07 (0.64)	4.09 (0.53)	3.65 (0.70)	F=3.838 (0.025)
Sources of finance for trading	Own Money Borrowed Money Margin Money	Newspaper	3.10 (0.97)	4.36 (0.50)	3.67 (0.84)	F=10.852 (0.001)
		Journals & Magazines	2.59 (1.16)	4.36 (0.67)	3.20 (0.99)	F=13.617 (0.000)
		TV Channels	3.46 (1.36)	4.45 (0.68)	2.83 (1.18)	F=7.048 (0.001)
		Commodity Related Websites	3.73 (0.85)	4.55 (0.52)	3.87 (0.57)	F=5.570 (0.005)
		Analysts Forecast	4.05 (0.63)	4.45 (0.68)	3.77 (0.43)	F=5.961 (0.004)
		Commodity Investor Forum	3.54 (0.95)	4.09 (0.83)	3.97 (0.55)	F=3.674 (0.029)
		Technical Analysis	4.54 (0.57)	3.91 (0.83)	4.20 (0.76)	F=5.676 (0.005)
		Others (Friends, Relatives etc)	2.14 (1.21)	3.36 (1.43)	2.50 (0.97)	F=5.325 (0.006)
Risk returns profile.	High risk high return Moderate risk moderate return Low risk low return	Newspaper	3.08 (1.26)	3.65 (0.75)	3.16 (1.01)	F=4.03 (0.02)
		Journals & Magazines	2.65 (1.38)	3.33 (0.96)	2.37 (1.26)	F=6.33 (0.00)
		Commodity Analysts Forecast	4.27 (0.45)	3.85 (0.65)	4.11 (0.57)	F=4.67 (0.01)
		Investor Forum	3.42 (1.14)	3.95 (0.75)	3.53 (0.51)	F=6.33 (0.00)
		Commodity Exchange Announcements	4.04 (0.96)	4.22 (0.83)	3.53 (0.69)	F=4.75 (0.01)
		Others (Friends, Relatives etc)	2.19 (1.47)	2.69 (1.10)	1.74 (0.87)	F=6.33 (0.00)

Parameters	Categories	Significant Source of information	Mean (S.D)			Test Statistics p value
modes of trading	Online Offline	Journals & Magazines	2.76 (1.304)	3.32 (0.92)		t=-2.309 (0.023)
		Commodity Investor Forum	3.57 (0.95)	4.00 (0.62)		t=-2.458 (0.016)
		Investment blogs	2.86 (1.16)	2.38 (1.01)		t=2.085 (0.040)
volume of trading per day	<5 lakh 5-10 lakh 10-15 lakh	Commodity Investor Forum	4.07 (0.54)	3.76 (0.94)	3.04 (0.88)	F=13.337 (0.000)
		Technical Analysis	4.23 (0.68)	4.64 (0.55)	4.26 (0.81)	F=3.889 (0.024)
		Commodity news	4.32 (0.71)	4.58 (0.61)	4.00 (1.13)	F=3.546 (0.033)
		Commodity Exchange Announcements	4.25 (0.72)	4.03 (0.81)	3.65 (1.11)	F=3.720 (0.028)
		Others (Friends, Relatives etc)	2.84 (1.14)	2.21 (1.36)	1.36 (0.752)	F=7.48 (0.001)
Expected rate of return of traders	less than 12% 12% - 24% 24% - 36%	Newspaper	3.78 (0.73)	3.41 (1.05)	2.83 (0.58)	F=3.472 (0.035)
		Journals & Magazines	3.22 (0.88)	3.04 (1.27)	2.17 (0.94)	F=3.361 (0.039)
		Commodity Investor Forum	4.17 (0.38)	3.74 (0.89)	3.00 (0.74)	F=7.471 (0.001)
		Others (Friends, Relatives etc)	2.78 (1.11)	2.44 (1.26)	1.42 (0.51)	F=5.189 (0.007)

return of 12% to 24% (Mean=3.74, S.D. =0.89) and who do trading of expect rate of return of 24% to 36% (Mean=3.00, S.D. =0.74). It was found to be significantly more than the neutral value with P value 0.001 which is less than 0.05. The least important significant source of information in terms of Volume of trading per day for trading was found to be the Others (Friends, Relatives etc) for all three types of traders who expect rate of return of less than 12% (Mean=2.78, S.D.=1.11), traders who expect rate of return of 12% to 24% (Mean=2.44, S.D=1.26) and who do trading with expected rate of return of 24% to 36% (Mean=1.42, S.D.=0.51). It was found to be significantly more than the neutral value with P value 0.007 which is less than 0.05. Newspaper was found to be significant source of trading for traders who expect rate of return of less than 12% (Mean=3.78, S.D=0.73), followed by traders who expect rate of return of 12% to 24% (Mean=3.41, S.D=1.05) and who do trading of expect rate of return of 24% to 36% (Mean=2.83, S.D=0.58). It was found to be significantly more than the neutral value with P value 0.035 which is less than 0.05. Journals & Magazines were found to be significant source of trading for traders who expect rate of return of less than 12% (Mean=3.22, S.D. =0.88), followed by traders who expect rate of return of 12% to 24% (Mean=3.04, S.D=1.27) and who do trading of expect rate of return of 24% to 36% (Mean=2.17, S.D=0.94). It was found to be significantly more than the neutral value with P value 0.039 which is less than 0.05.

Table 70 represents the volatility perception of stock brokers. The most of the traders who deals in inherited business (Mean=4.46, S.D. =0.66) and in non inherited trading business (Mean=3.70, S.D. =1.00) perceives that Technical analyst can make use of this volatility in generating good returns. It was found to be significant at 5% level of significance with  $p = 0.014$  which is less than 0.05.

The most of the traders who deals Self trading (Mean=3.88 (0.84)) and in Servicing clients (Mean=4.53 S.D. =0.52) and in both (Mean=4.74 S.D. =0.53) perceives that Volatility has been rising in Commodity market. It was found to be significant at 5% level of significance with  $p = 0.002$  which is less than 0.05. In terms of inherited and non inherited business most traders who deals multiples times in day (Mean=4.25 S.D. =0.639) believes that overall markets are calm in nature but there are incidences of high volatility as compared to traders who deals every day (Mean=3.82 S.D. =0.873) and every week (Mean=4.05 S.D. =.826) who perceives that with increasing technical innovations in stock market, volatility is rising.

**Table 70: Significant Difference in perception of Volatility by Stock brokers (n=50)**

Parameters	Category	Significant Source of information	Mean (S.D.)				p value
Inherited and non inherited business	Yes No	Technical analyst can make use of this volatility in generating good returns	4.46 (0.66)	3.70 (1.00)			t =2.548 (0.014)
Involved in	Self trading Servicing clients Both	Volatility has been rising in Commodity market	3.88 (0.84)	4.53 (0.52)	4.74 (0.53)		F=6.884 (0.002)
Kind of trading offered	Online Offline Both	Volatility has been rising in Commodity market	4.38 (0.62)	3.75 (1.26)	4.73 (0.45)		F =5.820 (0.006)
		There is more volatility in Commodity market as compared to stock markets	3.94 (0.77)	4.00 (0.00)	3.00 (1.29)		F =4.475 (0.017)
Kind of market do you operate	Primary Secondary Both	Volatility has been rising in Commodity market	3.50 (1.00)	4.57 (0.60)	4.68 (0.48)		F =7.295 (0.002)
		Largely on an average I have earned good returns due to increasing volatility	4.25 (0.96)	3.24 (1.26)	3.96 (0.68)		F =3.800 (0.030)
number of clients	0 – less than 50 50 – less than 100 100 – less than 150 150 – less than 200	Volatility has been rising in Commodity market	4.67 (0.48)	4.69 (0.48)	4.33 (0.82)	4.00 (1.00)	F =3.800 (0.030)
trader's top ten clients in terms of number of trades	Positional trader Day trader Long term investor	Volatility has been rising in Commodity market	4.40 (0.63)	4.76 (0.44)	4.20 (0.92)		F =3.520 (0.038)
		With increasing technical innovations in commodity market, volatility is rising	3.80 (0.78)	4.44 (0.65)	4.10 (0.57)		F =4.293, (0.019)
trader's clients with different objectives	Capital Appreciation Long term wealth Dividend	There is more volatility in Commodity market as compared to stock markets	2.69 (1.25)	3.74 (1.02)	3.30 (1.16)		F =3.937, (0.026)

Table 71 illustrates the perception of stock traders regarding volatility in stock market. The most of the traders who are positional traders (Mean=4.43 S.D. =0.50), day traders (Mean=4.11 S.D. =0.63) and program traders (Mean=4.17 S.D. =0.38) perceives that Volatility has been rising in stock market. It was found to be significant at 5% level of significance with  $p = 0.032$  which is less than 0.05.

Majority of the traders with trading experience of less than 3 years (Mean=4.57, S.D.=0.514), with 3- 5 years experience (Mean=4.15, S.D.=0.515) and with more than 5 years (Mean=4.20, S.D.=0.608) feels that Volatility has been rising in stock market. It was found to be significant with  $p=0.04$ . The least important statement for traders with trading experience of less than 3 years (Mean=3.21, S.D.=0.975) was that overall markets are calm in nature but there are incidences of high volatility as compared to traders with 3-5 years experience (Mean=3.87 S.D.=0.619) and more than 5 years experience (Mean=3.63, S.D.=0.740) who feel that this volatility will increase more in future.

In terms of frequency of trading most traders who deals multiples times in day (Mean=4.25 S.D.=0.639) believes that overall markets are calm in nature but there are incidences of high volatility as compared to traders who deals every day (Mean=3.82 S.D.=0.873) and every week (Mean=4.05 S.D.=.826) who perceives that With increasing technical innovations in stock market, volatility is rising. In terms of risk return profile majority of the traders feels that Volatility is rightly captured in Indian VIX by traders with high risk and high return profile (Mean=4.09 S.D.=0.95) followed by traders with low risk and low return profile (Mean=3.56 S.D.=0.63). As compared to traders with moderate risk and moderate return profile (Mean=4.07 S.D.=0.63) who believes that this volatility will increase more in future. The least significant statement was found to be that this volatility will increase more in future by traders with high risk and high return profile (Mean=3.57 S.D. =0.59) and low risk low return profile (Mean=3.38 S.D.=0.96) as compared to traders with moderate risk and moderate return profile (Mean=3.44 S.D.=0.85) who believes that volatility is rightly captured in Indian VIX. In term of mode of trading the most significant statement was found to be that Volatility offers good opportunities for traders for traders who do offline (Mean=3.86 S.D.=0.516) trading followed by traders who do online trading (Mean=3.83 S.D.=1.082).

**Table 71: Significant Difference in perception of Volatility by Stock Traders (n=100)**

Parameters	Categories	Significant Source of information	Remarks			p value
Type of trader	Positional trader Day trader Program Trader	Volatility has been rising in stock market	4.43 (0.50)	4.11 (0.63)	4.17 (0.38)	F =3.564, (0.032)
Trading Experience in Market	Less than 3 Years 3-5 Years 5 years and above	Volatility has been rising in stock market	4.57 (0.514)	4.15 (0.515)	4.20 (0.608)	F =3.172, (0.046)
		Overall markets are calm in nature but there are incidences of high volatility	3.21 (0.975)	3.89 (0.900)	3.75 (.840)	F =3.131, (0.048)
		I feel that this volatility will increase more in future	4.36 (0.842)	3.87 (0.619)	3.63 (0.740)	F =5.715, (0.005)
Frequency of trading	Multiple time in a day Every day every week	Overall markets are calm in nature but there are incidences of high volatility	4.25 (0.639)	3.58 (0.869)	3.70 (1.081)	F =4.364, (0.015)
		With increasing technical innovations in stock market, volatility is rising	3.35 (1.089)	3.82 (0.873)	4.05 (.826)	F =3.150, (0.047)
Risk return Profile	High risk High Return Moderate risk moderate Return Low risk Low return	Volatility is rightly captured in Indian VIX	4.09 (0.95)	3.44 (0.85)	3.56 (0.63)	F =4.918, (0.009)
		I feel that this volatility will increase more in future	3.57 (0.59)	4.07 (0.63)	3.38 (0.96)	F =8.918, (0.000)
Mode of Trading	Online Offline	Volatility offers good opportunities for traders	3.83 (1.082)	3.86 (0.516)		t =10.298, (0.002)

Table 72 depicts the volatility perception of different commodity brokers. Volatility is perceived by different traders differently. Majority of the traders with inherited brokerage business (Mean=4.46, S.D. =0.66) and non inherited business (Mean=3.95, S.D. =0.82) believes that there is more volatility in Commodity market as compared to stock markets. It was found to be significant at 5% level of significance with  $p= 0.046$ . The least important statement for both inherited (Mean= 4.23, S.D. =0.60) and non inherited business brokers (Mean=3.54, S.D.=0.99) was found to be that derivatives help in generating good return due to volatility. It is found to be significantly more than neutral value with 0.022 which is less than 0.005.

In terms of provision of services in commodity as well as stock market the most significant statement is found to be that the brokers desire that regulators should devise more measures to contain volatility by brokers who deals in commodity market only (Mean=3.52, S.D. =0.87) as compared to brokers who deals in both commodity and stock market (Men=4.18, S.D. =0.53) who believes that Derivatives help in generating good return due to volatility. The least important statement was found to be that derivatives help in generating good return due to volatility for those who deals in commodity market only (Mean=3.48, S.D.= 1.03) as compared to brokers who deals in both commodity and stock markets (Mean= 4.12, S.D.=0.93) who desire that regulators should devise more measures to contain volatility. In terms of kind of trading offered the most significant statement is found to be that Volatility is not good for Long term investors by brokers who deals in online trading only (Mean=3.92, S.D.=1.12) followed by brokers who deals in both online and offline trading (Men=3.19, S.D.=1.08). It was found to be significant at 5% level of significance with  $p=0.041$ .

In terms of kind of market operated the most significant statement is found to be that Derivatives help in generating good return due to volatility for brokers who deals in primary market only (Mean=5.00, S.D.=0.00) followed by those who deals in both primary and secondary market (Mean=3.83, S.D.=0.70) and brokers who deals in secondary market (Mean=3.36, S.D.=1.05). It was found to be significant at 5% level of significance with  $p=0.03$ . In terms of number of clients served the most significant statement is found to be that they desire that regulators should devise more measures to contain volatility for brokers who deals with 0-less than 50 clients (Mean= 3.85 S.D.=0.67) and 50- less than 100 clients (Mean=4.00 S.D.=1.11) as compared to traders who deals in deals in 200 & above (Mean=4.75 S.D.=0.50) followed by 150-Less than 200 (Mean=3.75 S.D.=0.50) and 100-Less than 150 (Mean=3.25, S.D.=0.89) clients who believes that New methods of trading like algorithmic trading increases volatility. The least important statement is found to be New methods of trading like algorithmic trading increases volatility for brokers who deals with 0-less than 50 clients (Mean= 3.05, S.D.=1.10) and 50- less than 100 clients (Mean=3.64, S.D.=1.15) as compared to traders who deals in deals in 200 & above (Mean=4.25, S.D.=0.50) followed by 150-Less than 200 (Mean=3.00, S.D.=1.16) and 100-Less than 150 (Mean=3.00, S.D.=0.76) clients who desire that regulators should devise more measures to contain volatility.

**Table 72: Significant Difference in Perception of Volatility by Commodity Brokers (n=50)**

Parameters	Categories	Significant Source of information	Remarks					p value
Inherited business	Yes No	There is more volatility in Commodity market as compared to stock markets	4.46 (0.66)		3.95 (0.82)			t value =2.053, (0.046)
		Derivatives help in generating good return due to volatility	4.23 (0.60)		3.54 (0.99)			t value =2.360, (0.022)
Provide service in stock trading also?	Yes No	Derivatives help in generating good return due to volatility	3.48 (1.03)		4.18 (0.53)			t value =-2.580, (0.013)
		I desire that regulators should devise more measures to contain volatility	3.52 (0.87)		4.12 (0.93)			t value =-2.268, (0.028)
Kind of trading offered	Online Both online & offline	Volatility is not good for Long term investors	3.92 (1.12)		3.19 (1.08)			t value =2.096 (0.041)
Kind of market operated	Primary Secondary Both	Derivatives help in generating good return due to volatility	5.00 (0.00)		3.36 (1.05)		3.83 (0.70)	Significant t value =6.592, p<0.05(0.003)
No. of clients served	0-Less than 50 50-Less than 100 100-Less than 150 150-Less than 200 200 & above	New methods of trading like algorithmic trading increases volatility	3.05 (1.10)	3.64 (1.15)	3.25 (0.89)	3.75 (0.50)	4.75 (0.50)	t value =2.661, (0.045)
		I desire that regulators should devise more measures to contain volatility	3.85 (0.67)	4.00 (1.11)	3.00 (0.76)	3.00 (1.16)	4.25 (0.50)	t value =2.966, (0.029)
What best describes your top 10 clients	Positional trader Day trader Long term investor	New methods of trading like algorithmic trading increases volatility	3.82 (0.96)		3.27 (1.03)		2.67 (1.37)	t value =3.389 (0.042)
Objective of client	Capital appreciation Long term wealth use commodity market as alternate	There is more volatility in Commodity market as compared to stock markets	4.50 (0.60)		3.73 (0.88)		3.77 (0.73)	t value =6.591, (0.003)

In terms of broker's top 10 clients (in terms of Value) the most important significant statement is found to be that new methods of trading like algorithmic trading increases volatility for brokers with positional trader clients 3.82(0.96), followed by day traders 3.27(1.03) and long term investors 2.67(1.37). It was found to be significant at 5% level of significance with  $p=0.042$ . In terms of objectives of clients the most significant statement is found to be that there is more volatility in Commodity market as compared to stock markets for brokers whose client's objective is capital appreciation (Mean=4.50 S.D.=0.60) followed by use commodity market as alternate (Mean=3.77 S.D.=0.73) and long term wealth (Mean=3.73, S.D.=0.88).

Table 73 depicts the volatility perception of commodity traders about volatility in commodity markets. In the table Majority of the traders with trading experience of 3- 5 years (Mean=4.35 S.D.=0.61) and more than 5 years (Mean=3.90, S.D.=0.88) perceives that overall markets are calm in nature but there are incidences of high volatility as compared to less experienced traders with experience of less than 3 years who feels that volatility will increase more in future. The least important statement for both the traders with trading experience of 3- 5 years (Mean=3.65, S.D. =0.84) and more than 5 years (Mean=3.24, S.D. =1.14) is that regulators should devise more measures to contain volatility as compared to less experienced traders with experience of less than 3 years (Mean= 3.75, S.D. =1.07) who perceives that overall markets are calm in nature but there are incidences of high volatility. The statement that Derivatives help in generating good return due to volatility was found to be significant for all three types of traders with experience of 3 years to 5 years (Mean=4.15, S.D. =0.56) followed by those with experience of less than 3 years (Mean=4.04, S.D.=0.36) and with experience of more than 5 years (Mean=3.62, S.D.=0.86). It is found to be significantly more than neutral value with 0.004 which is less than 0.005.

In terms of frequency of trading the statement there is more volatility in Commodity market as compared to stock markets was found to be statistically significant for traders who do weekly trading (Mean=4.29, S.D.=0.58), for traders who do trading multiples times in a day (Mean=3.67, S.D.=0.84) and for daily traders (Mean=3.57, S.D.=1.18). Majority of the traders with borrowed money (Mean=4.18, S.D.=0.87) and margin money (Mean=4.23, S.D.=0.50) perceives that derivatives help in generating good return due to volatility as compared to those who do trading with their own money who feels volatility has been rising in Commodity market. The least important statement for both the traders with borrowed money (Mean=3.91 S.D. =0.70) and margin money (Mean=3.93, S.D.=0.74) is that Volatility has been rising in Commodity market as compared to those who do trading with their own money (Mean= 3.53, S.D.=1.04) who perceives that largely on an average they have earned good returns due to increasing volatility.

In terms of number of commodities traded most of the traders trading between 5- 10 commodities (Mean=4.11, S.D. = 0.89) and traders with more than 10 commodities (Mean=3.60, S.D.=1.52) agree with the statement there is more volatility in commodity market as compared to those who deals in less than 5 commodities who agree with the statement that volatility is not good for Long term investors. The least important statement for both the traders trading between 5- 10 commodities (Mean=4.07, S.D.=0.55) and traders with more than 10 commodities (Mean=3.00, S.D.=1.41) agree with the statement that volatility is not good for Long term investors as compared to those who deals in less than 5 commodities (Mean= 3.57, S.D.=1.03) who agree with the statement that there is more volatility in commodity market as compared to stock markets. In terms of types of traders majority of the day traders (Mean=4.27, S.D.=0.56) agree with the statement that volatility has been rising in Commodity market as compared to positional traders (Mean=3.94 S.D.=0.61) majority of who agree with the statement Volatility offers good opportunities for traders. The least important statement for day traders (Mean=4.07, S.D. =0.55) and traders with more than 10 commodities (Mean=3.00, S.D. =1.41) agree with the statement that volatility is not good for Long term investors as compared to those who deals in less than 5 commodities (Mean= 3.57, S.D.=1.03) who agree with the statement that there is more volatility in commodity market as compared to stock markets.

In terms of mode of trading majority of the traders both online (Mean=4.08, S.D. =0.70) and offline day traders (Mean=4.35, S.D. =0.54) agree with the statement that Volatility affects future returns. It is found to be significantly less than the neutral value as p value is 0.045 which is less than 0.05. The least important statement for both online (Mean=3.56, S.D. =1.01) and offline traders (Mean=4.03, S.D. =0.499). It is found to be significantly less than the neutral value as p value is 0.009 which is less than 0.05. In terms of mode of trading volume per day both the traders under the category of trading volume of 5 lakh -10 lakh (Mean= 4.13, S.D.=0.47) and 10-15 Lakh (Mean=3.05, S.D.=0.85) lakh agree with the statement that largely on an average they have earned good returns due to increasing volatility as compared to traders with less than 5 lakh (Mean=3.88, S.D.=1.07) trading volume who agrees more with the statement that there is more volatility in Commodity market as compared to stock markets. The least important statement for both the traders under the category of trading volume of 5 lakh-10 lakh (Mean= 3.95, S.D. =0.91) and 10-15 Lakh (Mean=2.84, S.D. =0.89) is there is more volatility in Commodity market as compared to stock markets. In terms of mode of expected rate of return the traders with expected rate of return of less than 12% (Mean= 4.11, S.D. =0.58) are found to be significant, followed by traders with 12%-24% (Mean=3.71, S.D. =0.82) expected rate of return and 24%-36% (Mean=3.25, S.D. =1.36) expected rate of return.

**Table 73: Significant Difference in Perception of Volatility by Commodity Traders (n=100)**

Parameters	Categories	Volatility Perception	Remarks			p value
Trading Experience	Less than 3 years 3- Less than 5 years 5 years & above	Overall markets are calm in nature but there are incidences of high volatility	3.75 (1.07)	4.35 (0.61)	3.90 (0.88)	F=5.445 (0.006)
		Derivatives help in generating good return due to volatility	4.04 (0.36)	4.15 (0.56)	3.62 (0.86)	F=5.922 (0.004)
		I feel that this volatility will increase more in future	4.08 (0.58)	4.09 (0.75)	3.33 (1.15)	F=7.057 (0.001)
		I desire that regulators should devise more measures to contain volatility	4.00 (0.59)	3.65 (0.84)	3.24 (1.14)	F=4.366 (0.015)
Frequency of Trading	Multiple times in a day Every day Every Week	There is more volatility in Commodity market as compared to stock markets	3.67 (0.84)	3.57 (1.18)	4.29 (0.58)	F=3.395 (0.038)
Source of finance for trading	Own money Borrowed money Margin Money	Volatility has been rising in Commodity market	4.29 (0.59)	3.91 (0.70)	3.93 (0.74)	F=3.752 (0.027)
		Derivatives help in generating good return due to volatility	3.86 (0.60)	4.18 (0.87)	4.23 (0.50)	F=4.148 (0.019)
		Largely on an average I have earned good returns due to increasing volatility	3.53 (1.04)	4.18 (0.41)	3.97 (0.49)	F=4.349 (0.016)
Number of commodities in which trading is carried out	Less than 5 5- less than 10 10 & above	There is more volatility in Commodity market as compared to stock markets	3.57 (1.03)	4.11 (0.89)	3.60 (1.52)	F=2.73 (0.070)
		Volatility is not good for Long term investors	3.74 (0.96)	4.07 (0.55)	3.00 (1.41)	F=3.46 (0.035)
Type of traders	Day traders Positional traders	Volatility has been rising in Commodity market	4.27 (0.56)	3.88 (0.78)	-	t=2.647 (0.009)
		Volatility offers good opportunities for traders	4.25 (0.53)	3.94 (0.61)	-	
Mode of Trading	online Trading Offline trading	Volatility affects future returns	4.08 (0.70)	4.35 (0.54)	-	t=-2.029 (0.045)
		Largely on an average I have earned good returns due to increasing volatility	3.56 (1.01)	4.03 (.499)	-	t=-2.646 (0.009)
trading volume per day	<5 lakh 5-10 Lakh 10-15 Lakh	There is more volatility in Commodity market as compared to stock markets	3.88 (1.07)	3.95 (0.91)	2.84 (0.89)	F=9.998 (0.000)
		Largely on an average I have earned good returns due to increasing volatility	3.38 (1.13)	4.13 (0.47)	3.05 (0.85)	F=17.379 (0.000)
expected rate of return	Less than 12% 12% - 24% 24% - 36%	Largely on an average I have earned good returns due to increasing volatility	4.11 (0.58)	3.71 (0.82)	3.25 (1.36)	F=3.619 (0.030)

#### 4.6 Discussion

Stock and commodity market volatility has always been a subject of interest for investors, analysts, practitioners, researchers and policy makers. The various aspects of volatility in stock and commodity market have been extensively studied. Volatility is the measure of riskiness of an asset or variability of an asset. It can be studied using yearly, monthly or quarterly standard deviation of the stock or commodity market indices. Volatility also shows a particular behavior that seems to lead to abnormal returns more often than not, known as calendar anomalies.

One of the most widely used calendar anomaly is the Day of the week effect. Some of the researchers observed that the returns on Monday are less than other days of the week and returns on Friday are more than rest of the days of the week (Kenneth 1980, Barone 1990, Anshuman 2000, Ashish *et al* 2010, Sudarvel *et al* 2015). Other calendar anomaly is Month of the year effect. Some researchers argue that the month of the year effect is present (Choudary 2001, Ashish *et al* 2010, Neeraja 2014, Sudarvel *et al* 2015,) while there are others who found the month of the year effect to be absent in the stock markets (Kaur 2004, Garg *et al* 2010). Present study has studied the Day of the week effect in volatility of Indian stock market and commodity market indices. The presence of the Day of the week effect was tested on four selected stock market indices and five selected commodity market indices, from the date of inception of the index to 2018. The study has found the presence of the Day of the week effect in volatility of stock market indices but Day of the week effect was found to be absent in volatility in commodity market indices. The results are in contrast to the findings observed by Gibbon *et al* 1981 for commodity markets. The study also tested the presence of Month of the year effect in stock and commodity market indices volatility. The month of the year effect was found to be present in the selected indices of both stock and commodity markets except for Nkrishi. The results in the study are similar to the ones found by different studies (Dash *et al* 2011, Ray 2012, Keong *et al* 2010) where month of the year or seasonal effect is found to be present.

In addition the study has also analyzed the risk return relationship in stock and commodity market indices. The study used the return and standard deviation series of the selected stock and commodity market indices. These series has been tested for Stationarity using ADF and Phillip Perron test. Before applying GARCH-M model the presence of ARCH effect has been tested using ARCH-LM test. The return and volatility relationship has been studied using GARCH-M model. Risk return relationship is considered as one of the factor for investment decision. The study found no significant risk return relationship in selected stock market and commodity market indices except for Nifty Smallcap 50. The results of the

study are in consistence with the results of Kumar *et al* 2008, Lucey *et al* 2006 who found no significant risk return relationship in stock and commodity market returns. The results were in contrast with the studies of Guo *et al* 2008 who found presence of significant positive risk return relationship in commodity markets.

In terms of impact of macroeconomic variables on volatility in Indian stock and commodity markets, the study used Granger causality test and multiple regression models. Granger causality test has been applied on macro economic variables namely FII net flows, DII flows and yield on 10 year govt. bonds and volatility in selected stock market indices. The study found unidirectional causality between yield on 10 year govt. bond with Nifty Midcap 50, Nifty 500 and Nifty 50. The study found that the FII's net flows have significant negative impact on volatility in all selected stock market indices. Further DII's net flows have been found to have significant negative impact on volatility in Nifty 50 only, while, yield on 10 year govt. bond have been found to have insignificant impact on volatility in stock market indices. Overall In combination, the selected independent macroeconomic variables account for significant variability in volatility of stock market indices. The results in the study are similar to the ones found by past studies (Singh 2014, Jain *et al* 2012). Further the study analyzed the impact of macroeconomic variables namely GDP growth rate, Consumer price index and yield on 10 year govt. bond on volatility in commodity market indices. The study found unidirectional causality in variables where, volatility in MCX energy granger cause CPI and yield on 10 year govt. bond, and yield on 10 year govt. bond granger cause volatility in MCX Agri. Further, the study found that the consumer price index have significant positive impact on volatility in MCX Metal and MCX Agri only. Yield on 10 year govt. bond has been found to have significant negative impact on volatility in Nkrishi. GDP growth was found to have no significant impact on volatility in selected commodity market indices. Overall In combination, the selected independent macroeconomic variables account for significant variability in volatility of MCX Energy and MCX Agri only.

The GARCH family of models was also applied on stock and commodity market indices for modeling volatility. Volatility has been forecasted using symmetric and asymmetric GARCH models namely GARCH (1, 1), GARCH-M, EGARCH and TGARCH models. The study found the absence of ARCH effect in MCX Agri commodity market index so no GARCH model has been applied on this index. The models have been selected on the basis of AIC and SIC criteria. From symmetric GARCH models GARCH (1,1) model has been found to be the best model for all the selected stock and commodity market indices except for Nifty 500. The results are similar to those (Frimpong *et al* 2006, Gokcan 2000, Alberg *et al* 2008) yet different from other studies (Singh *et al* 2016, Chong *et al* 1999). From

asymmetric GARCH models TGARCH model has been found to be best model except for Nifty 500 and Nkrishi market indices.

Further the perception of market participants namely stock and commodity brokers and traders regarding volatility in stock and commodity markets has been studied. The study found that the most important source of information for stock brokers and stock traders and commodity brokers is company announcements while for commodity traders technical analysis is the most important source of information. The volatility perception of the market participants has been analyzed using different statements. The study found that the majority of the stock brokers and stock traders perceive that volatility has been rising in the stock markets while commodity brokers perceive that volatility has been rising in commodity markets. The commodity traders perceive that volatility affects future returns.

## **CHAPTER V**

### **SUMMARY**

This chapter covers a brief summary and conclusion of the study, so as to understand implications of the findings. This chapter includes the final conclusion of the study. This chapter is divided into following sections.

#### **5.1 Summary**

#### **5.2 Findings of the study**

5.2.1 Nature of volatility in stock and commodity markets

5.2.2 Relationship between risk and return in stock and commodity markets

5.2.3 Impact of macroeconomic variables on volatility

5.2.4 Forecasting volatility

5.2.5 Perception of market participants regarding volatility in stock and commodity markets

#### **5.3 Conclusion**

#### **5.4 Scope for further research**

#### **5.1 Summary**

Volatility in stock and commodity markets has always been the prime focus of analysis for investors, analysts, policy makers and researchers. Volatility is a vast term and volatility in stock and commodity markets has been studied from various different aspects, but the studies lack in providing best method to model and forecast volatility, especially in the commodity markets. The literature reveals that nature of volatility can be studied using calendar anomalies and other anomalies. The commonly used calendar anomalies are day of the week effect and month of the year effect. Literature also advocates that the volatility as a measure of risk is used for understanding its relation with return. The volatility return relationship is found to be insignificant in the literature for both stock and commodity markets. Further the literature reveals the significant impact of various macroeconomic variables on volatility in stock and commodity markets but very little research has been done on macroeconomic variables and its impact on commodity markets. For modeling volatility various symmetric and asymmetric models of GARCH family are there. The commonly used GARCH models are GARCH (1,1) (Bollerslev 1986), GARCH-M(1,1), EGARCH (Engle 1982), PGARCH, GJR-GARCH, QGARCH, TGARCH (Zakoian 1994) and many more. Many researchers have used these models for forecasting and modeling volatility but there is no consensus on single model to be the best model. Further different views of researchers are there regarding perception of market participants regarding volatility. Seeing the gap in the

literature on account of these things the present study was undertaken for the following objectives:

1. To study the nature of volatility in Indian stock and commodity markets.
2. To study the relationship between return and volatility in selected indices of Indian stock and commodity markets.
3. To examine the impact of selected variables on volatility in Indian stock and commodity markets.
4. To identify suitable model for forecasting volatility in Indian stock and commodity markets.
5. To analyze perception of market participants regarding volatility in Indian stock and commodity markets.

To fulfill the objectives of the study secondary data pertaining to stock and commodity market indices namely Nifty 50, Nifty Mid Cap 50, Nifty Small Cap 50, Nifty 500, Nkrishi, MCX Comdex, MCX Metal, MCX Energy and MCX Agri was collected. Further Secondary data pertaining to macroeconomic variables namely FII flows, DII flows and interest rates was also collected. Primary data was also collected from 100 stock and commodity traders and 50 stock and commodity brokers. The analysis on secondary data was done from the inception date of the indices till 31<sup>st</sup> December 2018. For the first objective, day of the week effect, month of the year effect and volatility was calculated, for second objective GARCH-M model was applied, for third objective granger causality and multiple regression was applied, for fourth objective symmetric and asymmetric GARCH models were applied. Further the responses of stock brokers, stock traders, commodity brokers, commodity traders were analyzed to understand their volatility perception and important source of information regarding volatility.

## **5.2 Findings of the study**

The findings of the study have been divided into five sections. First section deals with the nature of volatility, second section covers the relation between risk and return, third section deals with the study of impact of macroeconomic variables on volatility in stock and commodity markets, the fourth section deals with forecasting ability of different models, and fifth section deals with the perception of market participants about volatility in stock and commodity markets.

### **5.2.1 Nature of volatility in stock and commodity markets.**

- For stock market indices the year 2008 was found to be most volatile and the year 2017 was found to be the least volatile year in terms of yearly volatility of daily returns.
- For commodity market indices there were no common results for the highest and lowest volatile years in terms of yearly volatility of daily returns.

- For stock market indices the year 2008 was found to be most volatile and the year 2017 was found to be the least volatile year in terms of yearly volatility of monthly returns except for Nifty Midcap 50 for which the year 2009 was found to be most volatile.
- For commodity market indices the two highest volatile years were 2008 and 2012 the lowest volatile year was found to be 2017. In all the five commodity market indices the highest volatility was observed in MCX Metal in the year 2008 (0.151) and the lowest volatility was observed in MCX Agri in 2007(0.023).
- For stock market indices the month of May was found to be most volatile except in Nifty Smallcap 50 and the month October was found to be the least volatile month except for Nifty 500 in terms of monthly volatility of daily returns.
- For commodity market indices there were no common results for the highest and lowest volatile months in terms of monthly volatility of daily returns. In all the five indices the highest volatility was observed in MCX energy in the month of January and February (0.009) and the lowest volatility was observed in Nkrishi, MCX Agri (0.01).
- For stock market indices the day of the week effect was found to be present (Tuesday)
- For stock market indices and commodity market indices the month of the year effect was found to be present on different months of the year.

### **5.2.2 Relationship between risk and return in stock and commodity markets.**

- All the selected stock market and commodity market indices return series were found to be stationary.
- The volatility clustering was observed in stock market indices namely Nifty 50, Nifty Midcap 50, Nifty 500 and Nifty Smallcap 50.
- The volatility clustering was also observed in commodity market indices namely Nkrishi, MCX Comdex, MCX Energy and MCX Metal, except for MCX AGRI, where volatility clustering was found to be absent.
- The ARCH effect was found to be present in all selected stock market indices returns.
- The ARCH effect was also found to be present in all selected commodity market indices returns except for MCX AGRI.
- The risk return relationship was found to be significant for stock market indices returns at 5% level of significance except for Nifty Smallcap 50.
- The risk return relationship was found to be significant for commodity market indices returns at 5% level of significance.

### **5.2.3 Impact of macroeconomic variables on volatility**

- The macroeconomic variables FII flows and DII flows were found to have significant effect on volatility in stock market index returns.

- The macroeconomic variable CPI was found to have significant effect on volatility in commodity market index namely MCX Metal and MCX Agri.
- The macroeconomic variable GDP was found to have significant impact on volatility in MCX Energy and Yield on 10 year govt. bond was found to have significant effect on volatility in Nkrishi

#### **5.2.4 Forecasting Volatility**

- All the four stock market indices return series were found to be stationary.
- The commodity market return series were also found to be stationary.
- Volatility clustering was found to be present in all the four stock market indices return series.
- Volatility clustering was found to be present in all the four stock market indices return series except for MCX Agri in which volatility clustering was found to be absent.
- ARCH effect was further tested using ARCH-LM test. ARCH effect was found to be present in stock market return series.
- In commodity market series also ARCH effect was found to be present except for MCX Agri return series.
- For stock market indices the GARCH (1, 1) was found to be best symmetric model and TGACRH Model was found to be best asymmetric model except for Nifty 500 for which GARCH –in-mean and EGARCH models were found to be best models.
- For Nkrishi, MCX Metal and MCX Energy the GARCH (1, 1) model was found to be best symmetric model and TGACRH Model was found to be best asymmetric model.
- For MCX Comdex the GARCH in mean (1, 1) model was found to be best symmetric model and EGACRH Model was found to be best asymmetric model.

#### **5.2.5 Perception of market participants regarding volatility in Indian stock and commodity markets**

- Commodity brokers with inherited business consider commodity related websites as significant source of information.
- In terms of trading services broker/analyst forecast was found to be important source of information.
- Majority of the traders believe that there is more volatility in Commodity market as compared to stock markets.

#### **5.3 Conclusion**

The nature of volatility has been studied using monthly volatility of daily returns, yearly volatility of daily returns, and yearly volatility of monthly returns. The pattern of the

volatility was observed through the day of week effect and month of the year effect. For all stock market indices the year 2008 was found to be most volatile and the year 2017 was found to be least volatile. This may be due to the fact that 2008 leading to huge day to day volatility in asset prices. For commodity markets indices namely MCX Energy and MCX Comdex the year 2008 was found to be most volatile while 2011, 2006, 2012 was found to be highest volatile years for Nkrishi, MCX Metal and MCX Energy respectively. For the stock market indices the month of May was found to be most volatile except for Nifty Smallcap 50 for which October month was found to be most volatile. For commodity market indices mixed results for Monthly Volatility of daily returns were observed. The study found the presence of day of the week effect in all stock market indices. Tuesday was found to be significantly different from rest of the days for Nifty 50 and Nifty 500 while Tuesday and Wednesday was found to be significantly different from rest of the days for Nifty Midcap and Nifty Smallcap 50. For commodity market indices all the days were found to be significantly different from each other except for MCX Agri where Saturday was found to be statistically insignificant.

The GARCH in Mean model was applied on stock and commodity market indices to understand the risk return relationship. All the stock market indices series were found to be stationary and ARCH effect was found to be present in all series. The risk and return relation was found to be insignificant for all selected stock market indices except for Nifty 500 where such relation was found to be significant. For commodity market indices the GRACH coefficient was found to be insignificant for all the commodity market indices.

The granger causality test was applied to find the impact of macroeconomic variables on volatility in stock and commodity markets. The macroeconomic variables namely FII net flows were found to have significant effect on volatility in all selected stock market indices. The macroeconomic variables namely DII net flows were found to have significant effect on volatility in Nifty 50 stock market index while the yield return on 10 year govt. bond was found to have no significant impact on stock market indices. The macroeconomic variable namely CPI was found to have significant impact on volatility in MCX Metal commodity market index. Further GDP rate was found to have significant impact on MCX Energy while yield on 10 year Government bond was found to have significant impact on Nkrishi commodity market index.

### **5.3 Scope for further research**

The rising interest in the volatility in Indian stock and commodity markets must accompany research on the same. Study on the nature of volatility, the impact of macroeconomic variables, risk return relationship, and forecasting ability of different models will definitely be of more interest to researchers in the time to come. Further research in this regard may be done for different GARCH models for studying volatility in many different

ways. In addition there are various anomalies besides calendar anomalies that can be studied. Further constituents of stock market and commodity market indices can be studied for modeling volatility. Implied volatility can be combined with conditional volatility in further research. In addition relationship of calendar anomalies with volatility can be explored further.

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## ANNEXURE I

### QUESTIONNAIRE – STOCK TRADERS

The questionnaire is regarding perception of Stock traders regarding volatility in stock market. This is an academic work and part of PhD program. The responses of this questionnaire will not be shared with anyone.

1. Age in years (Please tick)  
20 - Less than 30       30- Less than 40       40- Less than 50   
50- Less than 60       60 or above
2. Sex (Please tick): Male       Female
3. Marital Status (Please tick) : Married       Unmarried
4. Highest educational background (Please tick)  
Matriculation       Senior secondary (10+2)       Graduate   
Post graduate       Professional
5. Family Size : \_\_\_\_\_( In Number of People)
6. Monthly Family Income in Rs. (Please tick)  
Less than 50,000       50,000 - Less than 1, 00,000   
1, 00,000 - Less than 1, 50,000       1, 50,000- Less than 2, 00,000   
2, 00,000 or above
7. House ownership: Own       Rented
8. If you are involved in trading, what best describes you(Please tick)  
Positional trader       Day trader   
Program trader       Algorithmic trader
9. In which of the following financial assets, do you trade (tick multiple items if applicable)  
Stock       Stock options       Stock futures   
Index futures       Index options
10. Trading experience in the market  
Less than 3 years       3-5 years       5 years & above
11. Frequency of trading  
Multiple time in a day       Every day       Every week
12. Source of Finance for trading  
Own money       Borrowings       Margin Money

13. Trading Motivation

Profession

Additional Income

Knowledge Gaining

Other Objectives (like time pass)

14. What is your goal for stock trading?

To grow aggressively

To grow significantly

To grow moderately

To grow with caution

To avoid losing money

15. Number of companies in which trading is carried out

Less than 10

10 to less than 20

20 & above

16. Kindly express the importance for following sources of trading information (Please tick)

S. No.	Sources of trading Information	Very Important	Important	Neutral	Unimportant	Not Important
1	Newspaper					
2	Journals & Magazines					
3	TV Channels					
4	Investments Related Websites					
5	Brokers / Analysts Forecast					
6	Investor Forum					
7	Own Technical Analysis					
8	Company Announcements					
9	Stock Exchange Announcements					
10	Others (Friends , Relatives etc)					
11	Investment Blogs					
12	Macroeconomic News					
13	Industry News					

17. How best you will describe your risk return profile

High risk high return

Moderate risk moderate return

Low risk low return

18. Which is your most frequent mode of trading

Online                   Offline                   Both

19. State the trading volume per day ( In Rs.)

< 5 lakh                   5-10 lakh                   10-15 lakh                   >20 lakh

20. State the stock indices you frequently use as reference for trading

S. No.	Indices	Tick (✓)
1	Sensex	
2	S&P CNX Nifty	
3	CNX Nifty Junior	
4	S& CNX 500	
5	CNX Mid-cap	

21. Assuming normal market conditions, what would you expect from this trading over time?

- To outperform the market
- To generally keep pace with the stock market
- To slightly trail the stock market, but make a good profit
- To trail the stock market, but make a moderate profit
- To have some stability, but make modest profits
- To have a high degree of stability, but make small profits

22. State the expected rate of return (ROR) per annum from your trading activities.

- Less than 12%                   12% - 24%
- 24% - 36%                   36% & above

23. To what extent do you rely on the following for your trading action

Analysis	Very High extent	High extent	Medium extent	Low Extent	Not at all
Company Analysis					
Industry analysis					
Macro economic analysis					
Technical analysis					
Behavioral Theories					

24. Please state your level of agreement regarding following statements (Please tick)

Risk Perception	Strongly Agree	Agree	Neutral	disagree	Strongly Disagree
My approach is to be cautious and avoid all risky investment					
Any trading activity that involves a great deal of risk is not really investments but it is gambling					
The more money one has, the more trading risk one can take.					
My broker decides the best trading levels for me					
The more familiar a trading opportunity is , the less risky it is					
A diversified portfolio reduces risk					
The older people take lesser trading risk					
The need to liquidate quickly prohibits me from considering trading in riskier products'					
The higher the trading yield or rate of return, the greater is its associated risk					

25. Reasons for choosing particular Stock Exchange

- More liquid market       Transparent market       Longer trading hours   
 Better broker services       Other

26. Kindly rate your level of agreement regarding volatility in stock market (Please tick)

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Volatility has been rising in stock market					
Overall markets are calm in nature but there are incidences of high volatility					
Volatility affects future returns					
Volatility offers good opportunities for traders					

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Technical analyst can make use of this volatility in generating good returns					
There is more volatility in stock market as compared to commodity markets.					
With increasing technical innovations in stock market, volatility is rising					
New methods of trading like algorithmic trading, increases volatility					
Volatility is not good for Long term investors					
Volatility is rightly captured in Indian VIX					
Derivatives help in generating good return due to volatility					
Largely on an average I have earned good returns due to increasing volatility					
I feel that this volatility will increase more in future					
I desire that regulators should devise more measures to contain volatility					

**ANNEXURE II**  
**QUESTIONNAIRE -STOCK- BROKER**

The questionnaire is regarding perception of broker regarding volatility in stock market. This is an academic work and part of PhD program. The responses of this questionnaire will not be shared with anyone.

1. Age in years (Please tick)  
20 - Less than 30                       30- Less than 40   
40- Less than 50                       50- Less than 60                       60 or above
2. Sex (Please tick)  
Male                       Female
3. Marital Status (Please tick)  
Married                       Unmarried
4. Highest educational background (Please tick)  
Matriculation                       Senior secondary (10+2)                       Undergraduate   
Post graduate                       Professional
5. Family Size : \_\_\_\_\_( In Number of People)
6. Monthly Income in Rs. (Please tick)  
Less than 50,000                       50,000 - Less than 1, 00,000   
1, 00,000 - Less than 1, 50,000                       1, 50,000- Less than 2, 00,000   
2, 00,000 or above
7. When did you start your brokerage business? \_\_\_\_\_ ( Please Mention year)
8. Is this Inherited Business? (Please tick)  
Yes                       No
9. Are you involved in? (Please tick)  
Self trading                       Servicing clients                       Both
10. Do you provide services in commodities trading also? (Please tick)  
Yes                       No
11. What kind of trading do you offer to your client? (Please tick)  
Online                       Offline                       Both
12. In what kind of market do you operate? (Please tick)  
Primary Market                       Secondary Market                       Both
13. If you are involved in trading, what best describes you (Please tick)

Positional trader

Day trader

Long Term Investor

14. Kindly express the importance for following sources of investment information (Please tick)

S. No.	Sources of Investment Information	Very Important	Important	Neutral	Unimportant	Not Important
1	Newspaper					
2	Journals & Magazines					
3	TV Channels					
4	Investments Related Websites					
5	Brokers / Analysts Forecast					
6	Investor Forum					
7	Technical Analysis					
8	Company Announcements					
9	Stock Exchange Announcements					
10	Others (Friends , Relatives etc)					
11	Investment Blogs					

15. Approximately how many clients do you serve? (Please tick)

0-Less than 50

50- Less than 100

100- Less than 150

150- Less than 200

200 and Above

16. What best describes your top 10 clients. (in terms of value) (Please tick)

Positional traders

Day traders

Long Term Investors

17. What best describes your top 10 clients. (in terms of No. of Trades) (Please tick)

Positional traders

Day traders

Long Term Investors

18. What do you think what is the main objective of your clients? (Please tick)

Capital appreciation

Long term wealth

Dividend

Use stock market as an alternative investment.

19. How tolerance for risk is best described for your client? (Please tick)

High Moderate Low 

20. Kindly rate your level of agreement regarding volatility in stock market (Please tick)

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Volatility has been rising in stock market					
Overall markets are calm in nature but there are incidences of high volatility					
Volatility affects future returns					
Volatility offers good opportunities for traders					
Technical analyst can make use of this volatility in generating good returns					
There is more volatility in stock market as compared to commodity markets.					
With increasing technical innovations in stock market, volatility is rising					
New methods of trading like algorithmic trading, increases volatility					
Volatility is not good for Long term investors					
Volatility is rightly captured in Indian VIX					
Derivatives help in generating good return due to volatility					
Largely on an average my clients have earned good returns due to increasing volatility					
I feel that this volatility will increase more in future					
I desire that regulators should devise more measures to contain volatility					

## ANNEXURE III

### QUESTIONNAIRE- COMMODITY TRADERS

The questionnaire is regarding perception of Commodity traders regarding volatility in stock market. This is an academic work and part of PhD program. The responses of this questionnaire will not be shared with anyone.

1. Age in years (Please tick)  
20 - Less than 30                       30- Less than 40                       40- Less than 50   
50- Less than 60                       60 or above
2. Sex (Please tick):  
Male                       Female
3. Marital Status (Please tick) :                      Married                       Unmarried
4. Highest educational background (Please tick)  
Matriculation                       Senior secondary (10+2)                       Graduate   
Post graduate                       Professional
5. Family Size : \_\_\_\_\_( In Number of People)
6. Monthly Family Income in Rs. (Please tick)  
Less than 50,000                       50,000 - Less than 1, 00,000   
1, 00,000 - Less than 1, 50,000                       1, 50,000- Less than 2, 00,000   
2, 00,000 or above
7. House ownership:    Own                       Rented
8. If you are involved in trading, what best describes you(Please tick)  
Positional trader                       Day trader
9. (a) In which of the following commodities, do you trade (tick multiple items if applicable)  
Metals                       Energy   
Bullion                       Agricultural   
(b) In which commodities do you trade the most \_\_\_\_\_
10. Your Trading experience in commodity market is  
Less than 3 years                       3- less than 5 years                       5 years & above
11. Frequency of trading  
Multiple times in a day     Every day                       Every week
12. Source of Finance for trading

Own money

Borrowed money

Margin Money

13. Trading Motivation

Profession

Additional Income

Knowledge Gaining

Other Objectives (like time pass)

14. What is your goal for commodity trading?

To grow aggressively

To grow significantly

To grow moderately

To grow with caution

To avoid losing money

15. Number of commodities in which trading is carried out

Less than 5

5-less than 10

10 & above

16. Kindly express the importance for following sources for commodity trading information (Please tick)

S. No.	Sources of Investment Information	Very Important	Important	Neutral	Unimportant	Not Important
1	Newspaper					
2	Journals & Magazines					
3	TV Channels					
4	Commodity Related Websites					
5	Analysts Forecast					
6	Commodity Investor Forum					
7	Technical Analysis					
8	Commodity news					
9	Commodity Exchange Announcements					
10	Others (Friends , Relatives etc)					
11	Investment Blogs					

17. How best you will describe your risk return profile

High risk high return

Moderate risk moderate return

Low risk low return

18. Which is your most frequent mode of trading

Online       Offline       Both

19. State the trading volume per day

< 5 lakh       5-10 lakh       10-15 lakh       >20 lakh

20. Assuming normal market conditions, what would you expect from this trading over time?

To outperform the market

To generally keep pace with the commodity market

To slightly trail the commodity market, but make a good profit

To trail the commodity market, but make a moderate profit

To have some stability, but make modest profits

To have a high degree of stability, but make small profits

21. State the expected rate of return (ROR) per annum from your commodity trading activities.

Less than 12%       12% - 24%       24% - 36%       36% & above

22. To what extent do you rely on the following for your trading action

Analysis	To great extent	To large extent	To some extent	not at all
Commodity Analysis				
Macro economic analysis				
Technical analysis				

23. Please state your level of agreement regarding following variables (Please tick)

Risk Perception	Strongly Agree	Agree	Neutral	disagree	Strongly Disagree
My approach is to be cautious and avoid all risky trading activities					
Any trading activity that involves a great deal of risk is not really investments but it is gambling					
The more money one has, the more trading risk one can take.					
My broker decides the best trading levels for me					
The more familiar a trading opportunity is, the less risky it is					

Risk Perception	Strongly Agree	Agree	Neutral	disagree	Strongly Disagree
A diversified portfolio reduces risk					
The older people take lesser trading risk					
The need to liquidate quickly prohibits me from considering trading in riskier products					
The higher the trading yield or rate of return, the greater is its associated risk					

24. Reasons for choosing particular Commodity Exchange

More liquid market       Transparent market       Longer trading hours

Better broker services       Other

25. Kindly rate your level of agreement regarding volatility in commodity market (Please tick)

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Volatility has been rising in commodity market					
Overall markets are calm in nature but there are incidences of high volatility					
Volatility affects future returns					
Volatility offers good opportunities for traders					
Technical analyst can make use of this volatility in generating good returns					
There is more volatility in commodity market as compared to stock markets.					
With increasing technical innovations in commodity market, volatility is rising					
Volatility is not good for Long term investors					
Derivatives help in generating good return due					

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
to volatility					
Largely on an average I have earned good returns due to increasing volatility					
I feel that this volatility will increase more in future					
I desire that regulators should devise more measures to contain volatility					

26. As per your perception and knowledge , what do you think in which of the following commodity group price volatility is higher

Metals

Energy

Bullion

Agricultural

## ANNEXURE – IV

### QUESTIONNAIRE -COMMODITY- BROKER

The questionnaire is regarding perception of broker regarding Volatility in commodity market. This is an academic work and part of PhD program. The responses of this questionnaire will not be shared with anyone.

1. Age in years (Please tick)  
20 - Less than 30       30- Less than 40   
40- Less than 50       50- Less than 60       60 or above
2. Sex (Please tick)  
Male       Female
3. Marital Status (Please tick)  
Married       Unmarried
4. Highest educational background (Please tick)  
Matriculation       Senior secondary (10+2)       Undergraduate   
Post graduate       Professional
5. Family Size : \_\_\_\_\_(Mention Number of persons in Family)
6. Monthly Income in Rs. (Please tick)  
Less than 50,000       50,000 - Less than 1, 00,000   
1, 00,000 - Less than 1, 50,000       1, 50,000- Less than 2, 00,000   
2, 00,000 or above
7. When did you start your brokerage business ? \_\_\_\_\_ ( Please Mention year)
8. Is this Inherited Business? (Please tick)  
Yes       No
9. Are you involved in? (Please tick)  
Self trading       Servicing clients       Both
10. Do you provide services in stock trading also? (Please tick)  
Yes       No
11. What kind of trading do you offer to your client? (Please tick)  
Online       Offline       Both
12. In what kind of market do you operate? (Please tick)  
Primary Market       Secondary Market       Both
13. If you are involved in trading, what best describes you(Please tick)

Positional trader  Day trader  Long Term Investor

14. Kindly express the importance for following sources of investment information (Please tick)

S. No.	Sources of Investment Information	Very Important	Important	Neutral	Unimportant	Not Important
1	Newspaper					
2	Journals & Magazines					
3	TV Channels					
4	Commodity Related Websites					
5	Brokers / Analysts Forecast					
6	Investor Forum					
7	Technical Analysis					
8	Commodity Related Announcements					
9	Commodity Exchange Announcements					
10	Others (Friends , Relatives etc)					

15. Approximately how many clients do you serve? (Please tick)

0-Less than 50  50- Less than 100  100- Less than 150   
 150- Less than 200  200 and Above

16. What best describes your top 10 clients. (in terms of Value) (Please tick)

Positional traders  Day traders  Long Term Investors

17. What best describes your top 10 clients. (in terms of No. of Trades) (Please tick)

Positional traders  Day traders  Long Term Investors

18. What do you think what is the main objective of your clients? (Please tick)

Capital appreciation   
 Long term wealth   
 Use commodity market as an alternate investment.

19. How tolerance for risk is best described for your client? (Please tick)

High Moderate Low 

20. Kindly rate your level of agreement regarding volatility in Commodity market (Please tick)

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Volatility has been rising in commodity market					
Overall markets are calm in nature but there are incidences of high volatility					
Volatility affects future returns					
Volatility offers good opportunities for traders					
Technical analyst can make use of this volatility in generating good returns					
There is more volatility in commodity market as compared to stock markets.					
With increasing technical innovations in commodity market, volatility is rising					
New methods of trading like algorithmic trading, increases volatility					
Volatility is not good for Long term investors					
Derivatives help in generating good return due to volatility					
Largely on an average my clients have earned good returns due to increasing volatility					
I feel that this volatility will increase more in future					
I desire that regulators should devise more measures to contain volatility					



## VITA

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University and year of award : Punjab Technical University, Jalandhar, 2013  
%age of marks : 81.50  
Title of Master's Project Report : Impact of Microfinance on Household Income  
**Ph.D. Degree** : **Business Administration**  
OCPA : 7.70/10.00  
Title of Dissertation : A study of volatility in Indian stock and  
commodity markets