A STUDY ON COMMODITY SPOT AND FUTURES MARKETS IN INDIA

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DECLARATION

I, Chodankar Trupti Dinanath hereby declare that this thesis represents work which has been carried out by me and that it has not been submitted, either in part or full, to any other University or Institution for the award of any research degree.

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Table of Contents

Table of Contents

Table of Contents

List of Tables

List of Tables

List of Tables

List of Tables

List of Tables

List of Figures

List of Figures

LIST OF ABREVIATIONS

ACE	ACE Derivatives and Commodity Exchange
ADF	Augmented Dickey Fuller Test
AIC	Akaike Information Criterion
ARCH	Auto Regressive Conditional Heteroskedasticity
AGCC	Arabian Gulf Cooperative Council
BSE	Bombay Stock Exchange
CBOT	Chicago Board of Trade
CE	Co-Efficient
CEs	Cointegration Equations
CME	Chicago Mercantile Exchange
CTT	Commodity Transaction Tax
DCE	Dalian Commodity Exchanges
DJAIG	Dow Jones AIG Commodity Index
DPL	Daily Price Limits
DDR	Due Date Rate
EGARCH	Exponential Generalized Autoregressive Conditional Heteroskedasticity
ECT	Error Correction Term
ECA	Essential Commodities Act
eNWRs	Electronic Negotiable Warehousing Receipts
EMH	Efficient Market Hypothesis
ECM	Error Correction Model
FMC	Forward Markets Commission
FC(R) A	Forward Contracts (Regulation) Act
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
GED	Generalized Error Distribution
ICEX	Indian Commodity Exchange Ltd
IPE	International Petroleum Exchange of London

IPSTA	Pepper and Spices Trade Association
IFSC	International Financial Services Centre
LM	Lagrange Multiplier
LME	London Metal Exchange
MCXAGRI	MCX Agriculture Index
MCXCOMDEX	MCX Composite Index of Metals, Energy and Agricultural Commodities
MCXENERGY	MCX Energy Index
MCXMETAL	MCX Metal Index
MCX:	Multi Commodity Exchange of India
MVHR	Minimum Variance Hedge Ratio
MGARCH	Multivariate Generalised Autoregressive Conditional Heteroskedasticity
NSEL	National Spot Exchange Limited
NBOT	National Board of Trade
NCDEX	National Commodity and Derivatives Exchange of India
NYMEX	New York Mercantile Exchange
NMCE	National Multi Commodity Exchange
NSDL	National Securities Depository Limited
NSE	National Stock Exchange of India Ltd.,
NYMEX	New York Mercantile Exchange
NYSE	New York Stock Exchange
OLS	Ordinary Least Square
OTC	Over-the-Counter
PP	Philip Perron
RJCRB	Reuters/Jefferies Commodity Research Bureau
SCRA	Securities Contracts Regulation Act
SEBI	Security Exchange Board of India
SSE	Shanghai Stock Exchanges
SHFE	Shanghai Futures Exchange
TOCOM	Tokyo Commodity Exchange
TAIFEX	Baltic Exchange and Taiwan Futures exchange
TGARCH	Threshold Generalised Autoregressive Conditional Heteroskedasticity
VECM	Vector Error Correction Model

VAR	Vector Autoregressive Model
VGARCH	Vector Generalised Autoregressive Conditional Heteroskedasticity
NYBOT	New York Board of Trade
NYMEX	New York Mercantile Exchange
SIC	Schwarz Information Criteria

ABSTRACT

Commodity market in India is the backbone of Indian economy. Though the commodity market existed over centuries, the futures market came into existence in the 19th century. As a dynamic developing country, India is one of the largest producers of agricultural commodities and consumer of bullion, metal and energy, which makes the role of commodity market essential. Indian commodity futures market has evolved exponentially both in terms of trading volume and its reach across the country since its inception. The effectiveness of commodity derivatives dwells upon the performance of three basic functions namely 1) Risk (Volatility) management of derivatives market 2) Price Discovery 3) Hedging Effectiveness. An efficient market can only help in achieving economic growth. In this backdrop, to completely understand efficiency of the Indian commodity derivatives market, the study analysis effectiveness of futures market in price discovery, the study explores the presence of stylized fact of volatility. Further, a comparative analysis is done to compare the appropriateness of static and dynamic hedge models and then tests their efficiency in reducing price variance. The study aims to examine the effectiveness of commodity futures market in price discovery and risk management in India with reference to select agricultural and non- agricultural commodities traded in Multi Commodity exchange in India (MCX). In particular, the research is mainly focused on examining: 1) the market structure and pattern of growth of commodity markets in India; 2) the causal relationship between futures prices and spot prices of commodity market; 3) The volatility pattern of the commodity market in India; 4) to estimate the optimal hedge ratio and hedging effectiveness for select commodities traded on Indian commodity derivatives market.

The study is empirical in nature which is purely based on secondary data, collected mainly from official website of the exchange MCX, SEBI and FMC. The study covered a period of twelve years from 1st January 2009 to 31st December 2020 using daily trading data. Being

the study based on sampling, twelve commodities composed of four agricultural commodities (Cardamom, Cotton, CPO and Mentha Oil) and eight non- agricultural commodities (Aluminium, Copper, Nickel, Lead, Crude Oil, Natural Gas, Gold and Silver) traded frequently without a break of more than three months have been selected from the exchange MCX. The MCX indices namely MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY also used to study the defined objectives as they are representatives of the commodity derivatives market. The methodology used to achieve the objectives comprises of an extensive application of econometric and mathematical modelling. The effectiveness of price discovery is measured through Johansen Test of Cointegration, VECM and Granger Causality Test. Volatility Persistence and asymmetric effect of Indian Commodity market is evaluated through GARCH (1,1), EGARCH and TGARCH model. The effectiveness of commodity derivatives in hedging is measured through hedge ratio and hedging effectiveness by using Ordinary Least Square (OLS) method, VECM and VECM-GARCH model through construction of hedged portfolio and unhedged portfolios. Finally, the analysis shows how it result into the process of risk management. In addition to that Descriptive statistics viz. Mean, Median, Standard Deviation, skewness and kurtosis is analysed. Augmented Dickey Fuller Test is also used to test the stationarity of the time series data.

The trading pattern of Indian commodity market shows a phenomenal growth since 2003 after formal approval by government of India with 22 exchanges. At the same time the prices of the commodities have increased. Remarkable growth is witnessed in the initial years of establishment of national exchanges up to the year 2005-06. Thereafter, a stable growth is recorded averaging to 40% per annum up to the year 2011-12. Total turnover in commodity futures decreased by 40.5% for the year 2013-2014. Sudden decline in volume and trade transactions is witnessed from the year 2013-2014 in commodity derivatives market. Multi

Commodity Exchange dominated the market with 94.2% share in the overall turnover (2019-20), up from the 91.2% share recorded in the 2018-19. The share of agricultural derivatives which was recorded the highest with 70% in 2004-05 during the initial years of commodity trading in India, has gradually declined to 30% by the year 2018-19. Analysis of volume contributions on the major national commodity derivatives exchange revealed that majority of the trade has been concentrated in few commodities and major volume has been contributed by non-agricultural commodities namely bullion, energy and metals.

Augmented Dickey Fuller Tests confirmed stationarity in all data series. JB statistics has been found significant at 5% level that indicates the non-normality in data distribution. A linear combination of integrated variables has been found stationary, so variables have been marked as co-integrated under Johansen Co-integration Test. The informational efficiency of the futures market evidenced by the VECM model has proved that futures prices play the role of a leader and transmit the information to the spot market for all the commodities under study. Granger Causality test disclose that there is unidirectional causality from commodity futures prices to spot prices for all market indices and for seven individual commodities namely Cardamom, Cotton, Aluminium, Copper, Lead, Crude Oil and Silver. There is bi-directional causality running from spot market price to futures market price and vice versa for five commodities namely CPO, Mentha Oil, Nickel, Natural Gas and Gold. Though bi-directional information flow exists for these commodities, the flow from futures market price to spot price is stronger. A stronger flow of information is exhibited from the futures to spot market which confirmed the efficiency of the futures market in discovering the prices for spot market of sample commodities. Analysis of dynamic behaviour of commodity futures market has focussed on issues around volatility clustering, mean reversion and volatility asymmetry effect relating to the sample commodities.

Empirical result provides evidence of the presence of stylized facts of volatility in Indian commodity market. The symmetric volatility model GARCH (1,1) have been applied, which reveals that there is high volatility persistence is found for all commodity market indices and sample commodities except for the index MCXAGRI and futures market of agricultural commodities namely Cardamom, Cotton and Mentha Oil. Low level of volatility persistence is observed for agricultural commodity futures since agriculture is a government regulated market, any innovation entering the market has short-lived impact due to government intervention. Commodities from metal and energy sector are found to be most volatile markets as these markets are mostly dependent on the foreign markets. All the return series of MCX indices and twelve commodities show sign of the mean reversion except for the commodity Crude Oil. Total value of ARCH and GARCH term is less than 1 as per GARCH (1,1) model which specifies that return volatility will not move indefinitely downward or upwards. In due course, the return volatility will come down to a mean level. The presence of leverage effect is confirmed in the case of spot and futures market of MCXAGRI, MCXENERGY, Cardamom, Copper, Nickel and Crude Oil and future market of Cotton and Lead. Here negative shock effect creates much greater levels of volatility when compared to positive shock effects.

It is observed that the VECM model and VECM-GARCH model is the superior model since the hedge ratio obtained is high and provided highest variance reduction as compared to OLS model. Hence, we can conclude from the empirical analysis that the VECM model can be used to estimate the hedge ratio, which will help the hedgers to compare and take advantage for a given position from the different future position. The empirical results suggests that reduction in variance that is attained by holding the derivatives futures contract is low and on an average range between 15% to 40% in most of the sample commodities. Thus, it can be concluded that the price risk reduction with commodity derivatives futures markets is only 15% to 40% in India. In case of agricultural commodities, Indian commodity futures markets provide lower hedging effectiveness (less than 20%) as compared to non-agricultural segment. It has been observed that commodities such as Natural Gas, Crude Oil and Copper has the lowest hedging effectiveness under non-agricultural commodities. Copper futures has the lowest amount of variance reduction (0.086%) followed by Natural Gas (5.02%) and Crude Oil (7.01%). It is also observed that the hedging role of Indian commodity futures markets has declined in the second sub-period (1st January 2015 to 31st December 2020) with reduced trading activity in the market. Some of the main reasons are NSEL scam and introduction of commodity Transaction Tax (CTT) in the year 2013. Suspension of trading in agricultural commodities at regular intervals, measures taken by SEBI in the year 2016 to increase the initial margin and reduction in the maximum position affected the market. In the same year demonetisation of rupee reduced the cash holdings of investors, hence affecting the commodity market. The empirical analysis suggests that Indian futures contracts are not effective for hedging exposures and overall hedge effectiveness has declined in recent years. The reason for low hedging effectiveness may be due to low awareness of futures markets among participants, low participation by hedgers, high transaction costs in the futures markets, policy restrictions, lower number of delivery centres, inadequate contract design or high transaction costs in the spot market. Traders of futures markets are using these futures for more speculation purpose than hedging as evidenced by the speculation ratio.

The present research has significantly contributed to the different spheres of commodity derivatives market functioning. The results of the study are related to advancement of theoretical understanding of the commodity futures market in India. Here comes the relevance of the present research which tries to study the information flow between spot and futures markets. It is likely influencing the decisions of the farmers in participating in futures trading and storage. This research work provides basic knowledge on the movement of Indian commodity market and its underlying market. The movement of both markets gives the investors and traders to take decisions on their dealing in the market. This research, actual relationship between spot and futures price market shows the picture on the opportunities of the hedging and arbitrage in the Indian commodity market. The study is of high relevance to both the users of this market and regulators. An efficient market helps the government for better price stabilization and implementation of other control policies. It provides reliable estimates for future spot prices to the traders and producers of the commodities. This would help investors hedge their commodity risk, take speculative positions in commodities and exploit arbitrage opportunities in the market. The present research would facilitate commodity producers, consumers, processors, traders and financial institutions to design an efficient asset allocation strategy. Thus, the outcome of this study is helpful for a variety of stakeholders who enthusiastically participate in commodity markets whether it is spot or futures market.

CHAPTER I
INTRODUCTION

This is an introductory chapter of the thesis, which covers evolution of commodity derivatives in India, functions of commodity derivatives exchange, commodity market participants and trading mechanism in commodity derivatives market in India. This chapter also comprises of review of literature and it has been divided into two sections.

Section I: Introduction to commodity derivatives market in India

Section II: literature review on the subject.

SECTION I

1.1 INTRODUCTION TO COMMODITY DERIVATIVES MARKET

1.1.1 Introduction

Derivative is an exceptionally emerging terminology in the world of the financial market which till now has been used in chemical sciences. In the world of financial market, derivative is defined as an instrument which derives its value from the underlying assets. These underlying assets may be Indices, financial securities, currencies, commodities and so on. Generally, derivative trading is available through three instruments; namely Options, Futures, and Forwards. In India, commodity derivative is allowed through Futures, Forward and Options contracts which have become standard risk management tools that enable risk sharing and thus facilitate the efficient allocation of capital to productive investment opportunities.

Indian Commodity Derivatives market has emerged as one of the fastest growing commodity derivatives markets in the world, since the year 2003 with the reintroduction of commodity derivatives trading in India. India is one of the major growers of commodities and at the same time consumes huge amount of commodities from energy and bullion sector. Given the growth in trading volumes and increasing integration of the Indian economy with the rest of the world, the Indian commodity derivatives market has begun to be recognized among the top derivatives exchanges of the world thus making it one of the highest growth areas in the financial sector today.

1.1.2 Evolution of Commodity Derivatives in India

The Commodity trading in India have existed for thousands of years. Their existence is found in "Kautilya's Arthasastra" and the words like Teji, Mandi, Gali, Phatak have been commonly heard in Indian markets. The organized derivative futures markets commenced in 1875 with the establishment of the Bombay Cotton Trade Association Ltd. The derivatives futures trade in oilseeds started in the year 1900 with the setting of Gujurati Vyapari Mandi which carried on derivatives futures trading in Castor seed, Groundnut Cotton. Trading in Derivatives futures in Wheat were present at different places in the state of Uttar Pradesh and Punjab. In 1919 Calcutta Hessian Exchange Ltd was set-up for future trading in jute goods and raw jute, but organized derivative future trading in raw jute started by Indian Jute Association Ltd in 1927. The Forward Contracts (Regulation Act) was enacted in the year 1952 to regulate the trading in futures and forwards. The Forward Market Commission was instituted as a regulatory body for commodities in the year 1953. However, Indian commodity market did not blossom over four decades. During the period of 1950 to 1993 many Committees were established namely Dantawalla Committee, Khusro Committee, Sharoff Committee by the Government of India to study the various aspects of futures trading. The derivatives futures trade in spices was first organized by the India Pepper and Spices Trade Association (IPSTA) in Cochin in the year 1957. Due to sharp fall in output, there was an unprecedented rise in the prices of major oils and oil seeds in mid 1960s. In

1966 derivatives futures trading was all together banned to have control on the movement of prices of many agricultural and essential commodities. In the year 1991after the introduction of economic reforms, Government of India appointed a committee on forward markets under the Chairmanship of Professor K. N. Kabra. In order to encourage the agriculture sector, the National Agricultural Policy 2000 has envisaged for external and domestic market reforms and dismantling all controls and regulations on agricultural commodity markets. The Government of India issued notification in April 2003 permitting derivative futures trading in commodities, paving the way to establish national level commodity exchanges.

1.1.3 Types of Derivatives

A commodity derivative may be defined as a monetary instrument that is tradable on or off a designated exchange; its price is directly dependent on the value of the primary commodity or upon any decided pricing arrangement or index. Derivatives involve the trade of obligations or rights based on the underlying primary product however; it does not directly involve transfer of property. Commodity derivatives are essentially trade contracts based on the underlying asset which is the commodity and the investors speculate on these, based on the expected price movements in the future. The complex form of derivatives is known as exotic derivatives and the simplest form of derivatives are termed as plain vanilla derivatives viz., Forward, Futures, and Option contracts. Brief of these contracts is given below:

1.1.3.1 Forward Contract

This contract is a transaction in which the buyer and seller agree upon the delivery of a specified underlying asset at a specified future date on a pre- determined price. These contracts are generally bipartite contracts with no intermediary and are not traded on exchanges. As all the financial risk is borne by the parties in the contracts, which may result in the inclusion of some sort of risk premium factor. These contracts are traded on over-the-counter (OTC). The specifications of these contracts like, price, quality, and delivery terms are negotiable between the buyer and the seller at the time of initiation of the contract. In Indian context, these contracts are more popular in currency and commodity market.

1.1.3.2 Futures contract

A futures contract is a firm contractual agreement between a buyer and seller for a specified asset for a fixed date in future. This can simply be characterized as the standardized form of forward contract. The standardization may be in terms of minimum contact size, maturity, trading mechanism, delivery terms, etc. The contract price will vary according to the market price but it is fixed when the trade is made. Essentially, both the parties have the right as well as the obligation to perform under the futures contract. Exchange imposes the margin on both the parties to the contract and follows mark to market system to ensure that the contract is settled at the time of maturity. The futures contracts offer liquidity to the parties entering into the contract and immunity to counter party risk.

1.1.3.3 Option Contract

Unlike futures contract, an Option contract separates the right and obligation between the two parties. It confers the right upon the option buyer, but not the obligation to buy (call option) or sell (put option) a specific underlying asset at a specified price, known as strike price or exercise price, up to or on a specific future date. It can simply be described as an insurance policy bought by the option writer, who takes over the obligation under the contract. In case the right is exercisable only on the maturity, it is termed as European option, while on the other hand if the right is exercisable any time up until the maturity, then it is termed as American Option.

1.1.4 Features of Commodity Derivatives Market

- Standardized: Commodity derivatives contracts are of standardized predetermined quantity, quality, and delivery date.
- Organized: Commodity derivatives contracts are traded on an organized commodity exchange in India like MCX, NCDEX etc. and LME, NYMEX etc. internationally.
- Facilitates Margin Trading: Trading in commodity derivatives do not involve investment of the full value of a contract but the traders are required to keep a margin ranging between 5% to 20% of the total value of the contract which varies across commodities and exchanges. This facilitates the traders to take benefit of leveraged positions.
- Physical Delivery: Commodity derivatives trading have the option to take actual delivery of the commodity on expiry of the contract. Physical delivery of the commodities requires providing by the member to the exchange prior delivery intimation and completion of all the formalities related to delivery as stated by the exchange.
- Regulated Markets Environment: Futures markets are being regulated by the Government through SEBI in India and Commodity Futures Trading Commission (CFTC) in USA, etc. which ensures fair practices in the commodity derivatives market.
- Eliminates Counterparty Risk: Commodity derivatives exchanges take the help of clearing houses to reassure fulfilment of the terms of the futures contract thereby avoiding the risk of default by the other party.

1.1.5 Key Functions of Commodity Derivatives Exchanges

Commodity derivatives exchange needs to provide a seamless trading platform with a fair, transparent and financially secure trading environment in keeping with the robust risk management practices. It should have a suitable risk management mechanism, normally in the form of a clearinghouse (owned by the exchange or by another operator) that ascertains the credit-worthiness of the parties of a contract and ensures the execution of contracts. It especially serves as a legal counter-party between each buyer and each seller of a derivatives contract on the exchange and it is called a central counter party.

The exchange also maintains a Settlement Guarantee Fund to ensure a high level of protection against the risk of default by a trader. Importantly, the clearinghouse or the Settlement Guarantee Fund of the exchange has to be used in case of default by a buyer or a seller to pay the other party. In order to guarantee that the parties will execute the contract and to maintain reserves to deal with default, the clearinghouse or SGF requests the parties to provide collateral in the form of cash or securities. The margin money fluctuates daily with the change in prices of the contracts on which traders have taken positions. In an event of adverse price movements, the traders are asked to increase their margin amount. The key functions of commodity derivative exchanges are as follows.

- ❖ Providing and enforcing rules and regulations for uniform and fair-trading practice.
- ❖ Facilitating trading in a transparent manner.
- ❖ Recording trading transactions, including circulating price movements and market news, to the participating members.
- ❖ Ensuring execution of contracts.
- ❖ Providing a system of protection against default of payment (clearing).
- ❖ Providing a dispute settlement mechanism.

- Designing the standardized contract for trading which cannot be modified by either party.

1.1.6 Commodity Market Participants

1.1.6.1 **Hedgers:** are those whose interest is in the ready delivery or specific delivery contracts and are basically taking advantage of commodity derivatives market to protect themselves against price changes. Their main aim is to insure themselves against the risk which is part of the price of the asset by taking advantage of the derivatives. Hedgers are in need of certain parties who are ready to take the opposite party position.

1.1.6.2 **Speculators:** They are like middle man. They basically do not have special interest in the underlying commodity, but waits for opportunity in the price changes favourable to them. Their interest is not to own the commodity. They are ready to take the risk which the hedgers want to pass on in the derivatives market. They buy from one and sell it to others in the hope of future price changes. They facilitate the required liquidity and depth to the market which the hedgers on their own fail to provide. The speculators are primarily experts in analysing the market and shoulder the risk of the hedgers for anticipated profits thereby providing a helpful economic function and are an important constituent of the commodity derivatives market. Without the speculators, the commodity derivatives market will not have liquidity and have chances of a collapse.

1.1.6.3 **Arbitrageurs:** are those who make the decision of simultaneous purchase and sale in two different markets so as to reap the benefit of price differences. Indirectly, they help eliminate the price differences in different markets. The arbitrageurs facilitate in bringing the prices of contracts across in a commodity in equilibrium.

The other substantial constituents in commodity markets include:

1.1.6.4 Commodity Traders: Commodity markets have complicated trading processes. Traders make efforts to include value to trading relationship by facilitating risk management traits. Traders also sometimes offer financing and other services. Commodity traders have cumbersome hedging needs, which depend on the peculiar type of their activities.

1.1.6.5 Commodity Consumers/ Producers: These constituents have natural underlying outright short (consumers) and long (producers) positions in the relevant commodity. The risk which is part of the exposure drives the applicability of commodity derivatives by consumers and producers. The use of commodity derivatives is mostly because of the pattern of cash flows. Producers need to make substantial capital investments to commence the production of a particular commodity. This particular investment decision is mostly made well before the sale and production of the commodity. This implies that the producer is well aware of the price changes in the commodity. The consumers need to decide on hedging is necessitated by the availability of alternative products and the capacity to transfer the increased input costs. In many of the commodities, consumers and producers deal directly with each other. The contracts include negotiated one to one long term purchase or supply contracts with the consumers and producers. The contracts may involve fixed price agreement to ensure decline in the price risk for consumers and producers. These agreements result in a number of obstacles. These include exposure to counter party credit risk, lack of transparency and low liquidity. The bilateral structure results in creating expected bad performance incentives. This shows the fact that the contracts integrate purchase/supply obligations and price risk constituent in a particular contract.

1.1.6.6 Commodity Processors: These participants have constraints of immediate price exposure. This shows that the processors have a spread opened to the price changes between the amount of the input and the amount of the output. For example, oil refineries are open to the differences in the price of the crude oil and the price of the refined oil products namely heating oil, aviation fuel, diesel, gasoline, etc.

1.1.6.7 Investors: This includes financial investors who search to invest in commodities as a separate asset class and distinct financial investment. Commodities are being gradually recognised as a specific class of investment which is a substantial factor that has favoured the structure of commodity derivatives markets.

1.1.6.8 Financial Institution/Dealers: Dealers participate in the commodity markets mainly as provider of risk management products and as a provider of finance. The dealer's part is akin to that in the derivative market in the other classes asset. The dealers basically provide immediacy of execution, credit enhancement, structural flexibility and speed. Dealers mostly include risk management products such as provision of finance which is part of other financial services.

1.1.7 Trading Mechanism in Commodity Derivatives Market in India

Although the trading mechanisms are widely the same in all commodity exchanges, they do vary slightly in few processes and usage and definition of terminologies. We are using the entire process and terms of MCX. MCX has been chosen since it is the largest commodity exchange in India and was ranked the sixth largest in the world (according to number of contracts traded) as per 2009 data. MCX is India's leading commodity derivatives exchange with a market share of 94% in terms of the value of commodity futures contracts traded in financial year 2019-20.

The total operational process can be categorised into three phases:

1.1.7.1 Trading

1.1.7.2 Clearing

1.1.7.3 Settlement

1.1.7.1 Trading

MCX has an online trading system that is order driven and transparent and reachable by participants through the internet VSAT and leased line modes operated by members or sub brokers spread across the country. The trading hours at MCX for agricultural commodities is between 10:00 am and 05:00 pm. However, for non- agricultural commodities it extends till 11.30 pm on all days from Monday to Friday. On Saturdays all commodities trade from 10.00 am to 02:00 pm. It is preceded by a special session or order cancellation session from 09:45 am to 09.59 am which is held to cancel pending orders prior to the opening of the market. Also, on account of day light saving, time trade is extended for non -agricultural commodities till 11:55 pm usually in the months of November to the following year March. Registered members/ brokers of MCX can trade online using the automated screen-based trading system called Trader Work Station (TWS). The Trader Work Station is an application through which the members can access the trading platform, place orders and execute trades. It displays prices, volumes of trades, gainers and losers of the day, open interest, net position etc.

On the trading screen best five buy and sell orders for every contract available for trading are visible to the market and orders are matched on price-time priority logic. Orders can be placed with time conditions (day order, good till cancelled order, good till date order, immediate or cancelled order) or with price conditions (limit order, market order or stop loss order). A Day order is valid for the day on which it is entered. If the order is not matched during the day, the order gets cancelled automatically at the end of the trading day. If an entered order finds a match, trade is generated; if not the active order becomes passive and queues up in the respective outstanding order book. A Good Till Cancelled (GTC) order is an order that remains in the system until the expiry of the respective contract in which it is entered or until when the same is cancelled by the member. An Immediate or Cancel (IOC) order allows a member to execute the orders as soon as the same is placed in the market, failing which the order will get cancelled immediately. The units of trading, delivery unit, lot size, tick size, expiry date all are specified by the exchange. During the trading, session of the day, the prices are allowed to vary only within a certain specified range called the daily circuit filter. It varies from commodity to commodity. In order to deal with the counter party risk inherent in trading, the exchange collects a margin amount. The amount is given by clients to the trading members who in turn transfer it to the exchange. Clients can Verify Trades executed on the MCX platform till next 7 days by entering minimum information. MCX follows a comprehensive and stringent margining system for all the futures contract allowed to be traded in on the exchange. Actual margining and monitoring of positions are done on an online basis. MCX uses SPAN® (Standard Portfolio Analysis of Risk) system which follows a risk-based and portfolio-based approach. The initial margin requirement is based on a worst-case loss scenario of portfolio at client level to cover VaR (Value at Risk) over a one-day horizon, subject to a minimum base margin defined by the FMC for the respective commodity. The SPAN Risk Parameter File (RPF) is generated by the Exchange periodically at pre-defined timings and RPF files so generated are provided to the members using the FTP service and on the Exchange website. In addition to SPAN margins, MCX levies additional margins and/or special margins whenever deemed necessary considering the volatility and price movement in the commodities. Such margins are also levied as per the directions of FMC. Tender period margins and delivery period margins are levied on contracts nearing expiry to ensure non default in commodity delivery.

Members at the Exchange:

- TCM: Trading cum Clearing Members who can trade on their own account as well as on account of their clients through a unique ID assigned by the exchange
- PCM: Professional Clearing Members who are entitled to clear trades executed by the other members of the exchange The members require to pay membership fees, initial security deposits, various types of margin amounts and transaction fees to the exchange.

After the entire days trade is completed, the system calculates the closing price of each and every contract. The closing price is equal to the weighted average price of all trades done during the last 30 minutes of a trading session. However, if the number of trades executed in the last 30 minutes is less than 10 then it is taken as the weighted average of last 10 trades of the day. If number of trades in a day is less than 10, then a weighted average of all trades executed during the day is taken. And in case there has been no trade at all the previous closing price is considered. At the end of the life of the contract, i.e., the expiry date, the contract is settled at the due date rate, usually calculated as the weighted average of the last 1 or 3 or 5 days prices in the spot market (of the market place where the contract is based) or as prescribed by the exchange in contract specification.

1.1.7.2 Clearing

Clearing of the trades that happen on the exchange is done through the exchange clearing house. Exchanges guarantee faithful conformity of all trade commitments undertaken on the trading floor or over electronic trading system with the help of the clearing house/ clearing corporation. Every clearing member has to abide by the rules as specified by the exchange. They have to open accounts with the clearing banks which have been appointed by the exchange. These banks necessarily have electronic fund transfer facility. Every member of the exchange has to maintain with the bank, the following accounts:

- Settlement account/ Clearing account
- Client account

From the settlement account, the member can issue cheques only to client account. The exchange will have the right to send debit instructions to the bank for charging the member for all payments like insurance, margins and dues etc. The client account is used for depositing the receivables and also for making payments to the clients. Money can also be transferred from this account to the settlement account to meet margin obligations or their pay outs. The Operational Procedure At the end of each trading day, with the help of FTP (file transfer protocol), the member can download all details of transaction executed by the member on the day, including positions carried forward from the previous day, closing position of the day and net obligation of each member along with the margin money utilised, margin money available, transaction fee payable/ receivable etc. The positions are marked to market on a daily basis and the MTM settlement is settled by debiting/ crediting the clearing accounts of the clearing members. The marked to market loss monitoring helps the exchange to deal with the counter party risk. During the trading session, the system tracks the notional as well as booked losses incurred by every member up to the last trade on a real time basis. The member gets signals at points of occurrences of certain loss percentages, however after reaching the loss of 75% of total deposit limit the member is suspended from the system. Thereafter the exchange generates an automated statement from debit or credit of settlement accounts and sends it to the clearing bank next morning. The member is allowed to trade further the next day, only after clearing off the net payable position. However, the clearing house is only a facilitator of the clearing and settlement process and has no responsibility as to the genuineness, quality and quantity of any delivery.

1.1.7.3 Settlement

The final settlement of any trade can be affected in three ways in case of commodity derivatives:

1.1.7.3.1 Squaring up of the open position

1.1.7.3.2 Cash settlement

1.1.7.3.3 Physical delivery

1.1.7.3.1 Squaring up of the Open Position

An open trade position can be squared up on any day before the contract expiry day. In closing out, the opposite transaction is affected to close out the original futures position. Hence a buy contract is closed out with a sale contract.

1.1.7.3.2 Cash Settlement

Contracts if held till the last day of the contract can be cash settled. In this case the contract is marked to market against the final settlement price at the end of the last trading date and all positions are declared closed. In the process, the trader either makes a profit or incurs a loss, which is settled in cash. Also, if the buyer or seller neither squares up the position nor gives any intention of taking/ giving delivery, then the exchange forcefully cash settles the position, wherein the trader has to pay a penalty too.

1.1.7.3.3 Physical Delivery

The prime difference between a commodity and financial derivative occurs in the settlement process. Financial derivatives are mostly cash settled. However, the commodity derivatives are often settled physically. Due to the weighty nature of the underlying asset, necessity of warehousing comes up. The problem is the limited storage facilities available and restrictions on interstate movements of commodities. Besides the duties and taxes also impact on the cost of goods.

The members having outstanding position on the expiry date of the contract have to give intention of tendering or lifting delivery in writing along with the quantity, quality and preferred delivery centre. If a member (buyer or seller) makes the intention but subsequently fails to complete commitment, then his position will be closed out at the due date rate and they also have a pay an additional penalty, major portion of which goes to the other party for compensating their losses. Prescribed delivery orders have to be filled in by the sellers, clearly stating the quantity, quality and delivery centre. The location mentioned for delivery should not be one where there is a restriction against movement of goods. The quality of goods delivered should be in accordance with the grade permitted by the exchange. The goods should accompany an accredited surveyor certification of quality. However, some tolerance limits are specified regarding the quality and quantity of goods. When goods come to the authorized warehouse for delivery they are tested and graded, according to some pre specified parameters. Depending on the outcome or level of variation from the stated quality and/ or quantity, some discount or premium is adjusted with the final price. This makes the process more rational, since some variations during physical delivery might be out of control. And the price adjustment process protects the buyer from any sudden loss which could incur due to deteriorated quality at time of delivery. The parties involved in the physical delivery process are therefore the accredited warehouse, approved registrar and transferred agents and approved surveyor. Only the approved assayer/ surveyor has the capacity to grade the commodities brought to the warehouse and specify the expiry date of the commodity. Delivery of a commodity post its validity/ expiry would be considered bad delivery. Grade certificates are also provided by the assayer. They also have the right to inspect the warehouses specified by the exchange. The accredited warehouses should meet the specific standards as set by the exchange. They can accept good only after proper gradation has been done and can store the same till the validity period after which it has to be kept separately, till the concerned member removes such goods. The process of dematerialization and rematerialisation of commodities are done through the registrar and transfer agents in coordination with the warehouse, exchange and depository.

SECTION II

1.2 LITERATURE REVIEW

The section reviews the existing literature on the concerned topic based on the nature of asset considered in the study, such as structure and growth of commodity derivatives market and efficiency of commodity market in India in terms of price discovery and risk management in the Indian and International Context. The literature review is classified into four headings namely growth and regulation, Price discovery, volatility and Hedging effectiveness commodity market.

1.2.1 Growth and Regulation of Commodity Market in India

Nair (2004) in a paper titled "Commodity Futures Markets in India: ready for take-off?" compares the growth paths being followed by the commodity derivatives market vis- a -vis the security derivatives markets in India. The author further revealed that the securities derivatives segment made rapid progress in a short span of time because of its sound institutional framework in the spot segment while the spot market acted as a drag on the progress of commodity derivatives markets. The study further concluded that Indian commodity derivatives market has to get ready to face the challenges thrown up by the global developments of ever-growing exchanges and integration of markets.

Rao (2007) in a paper titled "Commodity markets - All set to take on equity markets" outline the growth of commodity futures markets. The suggest that unlike equity, commodities effect every citizen of this country as a consumer or as a producer. The author further explains on economic benefits of futures trading and concludes optimistically about the growth of commodity derivatives market.

India Budget Report (2007) Outline the growth of traded commodities in the derivatives futures market. The study covered the major agricultural commodities (rice, wheat, jute, guar, cotton, coffee), major pulses (urad, arahar, chana), edible oil seeds (mustard seed, coconut oil, ground nut oil and sunflower oil), spices (pepper, chillies, cumin seed and turmeric), metals (aluminium, tin, nickel and copper), bullion (gold and silver), crude oil, natural gas and polymer among others. The report state that an efficient and well-organized commodity futures market is acknowledged to be helpful in price discovery for the traded commodities.

Agarwal, N., & Kaur, G. (2010) in an article titled "Agricultural Commodity Future Trading and its Implications" focussed on the conceptual perspective of commodity future trading and its implication on the commodity market. The main objectives of the article were to study the growth of the commodity market in India and study the price volatility, efficiency and arbitrage opportunity of agricultural future commodity market. The study revealed that there is abundant scope as much has not been done in the country with respect to the agricultural commodity market. Commodity derivatives futures trading, merchandising and stockholding of many commodities in India have always been regulated through several legislations such as the Essential Commodities Act (ECA), 1955, Securities Contracts Regulation Act, 1956 and Prevention of Black-marketing and Maintenance of Supplies of Commodities Act, 1980. There exist three-tier regulation for commodity derivatives futures trading in India. These are (a) Ministry of Consumer Affairs (b) the SEBI and (c) Commodity Exchanges. As per the act, the exchange that organises forward trading in regulated commodities can prepare its own rules (Articles of Association) and by-laws and regulate trading on a day-to-day basis. The SEBI provides a regulatory overview and approves the rules and bye-laws. The Essential Commodities Act (ECA) 1955 came into force to control production, distribution and supply of essential commodities for increasing and maintaining supplies and for securing their equitable distribution and availability at fair prices. Using the powers under the Essential Commodities Act (ECA) 1955, several departments of the central government have issued orders for regulating production, movements, distribution and quality of products relating to the essential commodities.

Balaji K. (2009) shown in his research undertaken on commodities market in India: policies, issues, growth, importance and the commodities market information in the year 2009 tried to comprehend the rules and regulations as well as the growth of commodity market during the year 2009. it highlighted the various regulations and policies that were followed in India. This study exposed that the market has made growth in terms of technology, transparency and the trading activity.

Ahuja, Narender L. (2006) in his paper "Commodity Derivatives Market in India: Development, Regulation and Futures Prospects" examined the development of commodity derivatives markets since 2003 in India with increased number of modern commodity exchanges, transparency and trading activities. The traded volume and value of trade has shown unpredicted mark. He noted that the rapid growth of the market has influenced by the role played by market forces and the government active encouragement and support for reforms in the derivatives market. He recommended that the promotion of barrier free trading in the derivatives market and allow market forces to determine the price.

M. Dhanbhakyam and **P. Kamalnath (2010)** in their paper "Financial Performance of National Commodity Exchange Companies (NMCE, MCX and NCDEX) in India: A Profitability and Efficiency Focus is an investigation into the present status, growth constraints and developmental policy alternatives for commodity market in India. They found that the empirical finding of the study in the context of commodity futures as a diversifying agent to the equity portfolio is twofold. The study also found that MCX Energy futures do not add any diversification benefit to the portfolio of equities whereas MCX Agriculture futures are found to be the best diversifying agents.

Dharmbeer, and Singh, B. (2011) in their study, "Indian Commodity Market: Growth and Prospects", reviews theoretical and empirical research on the growth and prospects of emerging commodity markets and the resulting implication on policy and regulation. They find that the hedging role of emerging derivatives markets in the Indian market has been supported by the various studies that have been conducted. All commodities are globally traded & the global demand and supply situation is widely known and accessible. Since commodity exchanges promote price transparency, then commodity exchanges will not fuel inflation.

Gupta, R. (2011) in his study "Commodity Derivative Market in India: The Past, Present and Futures" investigated the commodity derivatives market which was reintroduced in India in early 2000s. Since its inception, the market has grown at a fast pace. The growth is evident in the spread of market network as well as growth in traded volume. The various commodity exchanges have also emerged as key drivers of the market's growth. Earlier there were only regional commodity exchanges in the country. There are three national level commodity exchanges bourses, namely, MCX, NCDEX and NMCE which dominate the market.

Padmasree, Karamala (2013) in his paper, "Growth and Challenges of Commodity Derivative Market in India", examined the various aspects of the commodity derivatives market in India and noted that although there has been a significant growth registered in its value and volume, the Indian commodity markets still require a lot of work in terms of policy reforms, necessary infrastructure, wide range of training programmes are required to catch up with the developed commodity derivatives markets and establishment of proper legal framework. Trading in options should be introduced to provide wide choice of trading both to the farmers and investors.

Nilanjana, Kumari (2014) in her paper, "Recent Trends in Commodity Markets of India", examines that India is one of the top producers of a large number of commodities ranging from agricultural to non-agricultural products, with a long history in its futures trading. The commodity markets have been experiencing ups and downs since its inception, but with strengthening of the working our country has been able to bring a degree of stability to this market. It has been progressing in terms of technology, transparency and trading activities with the removal of government protection from a number of futures contracts. The action of government has thus, allowed the market forces i.e., supply and demand, to rule the commodities. Thus, the step proves to be a big lesson for all the developing economies that the pricing and risk management should be left to the market forces rather than to be dependent on the administered price mechanism.

Shshismita Bose (2008) has conducted a study on "Commodity Future market in India: A Study of trends in the National Multi Commodity Indices". The study focused on the various characteristics of the commodity futures market in India. The result based on MCX indices during the period 2005 to 2007 indicate that the market has higher exposure to Energy and Metal products. Test of Co-integration reveal futures and spot prices contribute to price discovery and the futures market provide information for current spot price and support to reduce volatility.

Gurbandani Kaur and D.N Rao (2010), has conducted a study titled "Efficiency of Indian Commodities Market: A Study of Agricultural Commodity Derivatives Traded on NCDEX". The study pointed out that the Indian commodity derivative market has seen a phenomenal growth in few years by achieving almost 50-time expansion in market. The statistical tools used are Auto correlation and Run tests on five commodities namely; Pepper, Guar seed, Malbar, Chana and refined Soya oil. The study observed the random walk hypothesis by testing the week form efficiency of the sample commodities. Indian agricultural commodity market is efficient in weak form of efficient market hypothesis.

Thomas (2003) in his study titled “Agricultural Commodity Markets in India: Policy issues for growth” outline the market design of commodity derivatives market in India. The paper presents some evidence on the role played by the derivatives market in price discovery. The study recommends three policy proposals for agricultural commodity markets in India: a) use of reference rates to strengthen transparency in the market. b) treatment of ware house receipts as securities c) exploring a greater role for cash settlement.

Malhotra M. (2012) in her study entitled “Commodities Derivatives Market in India: The Road Travelled and Challenges Ahead”, stated that commodity prices are crucial for the existence and growth of any industry and for the economy as a whole. It highlights that the reforms brought about by the government in the commodity markets so that industry can effectively manage the price risk. This was the rationale behind promoting and encouraging futures market for commodities. However, Indian commodity derivatives markets are still at nascent stage as compared to the commodity markets in US and China. They found that the investment avenues of individual investors depend mainly on annual income and risk-taking capacity. It was revealed that India is not well-equipped to deal with the dynamics of the markets.

1.2.2 Price Discovery

In the empirical financial economic literature, the question of whether the futures or the spot markets play a leading role in the price discovery process has often been raised and analysed.

Quan (1992) concluded that the price discovery process occurs in the spot market and gets transmitted to the futures market. Whereas, **Gardbade and Silber (1983)** found that the futures market play major role in the price discovery and spot market too has a role in the price discovery process. Even though the spot and futures markets of an asset are both subject to the same information, their lead -lag relationship among spot and futures markets shows whether there is unidirectional flow of information from the futures (Spot) market to the spot (futures) market or a bidirectional flow of information amongst these markets. The lead-lag relationship between spot and futures indicates how fast one market reflects the new information vis- a vis another and how well they are interconnected. If a departure from equilibrium occurs, prices in one or both markets should adjust to correct the disparity. In other words, it helps in understanding the strength of linkages among these markets and the speed of adjustments.

The present section discusses various empirical studies pertaining to the price discovery in the Indian and International context. Many theoretical and empirical studies in literature have been made by academicians, practitioners, and regulatory bodies to know the relationship between the future and spot prices of commodities traded on Indian Commodity Exchanges. The review of the previous studies here is attempted to get a comprehensive picture.

Garbade and Silber (1983) The study looks at the price discovery dynamics of various commodities such as gold, silver, wheat, corn and oats traded at the Chicago Board of Trade. Co-integration and Causality test is used to analyse the data and concluded that the gold and silver markets are highly co-integrated. They found that the futures market dominates the spot market**.** The outcome suggests that there is a price discovery process from spot to futures market and vice versa. The study further concluded that size and liquidity play a major role in the price discovery function.

Bessler & Covey (1991) the study applied co- integration methods on daily data and the results confirms the evidence of co- integration between nearby cash and futures prices, the result indicates that there is no evidence of co integration when more distant futures contracts were examined.

Jain and Leathan (1999) the researchers investigated the price discovery function for three U. S wheat futures market: Kanas City Board of Trade, Chicago Board of Trade, and Minneapolis Grain Exchange. The study revealed the existence of one equilibrium price across the three futures markets in the long run, but there was no cointegration among prices in the three-representative spot markets.

Koontz, Garcia, & Hudson (1990) the researchers analysed the relationship between live cattle futures and cash market. The study used Granger Causality test to identify the lead/lag relationship and casual flows between futures and cash market. They observed that the results are consistent with the ideal that the futures market is interacting closely with the cash market.

Yang et al. (2001) the researchers investigated the price discovery performance of future markets for storable and non-storable commodities. The outcome suggests that asset storability does not affect the price discovery function; it may bias the futures market estimations. The study further concluded that the futures markets can be used as a price discovery tool in both types of markets.

Gopal Naik et al., (2002) In their study the performance of six commodity futures markets in terms of both risk management and price discovery function is analysed. The usefulness of futures markets is usually reflected in the trends in membership of exchanges and the extent of liquidity. The usefulness of futures markets in risk management has also been examined by analyzing the risk involved in the futures, spot and basis of commodities. The role of price discovery has been studied by testing its forward pricing ability through co-integration test between futures and cash prices. The data period is from 1993 to 2000 for the sample commodities namely potato, castor seed, pepper, and Guar. The study showed that the most of these markets are not yet developed fully as efficient mechanisms of price discovery and price risk management.

P. Chellasamy and **Anu, K. M. (2015)** in their paper, "An Empirical Study on Commodity Derivatives Market in India", examined the commodity derivatives markets in India which is emerging as a global hub. Commodities play a significant role in the economic growth of the country. The study attempts to the stability of spot prices and futures prices commodities in India. The study aims to analyse the long-run efficiency of the commodities through the co-integration test. The co-integration methodology was used to investigate the long run efficiency of the selected commodities. The results of test indicate that the futures and spot prices are co-integrated. The presence of co-integration results indicates that the futures prices provide some useful information to the spot market commodities. The research findings reveal that there is unidirectional causality between the spot and futures prices for commodity silver and Gold.

Tanushree Sharma (2015) The Study focused on the long-term and short- term causality between of six agricultural commodities on the exchange NCDEX namely, potato, soya refined, soyabean, Gaur Gum, chana and pepper. The study revealed strong co - integration between the spot and future commodity prices of Guar gum and potato. Wald test and VECM model was used to measure the short run and long run causality between the commodities. The author concluded that in case of soyabean and soya oil futures prices lead to the spot prices, whereas bi-directional relationship was detected in case of chana and pepper.

Raghavendra RH, Velmurugan PS and Saravanan A (2016) The study analysed the relationship between future and spot prices of agricultural commodities such as Maize, Jeera Soybean, Chana, and Turmeric. The study used daily data of spot and future prices traded in the exchange NCDEX from January 2010 to March 2015. The study used Augmented Dickey- Fuller (ADF) test and Phillips-Perron (PP) to test stationarity of data and Johansen Co-integration test and Regression Model were employed to analyse the Lead-Lag relationship between Future and Spot Markets of the selected agricultural commodities. The results confirm the existence of long run equilibrium relationships between futures and spot prices for five agricultural commodities namely, Soya bean, Chana, Maize, Jeera and Turmeric in the long run. The results also confirm the presence of unidirectional relationship from future market to spot market prices for two agricultural commodities, viz., Soybean and Chana and bidirectional relationship between commodity futures and spot market for three selected agricultural commodities viz, Maize, Jeera and Turmeric.

Jyothi Shivakumar N.M, G. Kotreshwar (2017) the authors examined the efficiency of maize futures market using parameters like price transmission, price discovery and extent of volatility. The study used daily closing futures and spot prices of Maize for two kharif season contracts from September 2015 to May 2017. The Augmented Dickey Fuller (ADF) test has been used to check the stationarity of the time series data and data was found to be stationary after taking first difference. Johansen co-integration test was performed to investigate the long-run relationship between the Maize spot and futures commodity markets and Granger causality test was used to test the short run causality. The study inferred that there is co-integration or long-term equilibrium relationship between maize futures and spot market. Granger causality test indicate unidirectional causal relation from spot to futures market. The result thus indicate that maize futures market is not efficient and hence does not play an important role over the maize spot market due to its inefficiency.

Frank Asche & Atle G. Guttormsen (2002) The researchers investigated the relationship between future & spot oil prices for the time period from 1981 up to 2001. The econometric tools applied to study the data were Vector Error Correction models and Johansen test of Co integration test. The results indicated that the future prices guide spot prices and futures contracts having longer expiration time leads contracts with shorter expiration time.

Kumar and Sunil (2004) The study focussed on the price discovery in five commodities from six Indian commodity exchanges. For their study they have used the daily futures and comparable ready price and also engaged the ratio of standard deviations of spot and future rates for empirical testing of ability of futures markets to incorporate information efficiently. The study employed the Johansen Co integration Technique to analyse the efficiency of spot and future markets. They observed inability of the future market to fully incorporate information and confirmed inefficiency of the future market. The study further concluded that the Indian agricultural commodities future markets are not matured and efficient.

Zapata, Fortenbery and Armstrong (2005) The researchers investigated the relationship among the prices of selected sugar futures traded in New York and the world cash prices of export sugar. The study revealed unidirectional relationship from futures prices to cash prices. The result of co integration between cash and futures prices suggests that the sugar futures contract is a useful tool to reduce overall market price risk faced by the cash market participants selling at the world market.

R. Salvadi Easwaran and P. Ramasundaram (2008) The researchers made an attempt to analyse the efficiency of commodity futures market. The study focused on analysing the various aspects of price discovery and volatility in agricultural commodities. The study employed econometric tools to analyse price behaviour and price volatility of spot and futures markets by selecting few agricultural commodities from the exchange NCDEX and

MCX. The result indicated bottlenecks in trade of agricultural commodities and suggested policy measures for improving the Indian agricultural futures market. The study further concluded that futures markets are not efficient, which in turn implies that futures exchanges does not offer an efficient hedging mechanism against the risk arising from the price volatility. The implication of this study is that price discovery is not significant in the agricultural commodities futures market. The econometric analysis of the relationship between volume, price return, market depth, and volatility exhibited that the market volume and depth were not significantly influenced by the volatility and return of futures and spot markets.

Bose (2008) studied cointegration between spot and futures from June 2005 to Sep 2007 and uses indices from Multi Commodity Exchange (MCX) and agricultural commodities, indices traded at NCDEX. Johansen's co-integration approach with different forecasting horizon ranging from one day to one month was used. The study revealed the short-term association between the spot and future price indices. Causality Analysis is carried out to find out which market exerts a strong influence on the other. The result of the paper indicates that MCX indices which have a greater exposure to energy and metal products behave similar to the equity indices in terms of efficiency flow of information and efficiency. Correlation analysis reveals a very high correlation between the cash and futures prices. The outcome suggests that there is a strong relationship between the price series and offer preliminary evidence that both series respond likewise to changes in market fundamentals, however to a lesser degree in the case of agricultural commodities. NCDEX agricultural index on the other hand doesn't display such features and are well integrated with the spot market. The study makes remarks on the efficiency of price formation, convergence of commodity prices with world indices, relationship between MCX index and Indian single stock futures index.

Mahalik, Acharaya, and Babu (2009) the researchers made an attempt to examine price discovery and volatility spillovers in Indian spot-futures commodity market. The study applied Cointegration (Johansen,1991), VECM, and the bivariate EGARCH (Nelson,1991) model. This study used data on spot and futures indices of Multi-Commodity Exchange. The result indicate that commodity futures markets effectively served the price discovery function in the spot market, indicating that there is a flow of information from the futures to the spot market. In addition, the bivariate GARCH model showed that the volatility spillover from futures to the spot market is most apparent in the case of ENERGY and COMDEX index. The AGRI-Spot market acted as a source of volatility towards the agriculture futures market.

Mallikar junappa T and Afsal E M (2010) the researchers made an attempt to determine the lead-lag relationship between spot and futures markets in the Indian context based on high frequency price data of 12 individual stocks, observed at one-minute interval. The study employed the concept of co-integration and establishes the spot-futures relationship by using Vector Error Correction Model (VECM) represented by EGARCH framework. It was found that there is no significant leading or lagging effects in either futures or spot markets with respect to top 12 individual stocks. There exists a contemporaneous and bi-directional lead-lag relationship among the futures and the spot markets.

Jabir Ali and Kriti Bardhan Gupta (2011) has made an attempt to analyse the efficiency quotient of agricultural commodity markets by examining the associations between spot and future market prices. For the purpose of the study, 12 agricultural commodities traded on NCDEX were selected to analyse efficiency in the future markets. The authors employed econometric tools such as Phillips-Perron and Augmented Dickey-Fuller unit root test, Granger Causality Test and Johansen's Co-integration Test. The Co-integration test revealed the presence of extended long-term association of spot and future prices of majority of the agricultural commodities. The result confirms that the future market has a stronger ability to forecast subsequent spot prices of sugar chickpea and castor seed, soyabean and as compared to maize, pepper and black lentil wherein a bidirectional relationship existed in the short term.

Jackline S. and Malabika Deo (2011) the researchers investigated the link between the spot market and future market for the lean hogs and pork bellies for the time period from January 2001 to May 2010 and quantified the price discovery utility of commodity futures prices as against spot prices in the sample markets. The authors have used various econometric tools like Pairwise Granger Causality tests, Unit root tests, Phillips-Perron test and Augmented Dickey Fuller test. The Granger Causality test confirms existence of bi-causality relationship between these markets. The study further concluded that both the markets were in perfect equilibrium and that there was no profitable arbitrage existed in both the markets.

Anurag Agnihotri and Anand Sharma (2011) The study focused on the relationship between spot and future prices of four commodities namely natural gas, zinc, Chana and jeera traded on MCX and NCDEX. The study reveals that there a positive correlation exists between spot and future prices of the selected commodities. The results obtained indicates that the correlation coefficients by themselves is not able to detect convergence, however statistical tool such as regression linear test detects convergence between future and spot prices of the selected commodities more significantly.

Ali and Gupta (2011) authors made an attempt to study the long-term relationship between spot and futures prices for seven agricultural commodities namely Castor seed, Maize, Pepper Chickpea, Black Lentil, Soyabean, and Sugar. The study found cointegration in spot and futures prices. The study also revealed short-term relationship between spot and futures market, wherein the futures market had the ability to predict spot prices of four commodities namely Chickpea, Castor seed, Soyabean, and Sugar. There was a bidirectional relationship in the short -run among three commodities namely Maize, Black Lentil, and Pepper.

Kumar and Pandey (2011) have conducted an empirical study on effectiveness of commodity futures markets in India in price discovery function. The outcome suggests that the Indian Commodity futures market did not dominate the process of price discovery as they did in other developed markets. For the commodities under energy and precious metals, the futures markets lead the price discovery role. In the case of industrial metals and agricultural commodities, the price discovery takes place in both futures and spot markets. For the commodities under precious metals and energy segment, which are more tradable in nature, futures market is not affected by the spot markets.

Sanjay Sehgal & Namita Rajput, (2012) In their study entitled "Price Discovery in Indian Agricultural Commodity Markets". The study focused on 10 Agricultural Commodities traded in the exchange NCDEX for the period November 2003 to March 2012. They employed econometric tools such as Johansen's Co-integration Test, Granger Causality Tests to test process of price discovery. The study observed the process of price discovery in all commodities except for commodity Turmeric. Price discovery results are encouraging given the nascent character of commodity market in India. However, the market does not seem to be competitive.

Srinivasan (2012) the study looks at four futures and spot indices of the Multi Commodity Exchange of India (MCX), representing relevant sectors like energy (MCXENERGY), metal (MCXMETAL), agriculture (MCXAGRI) and the composite index of metals, energy and agricultural commodities (MCXCOMDEX). The study focussed on the price discovery process and volatility spillovers in Indian spot-futures commodity markets by applying

Johansen cointegration test, Vector Error Correction Model (VECM) and the bivariate EGARCH model. Data consists of daily closing prices of four commodity futures indices and its corresponding underlying spot indices of MCX, Mumbai for the duration from June 8, 2005 to November 30, 2010. The time series data of selected commodities markets are stationary at the first order level, and hence they are integrated in the order one. The results indicated that there exist autocorrelation and ARCH effects in the commodity prices and recommends Bivariate Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) model which is capable of Generalized Error Distribution (GED).

Kushankur Dey and Debasish Maitra (2012) have conducted study on the commodity Pepper to examine the price discovery process by applying Co-integration, Granger Causality and Error Correction Model. The study inferred that there was a unidirectional causality from futures to spot prices in the pepper futures market.

Pankaj Kumar Gupta and Sunita Ravi (2012) The study analysed the price discovery function and volatility spill over in relation to the spot and future commodity markets for the time period of 2005 to 2011. The closing spot and future prices for commodity Chana traded on NCDEX have been analysed using statistical tools such as unit root test, Johansen's co integration test, Vector error correction model, and EGARCH model. The study inferred that with respect the future market is more efficient then compared to the spot market and that the future market aids the spot market in the price discovery process.

Sendhil, et.al., (2013) have made an attempt to study entitled "Price Discovery, Transmission and Volatility: Evidence from Agricultural Commodity Futures. The study investigated the crucial factors that influences the price discovery process, considering a sample period from the year 2004 to year 2010 for four Agricultural Commodities traded on

NCDEX. The study applied Johansen's multivariate approach to examine the role of Futures market. The study revealed that the prices are integrated in three out of four commodities.

Isha Chhajed, Sameer Mehta (2013) the researchers have conducted a study entitled "Market Behaviour and Price Discovery in Indian Agricultural Commodity Market". The study period consists of from 1st April 2009 to 31st May 2010 for Agricultural commodities. Market behaviour was studied by employing Granger Causality. Backwardation and Contango approach. The outcome suggests a bi-directional causality relationship between spot and future prices. The Contango and backwardation estimation helped in identifying the hedging opportunity in the market. The findings indicated that if the changes in spot prices lead to the changes in future prices, then effective hedging strategies can be implemented. If the changes in futures prices leads the changes in spot price, effective speculative strategies can be formulated.

Aloysius Edward and Narasimha Rao (2013) have made an attempt to study "Price Discovery Process and Volatility spillover of Chilli Spot and Futures prices evidence from National Commodity and Derivative Exchange Ltd". The causality between Chilli spot and futures prices is examined by co-integration models, Granger causality test for a period April 1, 2006 to March 31, 2013. In long run the futures and spot market are co-integrated and causality exist between the two markets. There exist uni-directional causality and Chilli futures market provides direction to farmers and the market is efficient.

Tarun Soni (2013) have conducted a study on market efficiency of the futures contract of Guar Seed traded at National commodity and Derivatives Exchange ltd. (NCDEX). The study employed econometric tools such as Co-integration test and Error Correction Model. The data for the study consist of daily closing spot and futures prices from April 2004 to

March 2012. The study inferred that the futures market for Gaur seed was inefficient in both short and long term.

Prashanta Athma and K.V. Venugopal Rao (2013) researchers utilised data from COMDEX to analyse the temporal link between the spot and future prices in the commodity market. The Statistical tools such Augmented Dickey- Fuller Test, Johansen Co-Integration Test, Multiple Regression, Granger Causality Test and Vector Error Correction Model have been employed for data analysis. The Comdex data disclosed that the mean future prices are higher as compared to the mean spot prices and that this phenomenon could be attributed to the fact that Comdex combines both perishable as well as non-perishable commodities. The futures played a lead role in the markets and strongly influenced the predictions of spot prices. Similar conclusions were observed and confirmed when the Granger causality and Vector error correction model were used. They concluded that markets as a whole are efficient and the availability of Comdex data can enable traders to hedge their risk across a much larger canvas.

M. Babu, S. Srinivasan (2014), their study focused on analysing relationship between spot and futures prices in Indian commodities Market using Johansen Co-Integration Test. A sample of 10 commodities based on the total turnover during the study period was selected. The results of the study gave evidence that the prices of the commodities during the study period were independent.

Shakeel, M. and **Purankar, S. (2014)** have conducted research entitled “Price Discovery Mechanism of Spot and Futures Market in India: A Case of Selected Agri- Commodities”. The study investigated the price discovery mechanism in spot and futures prices of selected three agricultural commodities namely Castor Seed, Channa and Soya bean. It used Johansen Co-integration and the Vector Error Correction Model (VECM) to examine the lead-lag relationship between the spot and futures prices. The outcome of co-integration confirms the existence of long-run relationship between spot and futures prices of Channa, Castor seed and Soya bean, respectively. The result of vector error correction model indicates bidirectional causality between spot and futures prices of commodities Channa, Castor Seed and Soya bean, indicating that both the spot and futures prices of the selected agricultural commodities plays the leading role in price discovery process in India. The study inferred that commodity markets said to be informationally efficient and reacts more quickly to each other.

Krishna Singhal (2014) the study analysed the linear causal linkage connecting the daily future and spot prices of crude oil for a period commencing from 1st January 2009 up to 31st December 2011. The data was analysed and verified by ADF unit root test, whereas the lead lag relationship between spot and future prices was investigated by Granger Causality Test. The result confirms that future price leads the spot price i.e., the futures price of crude oil can be effectively used to predict its spot price. The study inferred that the price discovery in the futures market is much faster as compared to the spot market.

Viswanathan T. and Sridharan G. (2014) had made an attempt to study the causal relationship between the spot and future markets for commodity pepper. For the purpose of the study the day to day closing prices of pepper in the futures and spot markets traded on NCDEX during the period from 2005-2006 till 2012-2013 were collected. The data were then analysed using the Jarque -Bera test and descriptive statistics were employed to analyse the characteristics of time series data distribution of spot and future prices of commodity pepper. The study used Correlation analysis to detect auto correlation within the series. Augmented Dickey Fuller test was applied and it showed that the prices were stationary at first order level. The associations linking these two series of data were tested by the application of Granger Causality test. The Granger Causality test were applied to analyse the relationship between future and spot prices which showed that there existed bilateral causality linking the spot and future prices of pepper.

Gurmeet Singh (2015) under the research done on the topic "Role of Futures Market in Price Discovery: A Study of Indian Commodity Market" studied the role of futures market in the price discovery process for two non-precious metals namely nickel and zinc for the period from the year 2011 to year 2014. The study revealed that both the series of spot and futures prices are co-integrated of order one, and display a stable long-run equilibrium relationship. The results of VECM indicate that there is a bidirectional causality in spot and futures market but the futures market is found to be strong in terms of discounting new information than the spot market.

Rachana Kumari Bansal and Y.C. Zala (2015) the study analysed the relationship between spot and futures price for commodity Castor Seed. The study used the daily data of spot and futures prices from July 2004 to December 2013 traded on National Commodity Derivative Exchange of India Ltd (NCDEX). The study applied ADF (Augmented Dickey Fuller) test to check the stationarity of the time series and data was found to be stationary after taking first difference. The futures and spot prices were found to be co-integrated by using Johansen Co-integration test. The result of Granger Causality test confirms unidirectional Causality running from futures market to spot markets, which indicates its better hedging efficiency. This further indicates the efficiency of castor futures market.

Joshy. K.J and Ganesh L (2015) the researchers analysed the price discovery process of commodity gold. The study investigated the long run dynamic relationship between spot and futures markets and volatility impact of futures price on spot price and vice versa. The study used the daily data of spot and futures prices of gold traded on NCDEX during the year 2008 to the year 2012. The ADF (Augmented Dickey Fuller) test has been used to check the stationarity of the time series data and data was found to be stationary after taking first difference. Result of Johansen Co-integration test reveal that spot and futures prices of gold market were found to be co-integrated. The study applied Vector Error Correction Model (VECM) to analyse the price discovery process whose results suggests the dominance of spot market in price discovery process. It used Generalised Autoregressive Conditional Heteroscedasticity (GARCH) model to examine the volatility impact whose results inferred that both spot as well as futures do not have significant impact in the volatility of gold market in India.

Anto Joseph, Suresh K.G., Garima Sisodia (2015) the study focussed on asymmetric causal relationship between agricultural spot and futures prices in India. The study used the daily spot and futures close prices of eleven agricultural commodities viz; soy oil, chana (chickpea), castor seed, cotton oilcake, mustard seed, soy bean, coriander, turmeric, jeera (cumin seed), pepper and wheat for the period from January, 2008 to March, 2014. Asymmetric causality test suggested by Hatemi-J was applied whose results inferred that there is a unidirectional causality running from futures markets to spot markets in all the sample commodities under study. The study further concluded that futures market in India plays a dominant role in the price discovery process for all the selected commodities. The outcome suggests that futures market have stronger ability to predict subsequent spot prices which in turn indicates the efficiency of Indian agricultural futures market.

Gouri Prava Samal, Anil Kumar Swain, Ansuman Sahoo, Amit Soni (2015) the researchers investigated the efficiency of agricultural commodity markets by assessing the relationships between spot market prices and futures market prices of three agricultural commodities namely; turmeric, cotton, and castor seed in India. Daily data of closing spot and futures prices of sample agricultural commodities traded on NCDEX were used in the study. Result of Augmented Dickey-Fuller test indicates stationarity of data series after taking the first difference. Vector Auto Regression model was used to identify the interdependency level among spot and future prices. OLS Regression Analysis and Granger Causality tests have been applied to examine market efficiency. The study concluded that there is a long-term relationship between spot and futures prices for all the three sample commodities. The Granger causality test indicates that futures markets have stronger ability to predict subsequent spot prices for all the selected commodities.

1.2.3 Price Volatility in Commodity and Equity Market

Akanksha Gupta and Poornima Varma (2015) have made an attempt to examine the impact of futures trading on spot markets of commodity rubber in India. The study focussed on the price discovery role of futures market, direction of volatility spillovers, and the relationship between the futures trading activity and the spot price volatility. The Co-integration Test and Vector Error Correction Model indicate price discovery in futures market, which means there is a stronger flow of information from the futures market to the spot market. The outcome of Granger Causality tests indicates the existence of a bidirectional volatility spillover in the two markets and that futures trading activity is both a cause and consequence of spot market volatility.

Golaka C Nath, Tulsi Lingareddy (2008) In their paper, an attempt was made to study the impact of futures trading on agricultural commodity prices. A series of tests indicated that spot prices of urad and their volatilities have posted significant increases during the period of futures trading. A corresponding but relatively slow increase in the prices of total pulses was observed as a result the significant causal association existed between pulses and urad. Although gram prices too have posted a moderate increase during the post-futures trading period, but the impact was not found to be statistically significant. Futures trading has a significant and direct causal influence on urad prices, whereas the same has not been statistically significant in the case of commodity gram. Nevertheless, the average price change and volatility have increased during the period of futures trading in case of commodities gram, urad and total pulses. Thus, the argument of futures activity causing an increase in price volatilities is found to be true in the case of commodity urad but no statistical evidence was found in case of commodity gram. Though, there was a mild spillover of volatilities from urad to food grains, the flow did not extend to all commodities. Hence, the proposition of futures trading contributing to a rise in inflation (WPI) has no merit in the present context, bearing in mind the absence of a direct causal relationship between prices of pulses (gram and urad) and all other sample commodities.

Mukherjee Kedar Nath (2011) the author made an attempt to re-validate the impact of futures trading on agricultural commodity market in India. The statistical tools used are multiple regression model, VAR model and GARCH model. The result of the analysis revealed that the price volatility for most of the sample agricultural commodities was higher in pre- futures period and gets reduced after getting listed in the futures market. The empirical findings have significantly revealed the comparative advantage of futures market in dissemination of information, leading to a price discovery and risk management.

Qiang Ji, Ying Fan (2011) In their paper the influence of price volatility in the crude oil market is expanding to non-energy commodity markets. (With the substitution of fossil fuels by biofuel and hedge strategies against inflation induced by high oil prices, the link between crude oil market and agriculture markets and metal markets has increased.) This study measures the influence of the crude oil market on non-energy commodity markets before and after the 2008 financial crisis., The study investigates price and volatility spillover across commodity markets by introducing the US dollar index as exogenous shocks. The study applied bivariate EGARCH model with time varying correlation construction. The study inferred that the crude oil market has significant volatility spillover effects on non-energy commodity market, which establishes its core position amid commodity markets.

The overall level of correlation strengthened after the crisis, which indicates that the consistency of market price trends was enhanced affected by economic recession. The study further concluded that the influence of the US dollar index on commodity markets has weakened since the crisis. In conclusion, outcome suggests that crude oil as a strategic resource plays an important role in commodity markets. Regardless of whether the commodity market is in a boom period (7/2006–7/2008) or a downturn (8/2008–6/2010), the volatility crude oil prices always affect other commodity prices, and volatility spillover from the crude oil market to other commodity markets is significant. Moreover, influenced by global economic recession, the relationship between crude oil and other commodity markets was enhanced after the crisis.

Liu et al. (2008) the authors have used GARCH and TGARCH models to examine the VAR (Value at Risk) of the Chinese copper spot market and futures market. Furthermore, they employed a linear Granger Causality Test to study the information spillovers between the futures and spot markets and a kernel function to study the relationship between the two markets. The objectives of the study were to explore the existence of a strong relationship between the futures and spot markets. The outcome suggests that there is a two-way Granger causality between the copper futures market and the copper spot market. The study further concluded that information and risk spillovers from the futures market to the spot market.

Brijesh Kumar and Ajay Pandey (2011) the researchers investigated and analysed the cross market linkage with respect to 9 commodities from the Indian commodity market with future markets from other countries. The commodities selected for the study are from metals, energy, precious metals and agricultural products. They employed econometric tools such as Granger Causality Test, Vector Error Correction model, Johansen’s Co-integration Test and Variance Decomposition Techniques. The volatility spillover between Indian commodity market and other markets were studied using GARCH model. The paper concluded that there is co-integration in future prices and that world markets significantly have an impact on Indian markets. The authors detected a return spillover between MCX and LME. An interesting finding of the study was that the effect of LME on MCX was more prominent than that of MCX on LME. The study further concluded that volatility and return volatility spillover point to the fact that the Indian commodity futures markets play the role of a satellite market and the world markets provide it with inputs.

Ajay Kumar Chauhan, Shikha Singh and Aanchal Arora (2013) has conducted a study on Indian commodity markets volatility spill over effects between future and spot markets. The study focussed on market inefficiencies of the Indian commodity market covering the period from 1st April 2004 to 31st March 2012 for two agricultural commodities chana and gaur seed. The Phillip Perron, KPSS tests and ADF unit root test were used to investigate the existence of unit root within the price series. They found the presence of extended term equilibrium association between the future and spot market of the commodities. The study applied Vector Error Correction Model (VECM) to examine the error correction mechanism and detected those disturbances to the equilibrium relationships of the market can be mapped. The authors used the GARCH (1,1) test with squared lagged residuals of another exogenous variable series to examine effects of volatility spillover between futures and spot prices. The result indicated that commodity futures markets can lead the price discovery function with reference to the spot market, which indicates that there is dissemination of information from the futures to the spot market. They also concluded that although innovations in one market may enable the prediction of volatility in the same other market, the volatility spillovers originating in the futures enroute to the spot market will be dominant.

Ranajit Chakraborty, Rahuldeb Das, (2013) the study focussed on dynamic Relationship between futures trading and spot price volatility; evident from Indian commodity market., The daily closing prices of trading volume and open interest of futures from June' 08 2010 to 31st May for four agricultural commodities traded on NCDEX is collected for study. The study employed GARCH process to study the relationship between unexpected futures trading volume and spot price volatility. A weak form of causality between spot price volatility and unexpected open interest is observed. The study inferred that unexpected trading volume results in increase in price volatility.

Bessembinder and Seguin (1992) have conducted a study on contemporaneous relationship through augmented GARCH model. Futures trading volume and open interest series was decomposed into expected and unexpected component. The study employed VAR model to examine lead-lag relationship between spot price volatility, futures trading volume and open interest. Econometric tools such as Granger Causality test, Forecast Error Variance Decompositions and Impulse Response Function confirm that the lagged unexpected volatility causes spot price volatility for all the sample commodities.

Vasishat and Bharadwaj (2010) has conducted a study on the volatility of maize future market. The study applied statistical tools such as ADF, Co-integration, Granger Causality and GARCH models to test the data. Based on ADF, the result shows that the maize spot and futures price series are stationary at 1st difference. The co-integration shows the long run relationship between maize spot and futures price series. Granger causality shows the unidirectional relationship from futures to spot market. It means futures market is leading in price discovery process. The GARCH result shows the August volatility is high compared to September futures contract, which shows persistence and asymmetry in volatility of maize futures prices in the month of august.

Xu (1999) have conducted research on the shanghai stock exchanges (SSE) by using and comparing GARCH, EGARCH, and GJR-GARCH model. The results indicated that unexpected negative returns cause increase in volatility almost equal to that of an unexpected positive return of the same magnitude in Shanghai stock market. The study inferred that there was no so-called leverage effect or asymmetric behaviour in the Shanghai stock market. The main reason for this volatility is that the government policies that heavily affect the stock markets in Shanghai stock market have caused it.

Beakaert and Wu (2000) the study analysed the asymmetric volatility in the Japanese equity market by applying general empirical framework based on multivariate GARCH-in-mean model. Under the research done the authors differentiated between the two main explanations for the asymmetry and conclude that volatility feedback is the main cause of the asymmetry in the market.

Maqsood, Safar, Shafi, and Lelit (2017) The study modelled the stock market volatility of Nairobi Securities Exchange (NSE) from March 2013 to February 2016 by employing GARCH models. The results indicated a high degree of volatility persistence and evidence of risk premium in returns of NSE. The presence of Leverage effect was confirmed by using asymmetric models of GARCH. The study further concluded that asymmetric models better described the volatility of NSE.

Kumar and Khanna (2018) have conducted a study on the volatility pattern and spillover of stock markets of four countries namely, India, China, Hong Kong and Japan. The study employed econometric tools such as ARCH, GARCH (1,1), and bivariate GARCH-BEKK models to study volatility behavior and the spillover effect. The study showed that the Chinese stock markets to be the most volatile market and Indian markets to be comparatively stable markets in comparison to the other markets. The volatility persistence was also observed to be highest in the case of Chinese stock market. The cross-market ARCH effect was strongest between china and Japan followed by Hong Kong and Japan. It was weakest for China and India. Persistency of cross market volatility was highest for the pair of China and India followed by Hong Kong and India, and lowest for China and Japan.

Switzer and Khoury (2006) The study focussed on efficiency of the New York Mercantile Exchange (NYMEX) crude oil futures market during recent periods of extreme conditional volatilities. Their empirical results also suggest that both futures and spot prices exhibit asymmetric volatility characteristics.

Tripathi Trilochan (2008) under the study done price volatility is the feature of the Indian primary commodities market, which has been proved so irrespective of the commodities and futures trading and ban periods in India. Further, by using Granger's causality test, the study inferred that there is a co-movement of prices between the wholesale wheat market and rice markets and vice versa at an all-India level. The study further concluded that the wholesale black gram markets and wheat market at an all-India level are highly fragmented and have unilateral feedback between wholesale wheat market and black gram market in India.

Ahmad, Ali Shah and Shah (2010) the researchers investigated an impact of futures trading on spot price volatility. The study applied GARCH model, and they found volatility clustering among commodities. Their study also finds that introduction of futures market increases the volatility of underlying spot market. The study inferred that the futures markets highly volatile.

On the contrary, **Chong and Miffre (2009)** the researchers found that commodity futures market reduces risk in the spot market. The outcome suggests that adding commodity futures to Treasury-bill portfolios further reduce risk in volatile interest rate environment.

Ashutosh Verma and Vijaya Kumar (2010) have conducted a study entitled "An examination of Maturity effects in the Indian Commodity Futures Market". They discovered that there was increase in price volatility as the contract close to its maturity (Samuelson's hypothesis). The result confirms that, maturity effect is present to the tune of 45% in Wheat and Peeper contracts. The maturity effect explains the negative co-variance between spot price and net Cost of Carry.

Vijay Kumar Varadi (2012) under the research done entitled "Evidence of speculation in Indian Commodity Market". Price volatility is affected by several factors like demand and supply, attitude of speculators and investors and excess liquidity. The study made an attempt to find the impact of the above said factors in Indian commodity derivatives market. It highlights that during global crises, speculation played a crucial role in influencing the price volatility. Fortnightly data is gathered from FMC monthly series for MCX, NCDEDX and NMCEX for the period year 2006 to year 2010.

Siddiqui (2015) forecasted the volatility of commodity market using selected GARCH models. The results of GARCH model indicated that metal futures, metal spot, energy spot exhibited a high degree of volatility persistence. Low level of volatility persistence was observed in agriculture spot and energy futures. The results of EGARCH model confirms the presence of leverage effect. The results of CGARCH model indicated subsistence of trend and transitory component of volatilities in all indices except energy futures.

Sahai (2016) has conducted a study on the volatility modeling for the forecasting efficiency of GARCH models for Soy futures in India and the USA. The study concluded that GARCH (1,1) better modelled the Volatility of Soy Oil futures. The study also concluded that the model EGARCH (1,1) was more accurate in predicting the volatility of the U.S. Soy oil futures. The results indicate a high degree of volatility persistence in Soy oil futures.

Mukherjee and Goswami (2017) studied the volatility return from commodity futures in India of four commodities namely Mentha oil, potato, crude oil and gold for the study period from year 2004 to year 2012. The rolling standard deviation observed a decreasing volatility trend for commodity potatoes and increasing volatility trend for commodity gold. The outcome of GARCH (1,1) suggests a persistent volatility for all commodities except potato.

A variety of stylized facts namely volatility persistence or clustering, mean reversion, fat-tailed distribution, and leverage effect have been documented in previous research papers. A brief review of literature is given below.

Cont (2015) defines stylized fact as a "property common across a wide range of instruments, markets and time periods".

In a first ever study conducted to examine the persistence in volatility by **Mandelbrot (1963)** reported that the large changes in the price of assets are often followed by other large changes in prices while the small changes are often followed by small changes in the prices of asset.

Poterba and Summers (1984) the study justified that volatility is weakly serially correlated which implies that the impact of the shock on the volatility does not last long and the prices ultimately come to their original level. This phenomenon is known as Mean Reversion.

Fama and French (1987) the authors used long-horizon regression to report the existence of mean reversion in the US equity market by using.

A study conducted by **Crato and Ray (2000)** on commodity futures and currency futures found the presence of persistence in both the markets but the volatility was relatively more persistent in the commodity market.

Balvers et al. (2000) the outcome suggests evidence of mean reversion while studying 18 developed equity markets and advocated that mean reversion could be predicted using a contrarian investment strategy.

Rao (2008) had made an attempt to study the volatility persistence and spillover of equity market of Arabian Gulf Cooperation council (AGCC). The result indicated presence of persistence and cross-volatility spillover across six AGCC countries. The study observed that volatility tends to cluster in developed countries and appears to be even more persistent in emerging countries.

Pati and Rajib (2010) have conducted a study on the volatility persistence in Indian equity market and confirmed its presence in the market.

Karali and Thurman (2014) researchers investigated the presence of volatility persistence in Chicago Lumber market. The study revealed that time gap between arrival of news and delivery time of futures contract is the main variable that explains the volatility persistence. The presence of this phenomena is investigated in different financial market by many researchers.

Studies on leverage effect are as follows.

Black (1976) The concept of leverage effect was first introduced in the equity market, which was later tested by many researchers in another financial market.

According to **Engle and Ng (1993)** under the research done they discovered that bad news creates more volatility as compared to the good news of the same magnitude in US equity market.

Pindyck (2001, 2004) and **Ng and Pirrong (1994)** researchers have conducted a study on physical commodities and observed that high volatility periods are preceded by high volatility periods and vice-versa. Many researchers opined that leverage effect is frequently reversed in emerging countries i.e., the correlation between volatility and returns tends to be positive.

A comparative study of the commodity market and equity market by **Hunjra et al. (2011)** on cotton prices, sugar price and gold price, along with KSE 100 index observed that asymmetric and seasonal effect are more prominent in equity market than commodity market. The reason may be the equity market is more organized and structured in comparison to the commodity market.

Studies on **Mean Reversion** in Indian commodity market are as follows.

Kumar and Singh (2008) they study the mean reversion of five major agricultural commodities that include soybean, soya oil, caster seed, guar seed, maize, and two precious metals namely gold and silver. Unit Root Test and Variance Ratio Test on the daily spot and futures prices of the seven commodities was performed. Unit root analysis indicate presence of randomness in all price series and stationarity in return series. Mean reversion is observed in Variance Ratio Test of spot and futures prices for commodity guar seed. Whereas, only the spot price of maize and soya oil exhibits mean reversion. Johansen cointegration test confirms the presence of long-term equilibrium relationships between the futures price and its underlying spot price of the Indian commodity markets.

Edwards (1988) under the research done the author finds no evidence that futures trading increases general market volatility. While the outcome suggests that there are some evidences of futures trading inducing short-run volatility, which arises on (futures) contract expiration days, this does not carry over to longer periods of time. Thus, result indicate that it is doubtful that the recent volatility of stock and bond prices is attributable or associated with futures trading. The most likely explanation for the recent volatility is that it is caused by macroeconomic disequilibrium which increases uncertainty in futures market.

1.2.4 Basis Risk, Hedge Ratio and Hedge Effectiveness of Commodity Market in India

The basis literatures have mostly concentrated on performance of derivative market. Smaller the basis risk more effective is the derivatives market on the price risk management function.

“Basis” is a difference between “Spot price and Futures Price”.

Again, according to **Psindyck (2001)**, the spread between “Spot Price and “Futures Price” gives a straight estimation of the “Marginal Value of the Storage”; alternatively, we called as “Marginal Convenience Yield” (MCY). If MCY is large the spot price is higher than the futures price and vice versa. The level of inventories present in the spot market will be determined by basis and provides healthy information about private storage, which in turn provides a smoother pattern of price in the spot market hence reduce the volatility.

Netz, (1995) & Morgan, (1999). Hedging reduces the price risk at the cost of smaller basis risk. In a hypothetical scenario, the futures and cash prices should be congregated on maturity month and the basis should approach to be zero apart from delivery costs.

Lokare (2007) the results exposed that basis having systematic seasonal patterns and basis size is influenced by the local market circumstances.

Jiang and Hayenga (1997) the authors studied basis risk for two commodities namely corn and soyabean. The study inferred that apart from seasonal patterns and production levels, other aspects like storage costs and transportation also affect basis risk.

Naik and Leuthold (1991) The concept of the inter temporal model was conceptualized to focus on the basis in corn. Apart from storage costs, basis decomposed into different factors like risk maturity, premium and speculative component. the basis has been considered thoroughly for the perishable commodities like livestock where the futures and cash prices are supposed to converge at maturity. The basis for livestock fluctuates with shift in current and expected demand conditions.

Parcel et al (2000) they noted that seasonal patterns and fundamental factors are significant to the forecast nature of basis. As forecasting is focused, basis has been itemized in terms of lagged basis and other economic variables.

Liu et al. (1994) the authors studied basis in cattle futures and the forecasting of basis as a function and is influenced by the expected change in spot prices (near month contract) and delivery costs. The study concluded that lagged basis is less than fundamental variables.

Time series forecasting techniques can be used for identifying the basis **Garcia and Sanders, (1996)**, **Jiang and Hayenga, (1997)**. The union of futures (gains) suggested that forecasting basis has become problematic and more unstable as increased volatility and predicting basis are advanced levels of vertical integration; altering nature of spot market, direct sales or contracts with manufactures otherwise processors.

Hedging is an important concept when derivative is concerned. The price risk management is possible if the derivative segment is well efficient and effective. The producer who wishes to settle the price fluctuation in spot or cash market, the prefer derivative as a tool which safeguard their position in spot. The practice of managing price risk i.e., Critical movement in prices in physical market by the use of futures contracts is called as hedging. Pragmatic studies have also confirmed the advantages of hedging. In order to understand the key focus under hedging, researchers have proceeded with optimal hedge ratio and hedging effectiveness. Both optimal hedge ratio and hedging effectives are dependent upon price behaviour and condition **Garcia et al (2004).**

The concept of speculation and hedging in commodity futures was analyzed by **Johnson (1960).** He created a model that may assist in clarifying the concepts of hedging and speculation that contributed to a better understanding of market phenomenon. The major part of this analysis is summarized as follows. If a trader has expectations regarding only relative price changes, he necessarily takes a unit for unit position in the two markets. However, the study mentioned that hedge may contain a speculative element, depending on his reaction to expected relative price changes.

Holbrook Working (1960) the author wrote a series of articles about "traditional" concepts of the nature of hedging and the function of a futures market. "He envisages the hedger as one who does not seek primarily to avoid risk but one who hedges because of an expected return arising from anticipations of favourable relative price movements in the spot and futures markets. The trader does not somehow find himself with a given size inventory that has to be hedged against, but he takes positions in both markets as a form of arbitrage".

Ederington (1979) the author investigated the hedging performance of the futures markets in financial securities by applying a basic portfolio model that was earlier applied to the commodities futures market by **Johnson (1960) and Stein (1961).** He then extended his study by applying the same portfolio approach to determine the determine risk minimizing hedge ratio with the regression methodology Ordinary Least Square (OLS). The key objective of hedging is to reduce the risk of a given position. Thus, the author defined hedging effectiveness in his model as the reduction in variance. Depending on the model used to estimate the hedge ratio optimal hedge ratio can vary significantly. The empirical result suggests that two-week hedges using 90-day Treasury Bill futures are not effective in minimising exposures to change in price risk.

Benninga (1984) the author defined Minimum Variance Hedge Ratio (MVHR) as the slope coefficient in the OLS regression of changes in spot prices to changes in the futures price. In other words, MVHR is the regression coefficient which gives maximum hedging effectiveness. Following this approach, a large number of studies have focused on measuring the hedging efficiency. They strive to examine to what extent investors are able to minimise price risks by using futures contracts. Similar studies of **Markowitz (1959)** measured hedge effectiveness as the reduction in standard deviation of portfolio returns associated with a hedge. But, later **Johnson (1960), Stein (1961), Working (1962)** also measured hedging effectiveness as the percent reduction in variability.

According **to Carter (1989),** hedging will minimise price risk if the change in basis is less than the cash price variability. The factors which affect the hedging effectiveness and its construction is hedging horizon, basis risk, and the correlation between changes in cash prices to the futures prices. A large variety of alternative models is available to model and quantify the hedge ratio and hedge effectiveness.

Baillie and Myers (1991) the researchers estimated minimum variance hedge ratio based on daily data for two futures contracts maturing in the year 1982 and year 1986. They employed Bivariate GARCH model for four commodities namely cotton, coffee, beef, gold and soybean. The optimal hedge ratio is calculated as a ratio of the conditional covariance between futures and cash to the conditional variance of futures. The study inferred that the estimated optimal hedges ratios are confirmed to time variation. It also reveals that the assumptions of constant optimal hedge ratios are inappropriate. The study further concluded that the GARCH models provide a good picture of the distribution of commodity prices change, and the results appear to be more satisfactory than previous studies in the literature about modelling the unconditional distribution of change in commodity price. The study observed that both in -sample and out- of- sample GARCH based hedge ratios are found to be more effective in comparison to constant hedge ratios.

Kroner and Sultan (1993) the researchers proposed the use of Vector Error Correction Model to estimate the hedge ratio which takes into consideration the cointegration relationship between two variables. But VECM model has also been criticized on two grounds:

1) Hedge ratio in VECM model is derived from the unconditional variance but the actual minimum variance hedge ratio is based on the conditional variance.

2) A constant hedge ratio does not consider the fact that joint distribution of futures and spot prices varies over time.

Ghosh (1993), the author analysed stock index futures and underlying stock price index incorporating the cointegrating relationship. the objective of the study was to estimated hedge ratio by using Error correction method for S&P 500 index based on daily closing prices from January 1991 to December 1999. The outcome of study suggests that estimates of minimum variance hedge ratio are biased due to misspecification, if futures and spot prices are cointegrated and the error-correction term is not included in the regression model. The study finds that hedge ratio obtained from traditional methods are underestimated. The study inferred that hedge ratio obtained from Error Correction Model (ECM) shows significant improvement compared to OLS regression method. The study concludes that out -of -sample hedge ration performance is better for the ECM method compared to the OLS model.

Lien and Luo (1994) the authors have shown that, although GARCH describe the price behaviour, the cointegration relationship is the only truly crucial component when comparing the performance of various hedging strategies. Other authors also noted that this co-integration relationship cointegration between spot and futures prices plays a crucial role in determining the optimal hedge ratio

Park and Switzer (1995) the author analysed estimates of the risk minimizing futures hedge ratios for 3 types of stock index futures MMI Futures, S&P 500 and Toronto 35 index

Futures**.** Non-stationarity and cointegration test were used on the spot and futures prices series. The study applied Bivariate Cointegration model with a generalized ARCH error structure to estimate the optimal hedge ratio. The GARCH based hedge ratios indicate a considerable variation between June 1988 and December 1991. Such a variation in the hedge ratio shows the unreliability of the constant hedge ratio based on the conventional risk minimising estimation methods. The conclusion of the study is that for both within sample and out of sample, the Bivariate GARCH model is potentially superior over the conventional constant hedging strategy.

Pennings and Meulenberg (1997) the researchers analysed hedging efficiency together with the risks and costs of the hedge of potato futures contract. The study tested hedging performance for two short periods viz. one day and one week for the period of September 1995 to April 1996. The study described new measure of hedging efficiency and the concept of overall risk reduction. The conclusion of the study is that both basis and the market depth risk contribute to inefficient hedging possibilities of the potato futures contract.

Alexander (1999) the author investigated optimal hedging performance using cointegration for international equity portfolio. The results of study indicate that the futures and spot prices are cointegrated. Hedging performance of futures market is ineffective if spot and futures prices are not cointegrated. The study inferred that the hedging in cointegrated market has long term implications and also stated that Vector Error Correction model result provide better performance if the two-price series are cointegrated.

Mathew and Holthausen, (1991) earlier ideal hedge ratio was found to be one, which means one has to take the particular position in the futures market as is in spot markets, however due to the existence of basis risk the optimal hedge ratio can also be less than 1.

Lence (1995) the author compared risk minimizing and utility maximizing hedge ratio for a Midwest crop producer. There was considerable amount of divergence of utility maximizing optimal from the risk minimizing hedge. The outcome suggest that it was highly sensitive to lending and investing opportunities, transaction costs, and borrowing.

Myers, (2000), *w*hile investigating with in-sample measures, the results of hedging effectiveness obtained is seen better by using more advanced methodologies. However, variable result is observed in case of out-of sample hedging effectiveness, possibly due to a smaller number of observations in the out of sample investigation.

Bose (2008) findings indicated that hedging in agricultural commodities is a difficult task by carrying a study in Indian derivative market.

Lokare (2007) The study analysed the efficacy of commodity derivatives in price risk management. The result indicated that many of the commodities exhibited co-integration in spot futures prices, presaging that these markets were going in right direction of achieving improved operational efficiency. The study further concluded that hedging proved to be an effective proposition in respect of some commodities.

Singh & Singh (2015) chana futures contracts are found to be effective hedging instrument for the stakeholders such as farmers and traders. On the other hand**, Malhotra (2015)** investigated hedging efficiency of oil and oilseeds market in India by employing Minimum Variance Hedge Ratio (MVHR), Ordinary Least Squares (OLS) and VECM. The study showed that CPO and refined soya oil have satisfactory hedging effectiveness. Whereas, poor hedging effectiveness was observed in case of two commodities mustard seeds and mentha oil. Author further stated that both the commodities fall in the category of narrow commodities which are susceptible to price manipulation and cartel like activities by hoarders and speculators which led to poor hedging effectiveness.

Lien et al (2000) the author compared the performance of the hedge ratios obtained from the OLS method and the Constant – Correlation VGARCH (Vector generalized autoregressive conditional heteroskedasticity) model. They investigated ten spot and futures markets covering stock index futures, currency futures and commodity futures. The constant hedge ratio and the time varying hedge ratio were estimated in day-by-day rollover. The study revealed that hedge ratio suggested by OLS method performs better than the VGARCH model. The study further concluded that the forecasts generated by the VGARCH models are too variable.

Yang (2001) The author examined the hedge ratio and hedging effectiveness of Australian futures market for the period from January 1988 to December 2000. He considered only three months futures contracts and rolled over to next three months contracts on the first day of delivery month. Comparative analysis of four techniques namely OLS regression, Bayesian Vector Autoregressive (BVAR), Error Correction Model (ECM) and Multivariate Generalized Autoregressive Conditional Heteroskedasticity (MGARCH) was conducted. The empirical result suggests that out of three constant hedge ratios obtained from three methods, Error Correction Model (ECM) generates highest hedge ratio. The study revealed that MGARCH dynamic hedge ratio provide the highest degree of variance reduction but generates smallest rate of return. The study further concluded that hedge ratio obtained from the conventional regression model (OLS) performs the worst in terms of minimising variance of portfolio, but yields the highest rate of return. The study also revealed that in long term hedging, the time varying hedge ratios outperform the constant hedge ratio in terms of reducing portfolio variance.

Kenourgios (2003) The author carried out empirical investigation of the hedging effectiveness of S&P 500 stock index futures contract by employing conventional OLS method and time varying hedge ratio methods**.** The study used weekly settlement prices for the period July, 1992 to June 2002. The study inferred that the Error Correction Model is the appropriate method to estimate optimal hedge ratios as it provides better results than the conventional OLS method in price risk reduction. The evidence presented in this study strongly suggest that the S & P 500 stock index futures contract is an effective tool for hedging risk.

Choudhry (2004) the author investigated the hedging effectiveness of Hong Kong, Australian and Japanese stock futures markets. This study compares the hedging effectiveness of futures market by employing OLS method and the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) Model taking into consideration the time varying distribution of the changes in cash and futures price. The daily stock returns from the spot and future markets of Hong Kong, Australian, and Japanese from January 1990 to December 1998 have been used for the study. For the analysis of empirical tests for each country, two sets of futures prices based on two different expiry dates of the futures contract is used. The empirical result suggests that the time varying GARCH hedge ratio performs better than the constant hedge ratios. These results are also true for out of sample period.

Mc Millan (2005) The author studied hedging effectiveness of time varying Bivariate GARCH and GARCH – X hedge ratios against time invariant methods for six non-ferrous metals**.** The data was collected from the London metals exchange based on daily cash and three months futures settlement prices. The study revealed that hedging minimises the standard deviation of portfolio by 50% irrespective of the hedging methods being used. Finally, the study concluded that GARCH – X model provides best performance of effective hedge. Out of the four cases GARCH model provides the second most effectives hedge ratio. The empirical results suggests that only in one case OLS optimal hedge ratio performs better than the time varying hedge ratios. Thus, the study inferred that incorporating time variation into the optimal hedge ratio improves the hedging performance.

Ripple and Moosa (2007) the author examined the effect of the maturity on the hedging effectiveness of futures contracts**.** Daily and monthly data of Crude Oil spot and futures price is used to work out hedge ratio and measure the hedging effectiveness for near month and distant month futures contracts. The optimal hedge ratio is measured as the slope coefficient in a regression model (OLS). The empirical results suggests that hedging is more effective when the near-month futures contract, rather than distant month futures contract is used. This result is explained in terms of the higher correlation between spot prices and near month futures prices compared to more distant futures prices. The study observed that hedge ratios are lower for near month hedging, which is explained in terms of the Samuelson (1965) findings about the volatility of contracts with short and long maturities.

Roy & Kumar (2007) studied hedging effectiveness of wheat futures in India using least square method (OLS) and the outcome suggests that hedging effectiveness provided by futures markets was low.

Bharat Ramaswami, JatindarBir Singh (2007) the researchers have conducted a study entitled "Hedging and Emergence of Commodity Futures: The Soya oil Exchange in India". Soya oil futures contracts are studied through empirical strategies by commercial hedgers. If the market offers arbitrage opportunities to the hedgers and if such activity is significant, then the activities of commercial firms should affect the returns to their hedging portfolio.

Mandal & Anandadeep (2008) the authors examined the hedging effectiveness in Indian stock index futures market. The study focused on the procedure to estimate static and time-varying optimal hedge ratios. They employed econometric tools such as traditional OLS regressions, modified OLS viz. LTS, Error Correction Model (ECM), Vector Error

Correction Model (VECM) and Multivariate Generalized Autoregressive Heteroscedastic (M-GARCH) to estimate hedge ratios, not only for index underlying futures contract but also for mutual funds. The findings revealed mutual funds tend to be a good proxy for market portfolios.

Bhaduri, S. N., & Durai, S. N. S. (2008) The author analysed the hedging effectiveness of stock index futures of National Stock Exchange. The study was conducted by using four econometric models viz, Regression (OLS), VAR, VECM and M-GARCH. The effectiveness of the optimal hedge ratios derived from these models are examined in two ways. At first, the mean returns of the hedged and the unhedged position and then, the average variance reduction between the hedged and the unhedged position with the hedge ratios for 1-, 5-, 10- and 20-days horizon period. The results revealed that the time varying hedge ratio derived from the Multivariate GARCH model provides higher mean return and higher average variance reduction across hedged and unhedged position. The outcome suggests the performance of variance reduction for GARCH model gives better results only in the long-time horizons compared to the simple OLS method that performs better in the short time horizons. To determine the hedging efficiency, it is critical to use the optimal number of hedging instruments.

Brajesh Kumar, Ajay Pandey (2009) the study analysed the hedging effectiveness of four agricultural commodities (Castor seed, Soybean, Corn, and Guar seed), and seven non-agricultural commodities (Gold, Silver, Aluminium, Copper, Zinc, Crude oil and Natural gas) traded on National Commodity and Derivatives Exchange (NCDEX), and Multi Commodity Exchange (MCX) from the year 2004 to year 2008. The study applied Vector Autoregressive Model to estimate constant hedge ratio and Multivariate GARCH with constant conditional correlation model to estimate dynamic hedge ratio. The empirical result suggests that the agricultural commodities provide higher hedge ratio and hedging effectiveness as compared to non-agricultural commodities in India.

Santhosh Kumar and M. A. Lagesh (2011) The authors investigated price volatility and hedging behaviour of four national commodity futures indices which represent the relevant sectors like Agriculture (AGRI), Energy (ENER), Metal (META) and an aggregate of agricultural, energy and metal commodities (COMDEX) derived from the Multi Commodity Exchange (MCX) of India. A total of 1,563 daily closing prices (after adjusting for dates and missing observations, due to holidays) over the period of June 8, 2005 to August 31, 2010 have been used to measure the volatility and hedge ratio. The study applied GARCH (1,1) model to measure the spot return volatility of respective indices. Econometric tools such as DVECH-GARCH, BEKK-GARCH and CCC-GARCH were applied to estimate the time varying hedge ratio. Further, author went for an in-sample hedge ratios performance was estimated from bivariate GARCH models by employing hedged return and variance reduction approach. The empirical result suggest that all the econometric models were able to reduce the exposure to spot market as perfectly as possible in comparison to the un-hedged portfolio.

Srinivasan (2011) the author conducted a study entitled "Hedging effectiveness of Constant and Time varying Hedge Ratio in Indian Commodity Futures market: Evidence from the Multi Commodity Exchange". The study applied different econometrics models viz; OLS model, VECM and multivariate GARCH with Error-Correction Model estimations to estimate the performance of various hedge ratios. The hedging strategy derived from time variant hedge ratio model which minimizes the conditional variance, performs better than the alternative models for all commodity indices except for MCX agri. The result suggests that the investor's degree of risk aversion might play a relatively important role.

Brajesh Kumar, Ajay Panday (2011) the authors conducted a study entitled "Role of Indian Commodity Derivative Market in Hedging Price Risk: Estimation of Constant and Dynamic Hedge Ratio and Hedging Effectiveness". The hedging effectiveness of four agricultural commodities and seven non – agricultural commodities have been tested. The authors have used Vector Error Correlation and CCC M-GARCH model to estimate constant hedge ratio and dynamic hedge ratio respectively. Highest hedging effectiveness was recorded for agricultural commodities (32.7%) as compared to non-agricultural commodities (20%). Hedging effectiveness increased dramatically indicating that, Indian commodity markets are effective for hedging.

Malhotra & Meenakshi (2015) The study focussed on the risk reduction function of commodity futures market for commodities in the oil and oilseeds segment, namely mustard seed, mentha oil, refined soya oil, and crude palm oil. The calculation of the Minimum Variance Hedge Ratio (MVHR) was performed by applying the Ordinary Least Square (OLS) Method, OLS with additional variables and Error Correction Model (ECM). Hedging effectiveness was calculated using MVHR.

P. Sri Ram and B. Ramesh (2015) the research focussed on co-integration in spot and future prices and estimated the hedge ratio and hedging effectiveness of four non-agricultural futures contracts (Crude Oil, Natural Gas, Nickel, Gold) traded on Multi-commodity Exchange of India (MCX) from January 2010 to December 2014. The study applied ADF, Johansen Co-integration Test, Granger Causality Test and Vector Error Correction Model (VECM). Augmented Dickey Fuller test (ADF) was used to test stationarity of data in which data was found to be stationary after taking first difference. Johansen Co-integration Test was used to determine the presence of co -integration between future and spot prices. Vector Error Correction Model (VECM) was used to estimate hedge ratios. The study showed that there is long run equilibrium relationship between spot and future prices. the study observed short run existence of unidirectional causality was among different commodities. The hedge ratio in the range of 0.14 to 0.78 was considered to be efficient.

P. Sri Ram (2017) the study investigated hedge ratio and hedging efficiency of four non-agricultural future contracts traded on Multi-commodity Exchange of India (MCX). The study uses daily spot and future prices of four commodities namely copper, crude oil, gold and silver, for a period of 5 years from year 2011 to year 2016. The study applied Augmented Dickey Fuller (ADF) to test stationarity of data and Johansen Co-integration Test to determine the presence of long run relationship between spot and future prices. Hedge ratio and hedging effectiveness was estimated based on the residuals derived from Vector Error Correction Estimates. The result indicates that there exists a long run equilibrium relationship between spot and future prices and unidirectional causality in the short run. The result show hedge ratio in the range of 0.29 to 0.96 and was considered to be efficient.

The present chapter has reviewed the literature pertaining to derivatives with a view to study the current state of research. The study of long run relationship provides mixed results. Research results differ according to the methodology used, model, data, sample, and time period. For futures market to provide efficient price discovery, they must exhibit a close relationship with the price recorded in the spot market. The literature review shows that there has been some work on the topic of instability and volatility in commodity market and also many researchers have discussed hedging as risk minimisation tool. Based on the detailed analysis of past studies, a number of issues deserve special attention and warrant empirical examination in the Indian context. However, it is pertinent to acknowledge here the contribution made by the previous researchers in setting the clear agenda for the current research initiative, to expand the body of knowledge further.

CHAPTER II

RESEARCH METHODOLOGY

The chapter covers statement of research problem, significance of the study, research gap, research questions, research objectives, research hypothesis, methodology of the study (sample selection, data collection, data processing and data transformation), limitations of the study and chapterization scheme.

2.1 Statement of the Research Problem

The Indian commodity market has a very long history and one of the oldest commodity markets in India. Till now commodity markets in India have experienced many ups and downs and still remains underdeveloped. The commodity market regulator Forward Market Commission followed by Security Exchange Board of India has always been a watchdog of the commodity trading and imposed various regulatory policies. The Indian commodity market has been in existence long before the stock market but the Indian stock market has developed and achieved lot which is still inapplicable in the Indian commodity market. This is all because of the market efficiency of the stock market which has attracted huge market participants. However, the commodity market had failed in its regulatory system in creating an efficient market to trade.

Regulatory constraints post-independence resulted in virtual dismantling of the commodities futures markets. Though the basic objective and theme of commodity derivatives may not have changed over a period of time, the mechanism and practices have certainly undergone a huge change. The effectiveness of commodity derivatives dwells upon the performance of three basic functions namely a) Risk (Volatility) management of derivative market b) Price discovery c) Hedging effectiveness. Volatility in the prices of commodities or price risk is one of the most significant risks for traders, manufactures, and consumers. A number of research studies have aptly identified the presence of stylized facts of volatility in the equity derivatives market and identified it as an important tool to manage this risk. In the context of Indian commodity market, there is a dearth of literature which deals with time series model for volatility characteristics. Similarly, the derivative securities have also been with suspicion and, time and again, the doubts are raised on their utility for price discovery and hedging. The study focuses on the commodity derivative market in the Indian context. To completely understand efficiency of the commodity derivative market the study analyses effectiveness of futures market in price discovery, and explores the presence of stylized fact of volatility. Further, a comparative analysis is done to compare the appropriateness of static and dynamic hedge models and then tests their efficiency in reducing price variance.

2.2 Significance of the Study

Commodity market is an important constituent of the financial market of any country. It is the market where a wide range of commodities from different sectors namely bullion, base metal, energy and agricultural commodities like cotton, palm oil and cardamom etc. are traded. Studying about the Indian commodity market efficiency is important to have a balanced economic development. With a growing population of 138 crores (2020 Census), nature and growth potential of its economy, India would remain one of the largest markets for traders in global commodities.

It is important to understand why commodity derivatives are required and the role it can play in risk management. It is common knowledge that prices of commodities, metals, shares and currencies fluctuate over time. The possibility of adverse price change in future creates risk for business. Derivatives are used to reduce/or eliminate price risk arising from unforeseen price change. Companies need to be able to manage these risks if they are to be globally competitive, and this is where an efficient commodity futures market plays a vital role, not only in facilitating price/volatility risk mitigation but also catalyzing near-perfect price discovery.

Here comes the relevance of the present research which tries to study the information flow between spot and futures markets, as it is likely to influence the decisions of the farmers in participating in futures trading and storage. This research work provides basic knowledge on the movement of Indian commodity market and its underlying market. The movement of both markets gives the investors and traders to take decision on their dealing in the market. In this research, the causal relationship between spot and futures price market shows the picture on the opportunities of the hedging and arbitrage in the Indian commodity market.

The study is of high relevance to both the users of this market and regulators. An efficient market helps the government for better price stabilization and implementation of other control policies. It provides reliable estimates for future spot prices to traders and producers of the commodities. This would help investors hedge their commodity risk, take speculative positions in commodities and exploit arbitrage opportunities in the market. The present research would facilitate commodity producers, consumers, processors, traders and financial institutions to design an efficient asset allocation strategy. Hence, the study entitled “A Study on Commodity Spot and Futures Markets in India" examines the role of commodity derivatives market in respect of price discovery and risk management.

The present study is dealing with the following issues of Indian commodity market which have been identified by extensive literature review.

1) Study of stylized facts of volatility like, persistence, mean reversion and leverage effect in Indian commodity derivative market.
2) Examining the market efficiency of commodity futures market in performing the functions of price discovery and hedging.

2.3 Research Gap

Studies on relationship between commodity spot and futures market have been extensively carried on developed markets and few studies are focussed on the emerging markets. Especially for the Indian Commodity Market, the amount of literature is considerably less in number. Exchange based commodity trading started largely with the onset of national level commodity exchanges after 2003. In this respect, commodity market in India is much younger than the other international markets. This might be one of the reasons for finding a smaller number of works in the context of the Indian commodity market. As a result, the commodity market in India has not received enough attention of the researchers relative to the stock market. Because of the difference in the level of economic as well as the stock market developments, findings from the developed markets cannot be generalized for the emerging markets. Though commodity derivatives market in emerging economies like India have been growing, not much research has been done on testing the efficiency of commodity derivatives in price discovery and risk management. Therefore, it has been necessary, from time to time, to carry empirical studies to measure the efficiency of commodity futures in price discovery and risk management. The literature review shows the various studies on the hedging effectiveness of different derivatives markets. The evidences are quite mixed. Most of the previous studies revealed the fact that spot and futures markets may not react at the same time after the flow of new information. The dearth of conclusive statement on price discovery creates scope for the further examination of the issue in detail for the Indian commodity futures market. Research gap derived from literature review is as follows:

1. In India, even though the national level commodity exchanges started functioning in the year 2003, the commodity futures market is in the emerging stage. Moreover, empirical studies on price discovery role of the Indian commodity market are few in numbers and

most of the studies examine the price discovery role by using commodity indices or few commodities from the same category of commodities. However, each commodity has its own unique set of characteristics. Examining the price discovery role of Indian commodity market specifically at individual commodity level and including actively traded commodities from all categories may bring more insights into the inter-temporal causal relationship between commodity futures and spot prices.

2. The literature review on the factors determining commodity futures price volatility reveals that studies focusing on the time-varying volatility and leverage effects are almost non-existent. The study about time-varying volatility and asymmetric impact of good news (positive shock) and bad news (negative shock) on volatility may bring more insights into the determinants of commodity futures price volatility because it may help to understand the connection between information transmission and volatility explicitly.
3. In the Indian context, several researchers have examined the price dynamics and hedging efficiency between commodity futures and spot prices but time span of these studies was very short as they have been conducted shortly after the start of the national exchanges in late 2003. While there have been some studies in the area of hedging efficiency of the Indian stock market but limited research is available in Indian commodity derivatives market. As the stocks and commodities are different in nature, a special attention and close analysis are required for the Indian Commodity market.
4. Very few studies have examined the efficiency of the Indian commodity derivatives market comprehensively covering all categories of commodities simultaneously and long study period of twelve years. The concerned work has chosen commodities from agriculture, base metals, energy and bullion categories so as to incorporate maximum coverage of commodity types. And also, in last twelve years Indian commodity futures

markets have grown rapidly. It covers fairly longer study period compared to prior research of the subject.

An attempt has been made to empirically examine the effectiveness of commodity derivatives in price discovery and risk management in India with reference to select agricultural and non-agricultural commodities traded at Multi Commodity Exchange of India (MCX).

2.4 Research Questions

Futures markets should ideally help in price discovery by absorbing specific market information and adjusting them with demand and supply equilibrium, government policies, inflation rates, weather forecasts, market dynamics, hopes and fears and the like. However, in real life, matters are less reassuring as to whether futures prices in India satisfy the goal of efficient price discovery or rather it misdirects the prices. From the review of literature, it clearly indicates towards parallel existence of two contrasting results of relationship and no relationship between the spot and futures commodity markets. Given such and many other contradictory opinions in regard to the commodity spot and futures market interrelations, many findings have been drawn by researches and experts and evidences have been arrived at both for and against.

The following research questions are raised:

1. How vibrant the commodity market has been in terms of growth in volume and price trend.
2. How effectively do futures markets perform the price discovery function? Does price formation in one market influence the same in the other market?
3. Is the future price a predictor of spot price or the spot price to be a predictor of future price?

4. Whether volatility persists in select agricultural and non-agricultural commodities?

5. To what extent the existing futures contracts are suitable for hedging? If so, is this hedging effective in minimising spot price risk?

The above research **QUESTIONS** have been formulated into a research statement

Whether the commodity futures prices are useful in price discovery and risk management functions of spot prices efficiently?

The aim to find the efficiency of commodity futures market in price discovery and risk management through hedging of agricultural and non-agricultural commodities in India.

2.5 Research Objectives

The study entitled. "A Study on Commodity Spot and Futures Market in India" has been undertaken with the following objectives

1. To examine market structure and pattern of growth of commodity markets in India.

2. To examine causal relationship between Futures prices and Spot prices of commodity market.

3. To study the volatility pattern of the commodity markets in India.

4. To estimate the optimal hedge ratio and hedging effectiveness for select commodities traded on Indian commodity derivatives market.

2.6 Research Hypothesis

In order to analyse above mentioned objectives, following hypothesis were framed as well as tested to arrive at concrete results and findings:

Hypothesis of the study

Based on the **Objective two**, the following null hypotheses have been formulated.

$H0_1$: There is no significant relationship between commodity spot and futures prices.

$H0_2$: Commodity futures market prices do not influence commodity spot market prices.

$H0_3$: There is no significant granger causality from commodity futures prices to spot prices.

Based on the **Objective three**, the following null hypotheses have been formulated.

$H0_{1:}$ There is no significant price volatility in the commodity spot market.

$H0_2$: There is no significant price volatility in commodity futures market.

H03: There is no asymmetric impact of news on current volatility.

Based on the **Objective Four**, the following null hypotheses have been formulated

$H0_1$: There is no significant decrease in the variance of commodity spot returns (price risk) by hedging through commodity futures.

$H0_2$: There is no significant difference in hedging performance among different time periods

2.7 Methodology of the Study

Present section provides the detailed framework of research methodology used for carrying out the present research work. The study examines the efficiency of commodity market in India by analysing the commodity futures price patterns and growth, its relationship with spot prices, volatility persistence and hedging effectiveness of commodity market in India.

2.7.1 Nature and Source of Data

The efficiency of the commodity trading in the Indian market was examined by collecting data from the traded commodity contracts in the Futures market. Among the national commodity exchanges in India, the Multi National Commodity Exchange (MCX) holds 82.34% to the total value of commodity derivatives traded in the year 2009-10. The market share of MCX has increased to 94.2% of the total commodity traded for the financial year 2019-20 (Table 3.68). Hence, the study focussed on the commodities traded at MCX, as it holds the maximum market share in India. The study is based on secondary data and consists of the daily closing prices of spot and near -month futures contracts. The daily data of spot and futures price of the selected commodities are collected from Multi-Commodity Exchange (MCX) website www.mcxindia.com for the research period. Spot prices of the commodities are also taken from the respective exchanges.

2.7.2 Period of the Study

The time period chosen for study is twelve years which is adequate to determine the efficiency of the futures and spot markets in long run and is appropriate to estimate hedge effectiveness during the different phases of commodity derivatives market. Near month futures contracts originating and expiring during the period of 1st January 2009 to 31st December 2020 are selected for the study. The time period chosen for the study is depending on the availability of spot and futures prices on the exchange.

2.7.3 Selection of the Commodity Exchange

The Multi Commodity Exchange of India (MCX) is the most significant commodity exchange in India. Therefore, the risk-returns and other characteristics of Indian commodity market can be understood better by studying the commodities and indices listed and traded on the MCX. It is the major exchange for commodity derivative futures trading in India in terms of turnover traded. The MCX specializes in non-agricultural commodities like gold, silver, crude oil, natural gas, copper, aluminium, lead and nickel. MCX also offers trading in agricultural commodities. Currently, the MCX commands over 94.2% (table 3.68) of India's futures market and has already emerged as the most active exchange in the world for silver futures and the second most active in the world for trading in gold futures.

2.7.4 Sample Size

The selection of commodities has been done not on a random basis but on the basis of certain predefined criteria. The method of sampling adapted is conditional sampling. The study has selected sample commodities based on the following criteria.

a. Commodities actively traded on the MCX.
b. Commodities traded for twelve years from 1st January 2009 to 31st December 2020 and had no trading break of more than 3 months during the study period.

2.7.5 Sample Commodities and Indices

The major focus of this study is to examine the efficiency of derivative market in performing the function of price discovery and hedging. Hence the universe has been defined as the individual commodity futures and commodity futures Indices. The futures contracts on MCX Indices were introduced in the year 2005 wherein futures contracts on commodities have been introduced in different phases. The index is a portfolio of high performing assets of the specific exchanges and hence, each exchange has their own calculation of the index.

For achieving the defined objectives of the present study, the sample consisting of twelve commodities are drawn for the study which comprises of eight non-agricultural commodities and four agricultural commodities.

The List of commodities chosen as sample are as follows.

Table 2.1: List of Sample Commodities Selected for the Study

Non -Agricultural Commodities
Base Metal
1. Aluminium
2. Copper
3. Nickel
4. Lead
Energy
5. Crude Oil
6. Natural Gas
Bullion/Precious Metal
7. Gold
8. Silver
Agricultural Commodities
1. Cardamom
2. Cotton
3. CPO
4. Mentha Oil
Source: Author's Compilation

The sample consists of twelve commodities: Four belonging to agricultural sector viz., Cardamom (Spices), Cotton (Fibre), Crude Palm Oil and Mentha Oil (Oil and Oil seeds) and Eight non-agricultural commodities namely Aluminium, Copper, Nickel and Lead (Base-Metal), Crude Oil and Natural Gas (Energy), Gold and Silver (Bullion).

As Index is generally considered as the barometer of the market the study has considered four major indices. The MCX indices namely MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY are also used to study the defined objectives as they are representatives of the commodity derivative market. MCX COMDEX is a national index of MCX which was launched in June 2005. It constitutes bullion, metal, energy and agricultural commodities which are highly traded on the MCX platform. It was revised in the year 2007, 2008, 2009 and late 2015. It is necessary to replicate the test used for individual commodities futures with these indices to confirm that the results of individual commodities are not commodity specific rather can be generalized.

Data of near month futures with respective spot data has been taken for analysis. Market information has a greater impact on near month contracts than contracts of far farther-out delivery due to the smaller elasticity of supply and demand for shorter runs. Details of data period of each commodity futures along with their respective spot market is given in the table 2.2.

Table 2.2: List of Individual Commodities Selected for Study along with Data Period

Sr. No	Commodity	Data Period		Spot Market	Number of observations
		From	To		
Agricultural Commodities					
1	Cardamom	01/01/2009	31/12/2020	Vandanmedu	3288
2	Cotton	01/01/2011	31/12/2020	Rajkot	2359
3	Crude Palm Oil	01/01/2009	31/12/2020	Kandla	3242
4	Mentha Oil	01/01/2009	31/12/2020	Chandausi	3223
Non-Agricultural Commodities – Base Metal					
5	Aluminium	01/01/2009	31/12/2020	Raipur	3207
6	Copper	01/01/2009	31/12/2020	Thane	3067
7	Nickel	01/01/2009	31/12/2020	Thane	3290
8	Lead	01/01/2009	31/12/2020	Chennai	3237
Non-Agricultural Commodities – Energy					
9	Crude Oil	01/01/2009	31/12/2020	Mumbai	3247
10	Natural gas	01/01/2009	31/12/2020	Hajira	3268
Non-Agricultural Commodities – Bullion					
11	Gold	01/01/2009	31/12/2020	Ahmadabad	3206
12	Silver	01/01/2009	31/12/2020	Ahmadabad	3191
Source: Author’s Compilation					

Spot market prices is captured at the identified basis centres of a commodity, by getting price quotes from the empanelled polling participants representing the value chain comprising various user class viz. auctioneers, traders, cold store owners, farmer, grader, miller, commission agents, wholesaler's, processors, importers, exporters etc. The prices of the underlying commodity are polled and disseminated to the market. Spot price polling mechanism is a process of gathering information from a cross section of market players about the spot price of the commodity in the market.

Process of spot price polling is as follows:

1. Collection of spot prices from polling or information vendor or instalment markets.
2. Computing average of polled prices after removal of outliers.
3. Broadcasting of final price on Trader Workstations.
4. Calculation and generation of DDR as per contract specification.

Each commodity category has different spot price polling mechanism which is given in annexure IV.

The selection of this time period ensures the following:

- Uniformity of time period of sample commodities
- Recording of commodity futures prices in a transparent setup and liquid market.

  Further, this time period coincides with some of the major developments in the Indian commodity market which includes

  1. Merger of FMC and SEBI on 28th September 2015.
  2. Acceptability and better understanding of the free regime of commodities in Indian Market.

2.7.6 Collection of Data and Variables

The secondary data used in this study consists of the daily closing prices of futures and spot, for a period of twelve years i.e., from 1st January 2009 to 31st December 2020, for twelve commodities consisting of both agricultural and non-agricultural commodities. Data of near month futures with respective spot data is divided into two sub periods (1st January 2009 - 31st December 2014 and 1st January 2015- 31st December 2020) for the fourth objective i.e., to estimate hedge ratio and hedge effectiveness of Indian Commodity Derivatives market.

The closing prices of all sample commodities are collected from the websites of MCX for the research period. If there is any missing observation, due to non-trading, in any day and in any of the market, the common practice is to remove that specific interval(s) from the sample and therefore has been applied here also. The study consists of two variables, spot close price as dependent variable and futures close price as independent variable.

2.7.7 Processing and Transformation of Data: The study analyses the near-month futures contracts because these are most active and highly liquid contracts. The near-month futures time series is created based on a rolling basis. Maturity week is eliminated from the near-month futures series to remove the maturity bias effect. The daily closing prices of futures and spot of sample commodities have been transformed into 'Natural Logarithm i.e., *Ln* of daily closing prices' to reduce the heteroscedasticity effect in data. Daily 'Returns' are computed on all the sample commodities, both in the spot and the futures markets, as continuously compounded return, i.e., natural logarithmic differences of lagged price series as follows:

$$\boldsymbol{SR_t = ln\left(\frac{SP_t}{SP_{t-1}}\right) \times 100}$$

$$\boldsymbol{FR_t = ln\left(\frac{FP_t}{FP_{t-1}}\right) \times 100}$$

Where, SR_t and FR_t are natural logarithmic daily returns at time t; FP_{t-1} and FP_t and SP_{t-1} and SP_t are daily closing prices of commodity futures and their underlying commodities in spot market on two successive days t-1 and t, respectively.

The main purpose to transform data into logarithmic is to stabilise the variance. If there is a trend in the series and the variance appears to grow with the mean value. Which means, if the standard deviation of the series is directly proportional to the mean value of the series, a logarithmic transformation tends to stabilise the variance.

To eliminate the effect of a linear trend in a time series one has to perform a 'first difference' i.e., P_t - P_{t-1}, difference between the current price and the price lagged one period. First differencing helps to eliminate linear and polynomial trend components.

If data log transformation and first differencing are performed together in respective sequence, then time series data is transformed from level to growth rate. These two transformations are like filter to remove trend and increasing variance trend.

2.7.8 Statistical Tools and Techniques

The study is based on extensive use of econometric tools. The spot prices and futures prices were obtained in .csv (Comma separated values) format and data were initially processed using Microsoft Excel. Subsequently, statistical computations were carried by using software EVIEWS 9. The graphical representation has been done using the graphical tools available in the software Microsoft Excel.

There are number of methods that have been employed for the investigation of analysis in the present study. For testing the efficiency of commodity market in India in price discovery and price risk management, the spot and futures prices of sample commodities were tested by applying appropriate models to answer each objective of the study.

Research method is formulated for each objective of the study.

- The causal relationship between spot and futures prices is measured by applying Johansen Test of Cointegration, Vector Error Correction Model (VECM) and Granger Causality Test.
- Volatility Persistence in prices and asymmetric effect of Indian Commodity market is evaluated through GARCH 1,1, EGARCH and TGARCH model.
- The effectiveness of commodity futures in hedging is estimated by calculating hedge ratio and hedging effectiveness by using Ordinary Least Square (OLS) method, VECM and VECM-GARCH model through construction of hedged and unhedged portfolio. In conclusion, the analysis shows how it result into the process of risk management.
- In addition, descriptive statistics i.e., Mean, Median, Standard Deviation, Skewness and Kurtosis is covered which describe the data. Augmented Dickey Fuller (ADF) Test is also used to test the stationarity of the time series data.

There are a number of econometric tools that have been employed for the analysis in the present study. They are classified into three sections keeping in view the objectives of the study.

2.7.8.1 Statistical Tools and Econometric Models used to Examine Causal Relationship between Spot Price and Futures Price of Commodity Markets

The literature review suggests the increasing use of cointegration test to study the efficiency of derivatives market. Wang and Ke (2005) elaborated the use of cointegration test to explore the efficiency of futures market, as it provides predictive signal on price convergence. Precondition to test the market efficiency is to find out the cointegration between the spot price and futures price. It confirms that there exists a long-run equilibrium relationship between the two series. The absence of cointegration implies that futures prices provide slight information about movement in spot price, signifying that a futures market is not very efficient. The same approach has been used in the present study. After finding the existence of cointegration between the spot and futures prices, it is necessary to test the causality to assess the direction of relationship. In the current study, Granger Causality Test has been applied to assess the direction of relationship between spot and futures prices. Before going for Cointegration Test and Causality analysis, a unit root test is performed to examine the stationarity of all the spot and futures price series. Unit root tests based on Augmented Dickey-Fuller (ADF) test is employed in this study.

2.7.8.1.1 Descriptive Statistics

To know the distribution pattern and also the performance of the sample commodities descriptive statistics of the spot prices and future prices is analysed.

2.7.8.1.2 Unit Root Test (Augmented Dickey-Fuller Test)

Time series data need to be tested for unit root to further apply econometric models. Non-stationarity problem exists in time series data which implies that the mean and variance are not constant over time. When an econometric model is applied to non-stationary data, the behaviour studied holds true only for that concern time period, thus, it cannot be generalized to other time periods. The popular test to check stationarity in data series is the unit root test. Unit root is tested by applying the Augmented Dickey-Fuller (ADF) test given by Said and Dickey (1984).

Augmented Dickey-Fuller (ADF) test has been applied to analyse the stationarity of price and returns series of spot and futures market of sample commodities. Dickey and Fuller (1979), have revealed that when Y_t is non-stationary, the estimated t-value of the coefficient of Y_{t-1} follows the tau (T) statistic instead of general student's t-test. Thus, the test was named as Dickey-Fuller test. The ADF test adjust to the serial correlation in the error terms of Dickey-Fuller test by adding the lagged difference terms of the dependent variable ΔY_t.

The unit root test is done on individual variables to know whether the time series data is stationary or non-stationary. In unit root test, we expect the probability value to be less than 5%. Unit root test can be executed by including constant term (i.e., intercept) or both constant and trend or none. The Augmented Dickey Fuller (ADF) Test is a widely used test for testing stationarity of time series data. Equation used for estimation under the ADF test is as follows:

$$\Delta \boldsymbol{Y_t} = \propto_{\mathbf{0}} + \Upsilon\, \boldsymbol{Y_{t-1}} + \sum_{j=1}^{P} \boldsymbol{\beta_j}\, \Delta \boldsymbol{Y_{t-j}} + \boldsymbol{\varepsilon_t}$$

Where ΔY_t is the dependent variable, $\propto_0$ is an intercept or constant or trend, $Y_{t-1}$is the first lagged value to Y_t, ΔY_{t-j} is the change in lagged value of Y_t and ε_t is a pure white noise error term. The unit root is carried out under the null hypothesis y=1 against the alternative hypothesis of y < 1. First step is to compute the value of test statistic, then it can be compared to the relevant critical value for the ADF test. If the test statistic is less than the critical value, then the null hypothesis of y=1 is rejected, which means there is no unit root is present and the series become stationary.

2.7.8.1.3 Johansen Co-integration Test (1991)

Co-integration is applied to determine the existence of long run equilibrium relationship between the time series variables. The concept of co-integration was first presented by Granger (1981) and further elaborated by Engle and Granger (1987) and finally by Johansen (1995). The existence of co-integration in spot and futures price series of sample commodities can be tested by applying Johansen's Co-integration approach. The Johansen Co-integration test can be applied when the time series variables are non- stationary and integrated of the same order. The two test statistics used in Johansen Co-integration test for testing for the presence of co-integration or error term are Trace statistic and Maximum Eigen value. Trace Statistic and Maximum Eigen value are the two test statistics used in Johansen Co-integration Test to find out the presence of co-integration or error term

The price relationship between commodity spot market and futures market is examined using cointegration (Johansen's, 1991) test, that has several advantages. First, cointegration analysis reveals the extent to which two markets have moved together towards long run equilibrium. Secondly, it allows for adjustment in divergence of respective markets from long-run disequilibrium in the short run. The co-integrating vector identifies the existence of long run equilibrium, while error correction dynamics describes the price discovery process that helps the markets to achieve equilibrium (Schreiber & Schwartz, 1986).

There are two test statistics under the Johansen Cointegration Approach, which are formulated as:

Trace Test:

$$\lambda \, trace(r) = -T \sum_{i=r+1}^{K} ln\,(1- \lambda i)$$

Maximum Eigen value test:

$$\lambda \, max(r, r+1) = -T \;\; ln\,(1- \lambda_{i+1})$$

Where, r represents the number of cointegrating vectors under the null hypothesis and λi is the estimated value for the ith ordered Eigen value from the II matrix. It is the ith largest Eigen value of matrix II. T is the number of observations or sample size. (λ_{i+1}) is the $(1+r)^{th}$ largest squared Eigen value. Each Eigen value will have associated with it a different cointegrating vector, which will be eigen vectors. A significant non-zero eigen value indicates a significant cointegrating vector. $\lambda \, trace$ is a joint test where the null is that the number of cointegrating vectors is equal to or less than r against general or an unspecified alternative that are more than r. $\lambda\ max$ conducts separate tests on each Eigen value, and has its null hypothesis that the number of cointegrating vectors is r against an alternative of r=1. If the test statistics is greater than the critical value from the Johansen's tables, reject the null hypothesis that there are r cointegrating vectors in favour of the alternative that there are $r + 1$ (for $\lambda\ trace$) or more than r (for $\lambda\ max$).

2.7.8.1.4 Granger Causality Test

After investigating the existence of co-integration between spot and futures prices, it is essential to test the causality to evaluate the direction of relationship. Granger Causality Test indicates that whether there is a causal relationship between the spot and futures prices. In the current study, Granger Causality Test has been used to estimate the direction of relationship among the spot prices and futures prices. The Granger Causality Test is based on the assumption that the information relevant to the prediction of the respective variables, spot and futures prices, is contained solely in the time series data. In other words, the current spot price is associated to past values of itself as well as that of futures price and the current futures price is related to the past values of itself as well as that of spot price.

Johansen (1991) and Engle and Granger (1987) suggested that if there exists co-integration between two variables in the long-run, then there must either be unidirectional or bi-directional causality between these variables. If futures and spot prices are co-integrated, then causality must exist at least in one direction (Granger, 1986). Co-integration shows that causality exists between the two series, but it fails to display the direction of the causality relationship. To find out the direction of the causality, the Granger Causality Test is conducted with the help of the following equations:

Causal Relationship from Future to Spot Market:

$$\boldsymbol{R_{St} = \alpha_0 + \sum_{k=1}^{p} \alpha_{1k} R_{F(t-k)} + \sum_{k=1}^{p} \beta_{1k} R_{S(t-k)} + \mu_t}$$

Causal Relationship from Spot to Futures Market:

$$\boldsymbol{R_{Ft}} = \boldsymbol{\alpha_0} + \sum_{k=1}^{p} \boldsymbol{\alpha_{1k}}\, \boldsymbol{R_{S(t-k)}} + \sum_{k=1}^{p} \boldsymbol{\beta_{1k}}\, \boldsymbol{R_{F(t-k)}} + \boldsymbol{\mu_t}$$

In the above equations, R_{st} and R_{Ft} are returns of spot price and futures price in period t and $R_{S(t-k)}$ and $R_{F(t-k)}$ are the spot price and futures price returns in *k* previous periods, that is, period (*t*-*k*). α_k and β_k are the coefficients and μ_t are the error terms. For the first equation, the null hypothesis β_k =0 infers that previous periods futures returns do not granger-cause present periods spot price returns. However, if the null hypothesis is rejected using a standard joint test like the F-test, then it would imply that the previous periods futures price returns help in predicting today's spot price returns. Similarly, for the second equation rejection of the null β_k =0 (which means previous period's spot prices do not cause today's futures prices) would indicate the power of the previous values of spot price returns in predicting today's futures price returns.

2.7.8.1.5 Vector Error Correction Model (VECM)

Vector Error Correction Model explains the direction of causality that futures and spot market can have in the long run and the short run. This error correction mechanism helps to keep the price of futures and the prices of spot at equilibrium for both the markets. Vector Error Correction Model is also called Restricted Vector Autoregressive Model, it is used for non-stationary time series which are co-integrated. The speed of adjustment is measured by the coefficient of the equilibrium error term which must always be significant and negative. There is an existence of long run equilibrium relationship among variables if the coefficient of the error term is significant and negative. But if the coefficient of the error correction term is not significant and positive, it means that there is no existence of long run equilibrium relationship between the variables.

VAR model is designed for use with non-stationary time series that are cointegrated. Which means it is a restricted VAR that has cointegration restrictions built into its specification. The VEC specification restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relationships while allowing a wide range of short-run dynamics. The cointegration term is known as the Error Correction Term (ECT) as the deviation from long-run equilibrium is adjusted gradually through a series of partial short-run adjustments. The error correction models are designed in both directions, one with the spot price as the dependent variables, and the other with the futures price as the dependent variable.

The short-run and the long-run causality among spot price and futures price is estimated by using the following equation under VECM

$$\Delta \boldsymbol{S_t} = \boldsymbol{\alpha_s} + \boldsymbol{\lambda_s}\, \mathbf{Z_{t-1}} + \boldsymbol{\Sigma_{i=2}^{k}}\, \boldsymbol{\beta_{Si}}\, \boldsymbol{\Delta S_{t-i}} + \boldsymbol{\Sigma_{j=2}^{I}}\, \boldsymbol{\gamma_{Fj}}\, \boldsymbol{\Delta F_{t-j}} + \boldsymbol{\varepsilon_{St}}$$

$$\Delta \boldsymbol{F_t} = \boldsymbol{\alpha_F} + \boldsymbol{\lambda_F}\, \mathbf{Z_{t-1}} + \boldsymbol{\Sigma_{i=21}^{k}}\, \boldsymbol{\beta_{Fi}}\, \boldsymbol{\Delta F_{t-i}} + \boldsymbol{\Sigma_{j=2}^{I}}\, \boldsymbol{\gamma_{sj}}\, \boldsymbol{\Delta S_{t-j}} + \boldsymbol{\varepsilon_{Ft}}$$

Where, *S* and *F* are the intercepts and ε_{St} and ε_{Ft} are the error terms. Z_{t-1} is the error correction term, which measures how the dependent variable adjusts to the previous period's deviation from the long-run equilibrium:

$$\mathbf{Z_{t-1}} = \boldsymbol{S_{t-1}} - \boldsymbol{\alpha} - \boldsymbol{\delta F_{t-1}}$$

Where, δ is the cointegrating vector and α is the intercept. The two-variable error correction model expressed in equation 1 and 2 is a bivariate VAR(*n*) model in first difference augmented by the error-correction terms, λ_S Z_{t-1} and λ_F Z_{t-1}**.** The coefficients λ_S and λ_F are interpreted as the speed of adjustment parameters. The larger the λ_S, the greater the response of S_t to the previous period's deviation from the long-run equilibrium. The error correction coefficients, λ_S and λ_F, serve two purposes. First, to identify the direction of causality between futures and spot prices. Second, to measure the speed of deviation from the long-run relationship which gets adjusted by the change in the futures and spot prices.

2.7.8.2 Statistical Tools and Econometric Models used to Study the Volatility Pattern of the Commodity Markets in India.

To capture the stylized features of volatility there are number of models available in the literature. AutoRegressive Conditional Heteroscedasticity (ARCH) models have been applied in the current research study (table 2.3). The basic framework of ARCH family models is based on the heteroscedasticity of the volatility of time series data.

Table 2.3: ARCH Family Models Used to Study Volatility Dynamics

Models Applied in the Study	**Stylized Facts of Volatility**
GARCH (1,1) EGARCH (1,1), T GARCH (1,1)	Persistence, Mean reversion Leverage Effect
Source: Author's Compilation	

ARCH family models work better than the conventional models with the time series data as it does not work on the assumption of homoscedasticity of the variance of the error terms. Time series data unlikely to have variance of error constant over time and hence it displays heteroscedasticity. Autoregressive means 'regressing on itself' and Heteroscedasticity means 'changing variance'. Family of ARCH models have been developed keeping in view the heteroscedasticity and volatility clustering feature of time series data. ARCH family models namely GARCH and EGARCH models are specifically designed to model and forecast conditional variances. The variance of the dependent variable is modeled as a function of past values of the dependent variable and independent, or exogenous variables. Econometrics tool such as Augmented Dickey Fuller (ADF) test is applied to analyse the unit root properties of the time series data. The ARCH effect was examined by using ARCH-LM test. The volatility of the commodity market was investigated on the return series of the indices and individual sample commodities by using various ARCH family models. For analyse volatility clustering effect, GARCH (1,1) model has been applied. EGARCH and GJR-GARCH are applied to check asymmetric behaviour of the commodities.

2.7.8.2.1 Descriptive Statistics: The basic properties of the time series data are investigated by studying descriptive statistics. The descriptive statistics displays the mean, standard deviation, skewness, kurtosis, and Jarque- Bera statistics of commodity indices and individual commodities.

2.7.8.2.2 Augmented Dickey Fuller (ADF) Test: ADF test have been used to analyse the stationarity properties of the commodity indices and sample commodities. The stationarity of the series confirms that mean, variance, and autocorrelation remains constant over time.

2.7.8.2.3 Tests of Heteroskedasticity: It is imperative to confirm the occurrence of volatility clustering of ARCH effect, before applying any GARCH model in the study. The existence of ARCH effect shows that periods of high volatility are followed by periods of high volatility, and periods of low volatility are followed by periods of low volatility.

Various GARCH family models are used to examine the pattern of volatility of commodity markets in India. The symmetric and asymmetric models of GARCH model are applied to model the conditional volatility of commodity markets.

2.7.8.2.4 Symmetric Volatility Model

Generalized Autoregressive Conditional Heteroskedasticity GARCH (1,1) Model

Black (1976) stated, the returns are negatively correlated with volatility. The symmetric GARCH models is based on the assumption that conditional variance depends only on the magnitude and not on the positivity and negativity of the underlying asset. Basically, it assumes that both bad news and good news have same effect on volatility. GARCH (1,1) model is applied in this study to model the symmetric effect of volatility in the commodity market.

One of the limitations of the ARCH specification was that it looked more like a moving average specification than an auto-regression. Tim Bollerslev (1986) developed Generalized Autoregressive Conditional Heteroskedasticity model, which is an extension of ARCH model. In the ARCH model the variance is modelled as a linear combination as squared part errors of specified lag. In GARCH model, the conditional variance is modelled as a linear combination of specified lag of squared previous errors and conditional variance of specified lag. GARCH model explains variance by two distributed lags, one on past squared residuals to capture high frequency effect or news effect on volatility from squared residual from the mean equation. Second, on lagged values of variance equation itself, to capture long term influences. In the GARCH (1,1) model, the conditional variance expected at any given information set is combination of long run variable and the variance expected for the last period adjusted to take into account the size of the last periods. If sum of the coefficients of the lagged squared error and lagged conditional variance of the GARCH estimates of the commodity return series is close to unity that follows the persistence of shocks or otherwise known as presence of long memory. As the sum of such GARCH estimates is less than unity the series is still following the property of mean reverting. In other words, although volatility persists over a longer stretch of time, it ultimately returns to the mean level of volatility.

ARCH models were introduced by Engle (1982) and generalized as GARCH by Bollerslev (1986). GARCH models, have become widespread tools for dealing with time-series heteroskedasticity and are more widely used to model the conditional volatility of financial series.

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

ε_{t-1}^2 & σ_{t-1}^2 represent the ARCH and GARCH terms, respectively. This shows the short run dynamics of volatility pattern of the series. If a $\alpha + \beta < 1$, it shows low volatility; $\alpha + \beta = 1$ shows high volatility; and $\alpha + \beta >$ shows extreme volatility.

2.7.8.2.4 Asymmetric Volatility Models

Asymmetric Behaviour is one of the major characteristics of the derivative market. ARCH and GARCH models do not capture leverage or asymmetric effect discovered by Black (1976). Asymmetric effect arises when unexpected drop in price (Bad News) increases predictable volatility more than an unexpected rise in price (Good News) of similar magnitude. One of the primary restrictions of the GARCH model is that they enforce a symmetric response of volatility to negative and positive. This arises since the conditional variance is a function of the magnitude of lagged residuals and not their signs. In other words, the sign is lost by squaring the lagged error.

It is often found that bad news creates more volatility than good news. In such a situation, symmetric models are unable to recognize it as they assume both good and bad news have the same effect on volatility. This implies that conditional answers asymmetrically positive and negative residuals. Hence, a number of asymmetric models have been developed such as EGARCH (1,1) model by Nelson (1991) and TARCH (1,1) model by Zakoian (1994).

2.7.8.2.4.1 EGARCH (1,1) Model: One method proposed to capture leverage or asymmetric effects is Nelson's exponential GARCH or EGARCH model (1991). A comparison between the GARCH (1,1) model and the EGARCH (1,1) suggests a metric to examine the effect of news on conditional heteroskedasticity. EGARCH model allows both good news and bad news to have distinct impact on volatility. The logarithmic construction ensures that the estimated conditional variance is strictly positive, thus the non-negativity constraints used in the estimation of the ARCH and GARCH models are not necessary. This model represents the log of conditional variance. The existence of leverage effect can be analysed through this model which will help to capture the asymmetric effects in Indian Commodity markets.

$$\ln(\sigma_t^2) = \alpha_0 + \alpha_1 \frac{|\varepsilon_{t-1}| + \gamma_1 \varepsilon_{t-1}}{\sigma_{t-1}} + \beta_1 \ln(\sigma_{t-1}^2)$$

The left-hand side represents the log of conditional variance.

2.7.8.2.4.2 GJR-GARCH (TGARCH) 1,1 Model: The GJR model is also extension of GARCH model with additional term added to account for possible asymmetries. The TARCH model or threshold ARCH model is developed by Zakoian (1994).

$$\sigma_t = \alpha_1 \sigma_{t-1}(|\varepsilon_{t-1}| - \eta_1 \varepsilon_{t-1}) + \beta_1 \sigma_{t-1}$$

2.7.8.3 Econometric Models used to Test the Hedging Effectiveness of Commodity Futures Market in India

Hedging decisions based on futures contracts have to deal with finding optimal hedge ratio and hedging effectiveness. There are several models developed to estimate the optimal hedge ratio and hedging effectiveness i.e., conventional Ordinary Least Square (OLS) method, Vector Autoregressive regression (VAR) model, Vector Error Correction model (VECM) to estimate constant hedge ratio. Vector Error Correction Model with Bivariate Generalized Autoregressive Conditional Heteroscedasticity model (VECM-GARCH) estimates time varying hedge ratio and time varying conditional covariance structure of futures and spot prices. The current study applies OLS, VECM and VECM-GARCH models to estimate constant hedge ratios and time varying hedge ratio and hedge effectiveness of the sample commodities.

The hedge ratio which corresponds to the highest hedging effectiveness of all the models shall be used for the purpose of the futures contract. Futures contracts are used to hedge against the volatility of spot prices to maximize utility function or to decrease overall risk.

2.7.8.3.1 Basis Risk and Price Risk Analysis

A significant decrease in the variance of the hedged portfolio compared to the unhedged commodity position indicates that the futures are an effective instrument to hedge price risk in the underlying commodity. Hedging effectiveness is closely associated to the basis risk of the futures contract. (Carter, 1984) stated that the hedging activity can be considered as exchanging price risk for basis risk The difference between the spot price and its futures price is called basis. When the future contract nears expiry, it should be close to zero. The basis is significant measure of the cost of using the futures contract to hedge. Basis risk is calculated as the variance of the basis. The portfolio approach recognizes the presence of basis risk and ascertain the optimal futures position to reduce the variance of spot futures portfolio. Basis risk is attributed to quality, location and timing discrepancies among commodities traded in the spot market and that are deliverable as futures contracts. Generally, the basis does have some variability, however, hedging cannot fully eliminate price risk. It will reduce price risk, but only as long as the basis variability is less than the spot price variability (Carter, 1984). Hence, the lower the basis risk, the more effective is the futures market in terms of its function of price risk management. Generally, unhedged trader or producer faces the spot price risk whereas hedged investor deals with the basis risk. Spot price risk is risk occurred due to variability in the spot price of the commodity. By taking equal but opposite position in futures and spot market, traders or farmers square off their positions in the markets as against one another wherein, effect of price changes on their income level is thereby neutralised. If the spot price is less than the futures price of the underlying asset, the market is said to be in '*Contango'*. On the other hand, if the spot price is more than the futures price, the market is said to be in '*Backwardation'*.

The futures and spot price converge with each other when the futures contracts approach the expiry date. In the efficient markets, futures price converges to the spot price and hence, the basis risk becomes zero in the maturity month. Under such markets, producer or the trader who hedges the price risk can control his business risk by holding the futures contract until the maturity date. Naik and Jain (2002) stated that if basis risk is less than spot price risk then such contract is suitable for hedging. A ratio of variance of basis to the spot price of any contract which is less than 0.5 (a benchmark) could be considered to be effective in price risk management and thus, would attract more participants to the derivatives market.

The hedge ratio is defined as the ratio of the size of position taken in the futures market to the size of the position taken in the spot market. There has been debate about the optimal hedge ratio. Traditionally, the hedge ratio was considered to be '-1', that is, taking a position in futures market which is equal in magnitude and opposite in sign to the spot market. This strategy will eliminate the price risk, If the movement of volatility in spot prices and futures prices is same. Such a perfect correlation among futures and spot prices is rarely observed in the markets and thus, there was a need felt for a better approach. Johnson (1960) came up with an approach called 'Minimum Variance Hedge Ratio (MVHR)'. The concept of utility maximization (mean) was introduced keeping intact the main objective of risk minimization. Risk was defined as the variance of return on a two-asset hedged position.

(Benninga, et al., 1983) the authors stated that the Minimum-Variance Hedge Ratio has been suggested as slope coefficient of the Ordinary Least Square (OLS) regression, for changes in the spot prices on changes in the futures prices. The optimal hedge ratio for an unbiased futures market can be given by ratio of covariance of (spot price, futures price) and variance of (futures price). In other words, MVHR is the regression coefficient of the regression model (changes in spot prices over changes in futures prices). The R-square of OLS model indicates the hedging effectiveness.

(Johnson, 1960, Ederington, 1979) many authors defined hedging effectiveness as the minimisation of variance and considered utility function as risk minimization problem However, Rolfo (1980) and Anderson and Danthine (1981) estimated optimal hedge ratio by maximizing traders' expected utility, which is determined by variance of portfolio and expected return. Due to the nature of relationship (trade -off) between return and risk, many authors advocate that optimal hedge ratio must be calculated in mean-variance frame work. (Benninga, et al., 1984) stated that hedge ratio that reduces risk is optimal when the futures market is unbiased i.e., the expected return from the futures contracts is zero. In the case of biased futures market, minimum-variance hedge ratio has to be adjusted according to spot and expected futures prices, and the resultant basis.

The application of regression for calculating the hedge ratio and hedging effectiveness has been criticized on mainly two grounds. First, OLS model is based on unconditional second moments, but the variance and covariance should be conditional because hedging decision made by any trader is based on all the information available at that time. Second, the estimates based on OLS regression is time invariant however, the joint distribution of futures and spot prices may be time variant. Use of Vector Autoregressive Model (VAR) is not appropriate because in most of the markets, futures and spot prices are cointegrated in the long-run (which is a prerequisite condition of market efficiency). Vector Error Correction Model (VECM) model is widely used because it considers the long run cointegration between spot and futures prices.

There are a large number of models that can be applied to measure the hedging effectiveness. All these models can be classified into the following categories: a) Static hedging models, b) Dynamic hedging models. Dynamic hedging models are widely used as it incorporates the conditional information of time series data. Further, the research work in Indian context documented by Kumar and Pandey (2011) shows the significant explanatory power of Vector Autoregressive Model (VAR). Thus, on the basis of literature review, the following models have been selected for inclusion in the present research study.

- Ordinary Least Square Regression (OLS)
- Vector Error Correction Model (VECM)
- Vector Error Correction Model- GARCH (1,1) Model (VECM- GARCH)

2.7.8.3.2 Ordinary Least Square (OLS) Method

A conventional method of finding an optimal hedge ratio is using simple Ordinary Least Square (OLS) estimation of linear regression model. In this method changes in spot prices, that is, spot returns are regressed on the changes in the futures prices, i.e., futures return. To reduce the variance of the hedged portfolio's returns, the appropriate hedge ratio, i.e. The Minimum- Variance Hedge Ratio (The number of units of the futures asset to sell per unit of the spot asset held) is the slope estimate (i.e., β) in a regression. The dependent variable is a time series of spot returns and the independent variable is a time series of futures returns. The R square, (R2), of this regression equation indicates the hedging effectiveness.

Regression Equation:

$$R_{st} = \alpha + \beta R_{ft} + \varepsilon t$$

Where, *Rst* and *Rft* are the spot and futures return for period *t*. *εt* is the residual term and *α* is the intercept coefficient (constant). *β* is the slope coefficient which provides an estimate of the optimal hedge ratio (the minimum hedge ratio). The R^2 of this model indicates the hedging effectiveness.

Using OLS regression for estimating the hedge ratio and assessing hedging effectiveness based on its R-square, has been criticized mainly on two grounds. First, they criticized the hedge ratio obtained from OLS regression method, saying that it becomes biased if there is a cointegration relationship between the spot and futures prices. The hedge ratio estimated using OLS regression is based on assumption of unconditional distribution of spot and futures prices; whereas, the use of conditional distributions is more appropriate because hedging decision made by any hedger is based on all the information available at that time. Second, the estimates based on OLS regression is time invariant but the joint distribution of spot and futures prices may be time variant (Mandelbrot, 1963; Fama, 1965). In most of the markets, spot and futures prices are cointegrated in long-run (which is a necessary condition of market efficiency). Estimation of constant hedge ratio through Vector Error Correction Model (VECM) model, which considers the long run cointegration between spot and futures, is therefore widely used.

2.7.8.3.3 Vector Error Correction Model (VECM)

The OLS model did not take into consideration the effect that the two-time series are cointegrated, which was further addressed by Ghosh (1993), Lien and Luo (1994), Lien (1996) and Johnson 1999). When spot and futures prices are cointegrated, return dynamics of the both the series can be modelled through Vector Error Correction Model (VECM). (Engle and Granger, 1987) stated that VECM specifications allow for a long-run equilibrium error correction in prices in the conditional mean equations.

If the spot and futures series are co-integrated of the order one, then the Vector Error Correction Model of the series is given as follows:

$$\Delta S_t = \alpha_s + \lambda_s Z_{t-1} + \Sigma_{i=2}^{k} \beta_{Si} \Delta S_{t-i} + \Sigma_{j=2}^{I} \gamma_{Fj} \Delta F_{t-j} + \varepsilon_{St}$$

$$\Delta F_t = \alpha_F + \lambda_F Z_{t-1} + \Sigma_{i=21}^{k} \beta_{Fi} \Delta F_{t-i} + \Sigma_{j=2}^{I} \gamma_{sj} \Delta S_{t-j} + \varepsilon_{Ft}$$

Where, α_s and α_F are the intercepts and ε_{St} and ε_{Ft} are the error term, which measures how the dependent variable adjusts to the previous period's deviation from the long-run equilibrium:

$$Z_{t-1} = S_{t-1} - \alpha - \delta F_{t-1}$$

Where, $Zt-1$ = St-1 - δ $Ft-1$ is the error correction term. δ is cointegrating vector and α is the intercept. The two variable Error Correction Model expressed is a bivariate VAR(n) model in first difference augmented by the error- correction terms. The Coefficients λs, λf are interpreted as speed adjustment parameters.

After estimating the system of equation, the residual series are generated to estimate the variance and covariance of the series to calculate the minimum variance hedge ratio. The error terms in the equations, εSt, and εFt are independently identically distributed (IID) random vector. The minimum variance hedge ratio is calculated as

$$H = \frac{\sigma_{sf}}{\sigma_f}$$

Where, H= hedge ratio, Var (ε_{st})= σ_s , Var (ε_{Ft})= σ_f , Cov ($\varepsilon_{st}, \varepsilon_{Ft}$) = σ_{sf}

The performance of the hedging strategies can be examined by finding the hedging effectiveness of each strategy. In order to compare the performances of each type of hedging strategy, unhedged position is constructed on the spot market, and a hedged position in a particular commodity is constructed with the combination of both the spot and the futures contracts. The hedge ratios estimated from each strategy determine the number of futures contracts to be held for minimization of risk. The hedging effectiveness is calculated by the variance reduction in the hedged position compared to the unhedged position for each time horizon. According to Baillie and Myers (1991), the returns on unhedged and hedged positions are calculated as follows:

$$\boldsymbol{R}(\boldsymbol{u}) = \boldsymbol{S}_{\boldsymbol{t}+\mathbf{1}} - \boldsymbol{S}_{\boldsymbol{t}}$$

$$\boldsymbol{R}(\boldsymbol{h}) = (\boldsymbol{S}_{\boldsymbol{t}+\mathbf{1}} - \boldsymbol{S}_{\boldsymbol{t}}) - \boldsymbol{h}^{*}(\boldsymbol{F}_{\boldsymbol{t}+\mathbf{1}} - \boldsymbol{F}_{\boldsymbol{t}})$$

Variances of an unhedged and a hedged portfolio are**:**

$$\boldsymbol{Var}(\boldsymbol{u}) = \boldsymbol{\delta}_{\boldsymbol{s}}^{\mathbf{2}}$$

$$\boldsymbol{Var}(\boldsymbol{u}) = \boldsymbol{\delta}_{\boldsymbol{s}}^{\mathbf{2}} + \boldsymbol{h}^{\mathbf{2}}\boldsymbol{\delta}_{\boldsymbol{f}}^{\mathbf{2}} - \mathbf{2}\boldsymbol{h}^{*}\boldsymbol{\delta}_{\boldsymbol{sf}}$$

where, *St* and *Ft* are natural logarithm of spot and futures prices; *h** is the hedge ratio; *RH* and *RU* are return from hedged and unhedged portfolio; *σS* and *σF* are standard deviation of the spot and futures return; *σs,f* is the covariance between spot and futures returns; *Var(u)* and *Var(h)* are variances of unhedged and hedged positions respectively.

Edernigton (1979) proposed a measure of hedging effectiveness as the percentage reduction in variance of the hedged and the un-hedged positions. Hedging effectiveness is defined as the ratio of the variance of the unhedged position minus variance of hedge position over the variance of unhedged position.

The Hedging Effectiveness *(HE)* is calculated as:

$$\boldsymbol{HE} = \frac{\boldsymbol{Var(u) - Var(h)}}{\boldsymbol{Var(u)}}$$

2.7.8.3.4 VECM-GARCH (1,1) MODEL

Bollerslev, et. al., (1992) stated that a time series data when taken on return usually possesses an ARCH-effect or generally known as time varying heteroscedastic volatility. The calculation of hedge ratio and hedging effectiveness may turn out to be unsuitable due to the ARCH - effect in the return series of spot and futures prices and their time varying joint distribution. GRACH model is used to capture the time varying volatility to the hedge ratio and also to integrate the non-linearity in the mean equation.

The existence of ARCH effect in the residual series derived from VECM model confirms the necessity to estimate conditional variance, covariance, and time series hedge ratio by applying multivariate GARCH model. The average hedge ratios and hedging effectiveness estimated from VECM-GARCH model are slightly more effective than the constant hedge ratios calculated from VECM model because VECM-GARCH model incorporates the autoregressive nature of time series.

A model is developed from VECM model for the variables which show a long run relationship among spot and futures prices.

$$\Delta \boldsymbol{S_t} = \boldsymbol{\alpha_s} + \boldsymbol{\lambda_s}\ \mathbf{Z}_{t-1} + \boldsymbol{\Sigma_{i=2}^{k}}\ \boldsymbol{\beta_{Si}}\ \boldsymbol{\Delta S_{t-i}} + \boldsymbol{\Sigma_{j=2}^{I}}\ \boldsymbol{\gamma_{Fj}}\ \boldsymbol{\Delta F_{t-j}} + \boldsymbol{\varepsilon_{St}}$$

$$\Delta \boldsymbol{F_t} = \boldsymbol{\alpha_F} + \boldsymbol{\lambda_F}\ \mathbf{Z}_{t-1} + \boldsymbol{\Sigma_{i=21}^{k}}\ \boldsymbol{\beta_{Fi}}\ \boldsymbol{\Delta F_{t-i}} + \boldsymbol{\Sigma_{j=2}^{I}}\ \boldsymbol{\gamma_{sj}}\ \boldsymbol{\Delta S_{t-j}} + \boldsymbol{\varepsilon_{Ft}}$$

Bollerslev, et. Al. (1988) A restricted version of the above model with only diagonal elements of matrix α and β are considered. The correlations between conditional variances are considered to be constant. Bollerslev, et. Al., (1988) represented the diagonal of the covariance element $h_{sf,\ t}$ and the conditional variances elements $h_{ff,\ t}$ and $h_{ss,\ t}$ as follows:

Bollerslev, et.al., (1988) Equations:

$$\boldsymbol{h_{ss,t} = C_{ss} + \alpha_{ss}\varepsilon^2_{s,}t - 1 + \beta_{ss}h_{ss,}}\textbf{t-1}$$

$$\boldsymbol{h_{sf,t} = C_{ss} + \alpha_{sf}\varepsilon^s t - 1\varepsilon_f, t - 1 + \beta_{sf}h_{sf,}}\textbf{t-1}$$

$$\boldsymbol{h_{ff,t} = C_{ff} + \alpha_{ff}\varepsilon^2_{f,}t - 1 + \beta_{ff}h_{ff,}}\textbf{t-1}$$

Time varying hedge ratio:

$$\boldsymbol{h_t} = \frac{\boldsymbol{h_{sft}}}{\boldsymbol{h_{fft}}}$$

2.8 Limitations of the Study

The limitations of the research are listed below:

1. The current study is based upon the secondary data derived from website of the exchange. Primary data has not been considered i.e., communication with the market players would portray the real picture of the market.
2. The sample size of twelve commodities representing different sectors like bullion, metal, energy and agriculture traded at Multi Commodity Exchange (MCX) to some extent limits the generalisation of the results of the study. Hence, it may not be appropriate representative of the entire commodity markets selected for the purpose of the study.
3. The study considers the daily closing spot and near month futures prices of commodities. Intra-Day variations in data have not been considered, which could have impact on the results of the study. The results pertain to the study period of twelve years

i.e., from 1st December 2009 to 31st December 2020 which may differ from other time periods. The behaviour in the market movement may differ during different time period.

4. Options were not allowed for trading in any recognised commodity exchange in India. Options trading started in the year 2017. Thus, in present study, only futures contracts are considered for study.
5. The commodity derivatives market study is confined to the dominant national level commodity exchange namely Multi Commodity Exchange (MCX). The other national level commodity exchanges are not considered for the study.

2.9 Chapterization Scheme

The present thesis is organised into seven chapters.

Chapter I: Introduction

The first chapter is the introductory chapter of the thesis which provides a detailed discussion on commodity derivatives market, starting from the evolution stage to the present state of the commodity markets in India, commodity market participants, trading mechanism of commodity derivatives market in India. The chapter also reviews the scholarly work done by various researchers in the area of derivatives markets. The research work done by various researchers on the price discovery, market efficiency, volatility and asymmetric effect and efficiency of commodity derivative market in terms of hedge ratio and hedging effectiveness at Indian and international level are covered.

Chapter II: Research Methodology

The chapter covers statement of research problem, significance of the study, research gap, research questions, objectives of the study, research hypothesis, methodology of the study (sample selection, data collection, processing and data transformation, statistical tools and econometric models), limitations of the study and chapterization scheme.

Chapter III: Market Structure and Growth of Commodity Markets in India

The chapter begins with the structure and regulatory framework of commodity market in India. Further brief profile of sample commodities is presented along with spot market transactions. This chapter also states the commodity exchanges in India and presents the turnover of commodity derivatives market in India, market share and turnover of commodity exchanges, major group of commodities traded in derivatives market, top ten agricultural and non-agricultural commodities futures contracts traded.

Chapter IV: Effectiveness of Commodity Derivatives Market in Price Discovery

This chapter examines the causal relationship between commodity spot and futures markets in India. The empirical analysis is conducted by employing descriptive statistics, Augmented Dickey-Fuller (ADF) Test, Johansen Co-integration Test, Granger Causality Test and Vector Error Correction Model. The empirical results have been discussed in detail.

Chapter V: Analysis of Volatility Persistence of Indian Commodity Markets

The chapter investigates the stylized facts of volatility of commodity markets namely volatility persistence, mean reversion and asymmetric effect of commodity markets in India. Research hypothesis were tested using GARCH (1,1), EGARCH and TARCH model. The empirical results have been discussed in detail.

Chapter VI: Hedge Effectiveness of Futures Contracts in Indian Commodity Derivatives Markets

This chapter estimates the hedge ratio and hedging effectiveness of futures contracts in commodity derivatives market. The empirical analysis and discussion is conducted by employing OLS, VECM and VECM-GARCH model. The empirical results have been discussed in detail.

Chapter VII: Summary of Findings and Conclusion

This chapter deals with summary findings drawn from the empirical study and discussion, conclusion based on the findings of the current study and recommendations in the form of policy alternatives to draw the attention of the authorities for the further development of the commodity market. The chapter ends with the possible avenues for further research in this area.

CHAPTER III

MARKET STRUCTURE AND GROWTH OF COMMODITY MARKETS IN INDIA

One of the interesting developments in the last decade has been the growing popularity of commodity derivatives. The market has made enormous transformation in terms of transparency, technology and trading activity. This has come to light only after the government ban was withdrawn and market forces were allowed to play their role. The commodity derivatives segment remained immature due to government intervention in many commodities to control prices. Keeping in view the importance of commodity markets, the present study analysed the performance of commodities over the past years in the commodity markets. The chapter is divided into three sections:

Section I: Market Structure and Regulatory Framework of Commodity Market in India

Section II: Brief Profile of Select Sample Commodities

Section III: Growth of Commodity Derivatives Market in India

SECTION I

3.1 Market Structure and Regulatory Framework of Commodity Market in India

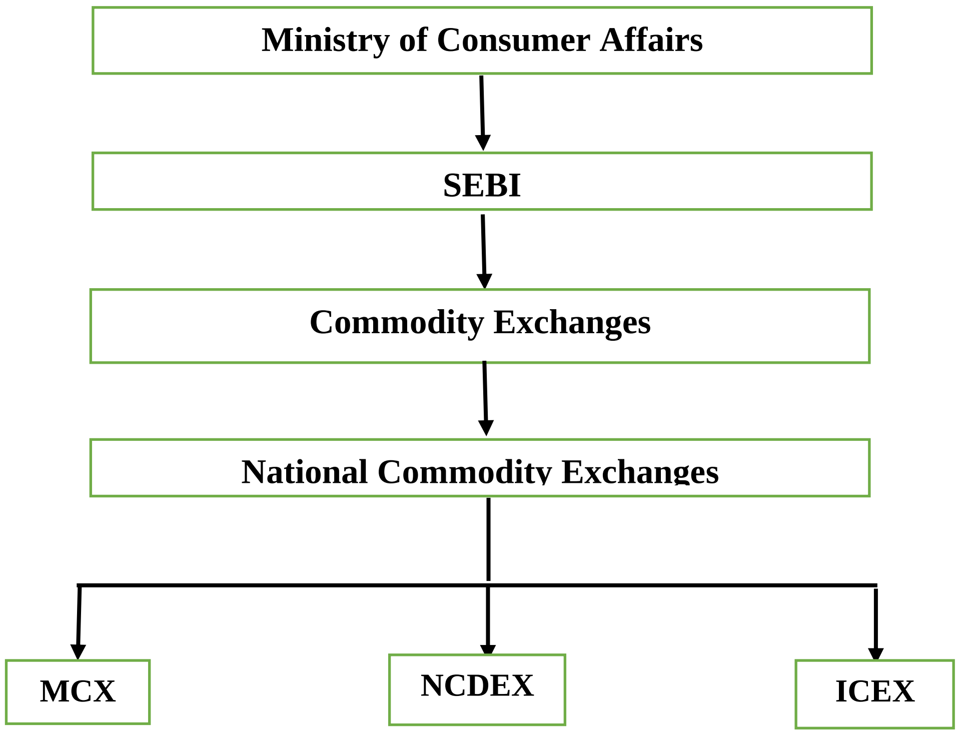
In this section, an attempt is made to briefly narrate the structure of the commodity market in India. Present scheme of regulation, time-line of commodity derivatives market (Pre- and Post- merger of FMC and SEBI). The section also states transformation of Indian commodity derivatives market and brief description of commodity exchanges operating in India.

3.1.1 Structure of Commodity Derivatives Market in India

Commodity market is a market which comprises of buying and selling of soft and hard commodities. India has experienced remarkable progress in the commodity derivatives futures markets since inception from the year 2003. The commodities market exists in two distinct forms, the exchange-based market and the over-the-counter (OTC) market. Additional, as in equity market, there exists the spot and the derivatives segments. Spot markets are basically OTC markets and participation is restricted to people who are involved with that commodity, such as the farmer, wholesaler, processor, etc. A majority of the futures derivatives trading takes place through the exchange-based markets with standardized contracts, settlements. Commodity derivatives exchange-based markets are fundamentally similar to equity derivatives market in their working, i.e., standardized contracts and a person can purchase a contract by paying only a small percentage of the contract value. Besides, even though there is a provision for delivery of commodities, most commodity derivatives contracts are squared-off before expiry and are settled in cash. Thus, one can see an active participation by people who are not related with the commodity.

The three -tier structure of commodity derivatives markets in India is as follows:

Fig 3.1 Structure of Commodity Derivatives Market in India



Source: Author's Compilation

Indian commodity market comprises of certain structure which is based on some hierarchical system. It encompasses three tier structure of trading functions. These are Central Government, SEBI and Recognized Exchanges.

3.1.2 Present Scheme of Regulation

The commodity derivatives futures traded in commodity exchanges was regulated by the Government as per the rules framed under the Forward Contracts Regulations Act, 1952. Forward Market Commission was the regulator for the commodities trading in India up to 28th September, 2015 which was merged with the capital market regulator Security Exchange Board of India (SEBI). At present, SEBI is managing and controlling derivatives market trading activities along with the investor's protection measures. In order to effect the merger with FMC, SEBI has amended Securities Contract (Stock Exchanges and Clearing Corporation) Regulations, 2012 (SECC) and SEBI (Stock Broker and Sub Broker Regulations) 1992 on September, 2015. SEBI has also formed a separate commodity derivatives market regulation department for the overall regulation of commodity derivatives market which includes exchange administration, risk management, market policies and handling of inspections and complaints.

The Indian Commodity Market can be divided into three layers to supervise the functioning of Commodity Markets in India. First and the top most layer comprises of the Government of India (Ministry of Consumer Affairs), second layer or the middle layer comprises of Forward Market Commission which is now merged with SEBI (Securities and Exchange Board of India) and third layer involves Commodity Exchanges.

Three Tier Structure of Commodity Market in India

1. Central Government (Ministry of Consumer Affairs)
2. Securities and Exchange Board of India
3. Commodity Exchanges

The First Tier: Central Government (Ministry of Consumer Affairs)

- Power to grant or withdraw recognition to commodity exchanges.
- Notify commodities under section 15, 17 and 18(3)
- Grants trading permissions subject to appropriate regulatory measures.
- Surveillance and monitoring of the commodity markets.
- Conducts inspection of exchanges and their members

The Second Tier: SEBI (Securities and Exchange Board of India)

- Choose independent directors on the boards of exchanges
- Suspension of member of the exchange
- Assists police authorities to investigate and prosecution for irregular or illegal trading.

The Third Tier: Commodity Exchanges

- Conduct trading on the basis of the bye laws, articles approved by the Commission.
- May take action against any intermediary.

India has three national level commodity exchanges namely, Multi Commodity Exchange Ltd. (MCX), National Commodity and Derivatives Exchange Ltd. (NCDEX) and Indian Commodity Exchange Limited (ICEX). In 2018 both National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) launched trading in commodities. In 2007, regional commodity exchanges dominated futures trading due to their domain expertise and through the “open outcry” system of bidding. However, larger commodity exchanges such as National Multi Commodity Exchange (NMCE), Multi Commodity Exchange (MCX) and National Commodity & Derivatives Exchange (NCDEX), offered computer-based trading, gradually strengthened their reach in major growing areas and also acquired domain expertise. Thereafter, two exchanges, Universal Commodity Exchange and Ace Derivatives & Commodity Exchanges, started nationwide online futures, However, they soon shut down.

Following the merger of the two regulators, SEBI had, in December 2015, introduced “exit route” for commodity exchanges, which were deemed to be securities exchange after September 2015. Out of the five regional commodity exchanges which were operational in December 2015, four regional commodity exchanges exited the market due to their inability to achieve the minimum net worth norm after the merger of the erstwhile regulator the Forward Markets Commission (FMC) with SEBI in September 2015. These exchanges include India Pepper and Spice Trade Association (IPSTA), Rajkot Commodity Exchange (RCX) and Bombay Commodity Exchange and Cotton Association of India. Sebi also allowed Cotton Association of India to exit from futures in December 2016 due to thin volumes. Thereafter, Hapur Commodity Exchange Ltd (HCX) fifth and last exited the market in the year 2018.

3.1.3 Merger of the Forward Market Commission (FMC) with Securities and Exchange Board of India (SEBI)

The Central Government of India proposed merger of Forward Markets Commission (FMC) with the Securities and Exchange Board of India (SEBI) in the Union Budget for financial year 2015-16, effective from September 28, 2015. The reason for merger was to facilitate convergence of rules and to take advantage of economies of scale by the exchanges and other stakeholders. SEBI has extensive powers to regulate the markets because it has efficiently regulated the securities market for over 25 years. After the commodity derivatives market being brought under SEBI, it is expected that the commodity derivatives market will be on par with the securities market in terms of risk management, regulations, new products and participants, technology, surveillance, enforcement framework, investor protection and supervision, code of conduct for intermediaries.

3.1.4 Commodity Derivatives Market in India: A Time Line

1875: Organized derivatives futures market emerged in India by the setting up of Bombay Cotton Trade Association Ltd.

1893: Bombay Cotton Trade Association was established as "Bombay Cotton Exchange Ltd" due to widespread discontent between leading cotton mill owners and merchants.

1900: Gujarati Vyapari Mandali was established for derivatives futures trading in groundnut, castor seed.

1913: Chamber of Commerce Hapur was set up for derivatives futures trading in wheat.

1919: Derivatives futures trading in raw jute and jute commenced in Calcutta with the formation of the Calcutta Hessian Exchange Ltd.

1920: Derivatives Futures market in bullion started in Mumbai and later similar markets came up in other states.

1952: Passing of the Forward Contracts (Regulation) Act (FCRA).

1953: Establishment of the Forward Markets Commission.

1955: Restriction of free trade in many commodities.

1980: Recommendation of Khusro Committee for re-introduction of derivatives futures in most commodities.

1983: Government. amends by laws of exchanges of Bombay, Calcutta and Ahmedabad and introduced carry forward trading in specified shares.

1994: Kabra Committee recommends the reintroduction of *futures* trading in seventeen commodities.

1998- Varma Committee recommends risk containment measures for derivatives trading.

2000- Implementation of National Agricultural Policy led to dismantling of all controls and regulations in agricultural commodity markets.

2003: Removal of the ban on *futures* trading. *Futures* trading is permitted on almost all commodities but options on commodities still prohibited. Three national level multi commodity exchanges NMCE, MCX, and NCDEX were set up in 2004.

2007: Govt. of India decided to suspend the *futures* trading in rued, tar and wheat.

2008: Govt. of India banned *futures* trading on another four commodities namely rubber, chana, soy oil, and potato for nine months.

2008: FMC issued guidelines on setting up of new national multi commodity exchanges.

2009: Recognition to ICEX as 4th national exchange.

2010: Recognition to ACE as 5th national exchange.

2010: Notified “Iron ore” under section 15 of the FCRA 1952.

2012: Recognition to UCX as 6th national exchange.

2013: FMC functions under the administrative control of the Department of Economic Affairs, Ministry of Finance from September 2013.

2015: FMC merged with SEBI.

3.1.5 Timeline of Commodity Derivatives Market Post Merger of SEBI-FMC

The commodity market regulator FMC was merged with Securities and Exchange Board of India (SEBI) in September 2015 to create a single regulator for commodity and equity markets. Since the merger, SEBI has announced major reforms for the commodity markets. Subsequent to the merger of Forwards Market Commission with SEBI, SEBI has taken various steps to streamline and strengthen the rules applicable to the commodity derivatives market as at the same time guide the different stakeholders of the commodity derivatives market in India to the regulatory requirements of the Securities Contracts (Regulation), Act, 1956.

29 September 2015: SEBI introduced new eligibility and net worth requirements to register the commodity derivatives exchanges. The requirements are same as required for the trading in equity and all the registered members were required to be compliant with the eligibility norms.

01 October 2015: SEBI has introduced stricter risk management structure for national commodity derivatives exchanges with regard to assets in setting up an exchange, net worth criteria, margin requirements, settlement guarantee fund, base minimum capital etc. The norms are similar as those needed by the equity exchanges and implementation was supposed to be by 1st January 2016.

21 October 2015: SEBI introduced a separate risk management requirement for the regional commodity derivatives exchanges.

26 November 2015: SEBI issued dates to all commodity exchanges to adhere to the formalities of Securities Contract (Regulations) Act, including norms on regulatory fee, corporatization and demutualization, ownership, cleaning and settlement, governance, net worth, delisting, dematerialization of securities, formation of various exchange-level committees etc.

9 December 2015: SEBI directed commodity exchanges to submit monthly development reports, commencing from April 2015.

11 January 2016: SEBI introduced the exit requirements for commodity exchanges.

29 January 2016: SEBI reduced position limit and month open position limits at both member and client level for all agricultural commodities.

17 March 2016: SEBI allowed commodity derivatives trading at the International Financial Services Centre (IFSC). Stock exchanges which were functioning in IFSC are permitted to trade in commodity derivatives. The SCRA was amended to include commodity derivatives as “eligible securities”, which implies that institutions such as mutual funds and foreign portfolio investors could invest in the commodity derivatives market. However, the mutual funds are yet to be amended their rules to facilitate participation of institutional investors in the commodity derivatives market.

29 March 2016: SEBI introduced stricter cyber resilience framework and cyber security for the commodity exchanges to improve monitoring standards, protection and governance. The new norms were to be effective from 01 January 2017. SEBI also made the modification of client codes after execution of trades in any commodity exchange.

25 April 2016: SEBI ordered compulsory disclosure of the property trading by commodity brokers to their clients to improve transparency in the dealings between clients and stock brokers in commodity derivatives market.

11 August 2016: SEBI made mandatory system of audit of stock brokers and trading members annually of national commodity derivatives exchanges, which is same as the equity space.

19 August 2016: To facilitate more active participation in the commodity derivatives market, SEBI allowed exchanges to grant hedge limits and offer incentives to hedgers to their clients and members which is in addition to the usual position limit sanctioned to them.

30 August 2016: SEBI directed commodity exchanges to communicate derivatives prices through SMS and any other electronic channel like email, instant messengers etc for the commodities which are subscribed on a daily basis free of charge.

02 September 2016: SEBI ordered exchanges to adopt stricter spot price polling system for commodities and improve disclosures relating to such system.

7 September 2016: SEBI stipulated the first trading day limit and daily price limits for non-agricultural commodity derivatives trading.

20 September 2016: SEBI suggested stricter requirements for commodity futures to qualify to be traded on the commodity exchanges on a continuous basis. Tougher requirement with regards to change of contracts is incorporated to avoid sudden change in contract terms of abrupt stoppage of futures contracts. SEBI prescribed exchanges not to change anything in ongoing trading contract without prior intimation and approval from SEBI.

26 September 2016: SEBI strengthened the investor protection fund requirements for the commodity exchanges.

20 January 2017: SEBI floated a discussion paper asking suggestions on ways to price and settle commodity options contracts.

May 29, 2017: MCX became the first Indian exchange to launch options on commodity futures by commencing trading in options on gold futures on October 17, 2017. Subsequently NCDEX launched options on Guar Seed Futures on January14, 2018.

June 2017 SEBI: Allowed participation of Category III Alternative Investment Funds (AIFs) in the commodity derivatives market, which marks the beginning of institutional participation in the commodity derivatives market.

July 2017: SEBI in prescribed a revised comprehensive framework for determination of numerical value of overall client level open position limits for agricultural commodities based on the categorization of the agricultural commodities into broad, narrow and sensitive commodities such that broad commodities have higher position limits as compared to narrow or sensitive commodities.

September 2017: SEBI permitted FPIs to participate in commodity derivatives contracts traded in stock exchanges in IFSC.

October 2017: SEBI issued broad guidelines for deciding appropriate settlement mode for commodity derivatives contracts in which it has been indicated that the first preference shall be given for settlement by physical delivery. Cash settlement could be permitted under special Circumstances.

January 2018: SEBI during widened the ratio between the highest to lowest transaction charges in the turnover slab of any contract to 2:1.

March 2018: SEBI during March 2018 permitted liquidity enhancement scheme (LES) in commodity derivatives contracts.

March 2018: SEBI in decided that commodity exchanges may provide spread benefit in initial margin across futures contracts in a commodity complex subject to certain conditions.

October 01, 2018: Single exchange can launch products in all segments of the securities markets. Two exchanges namely NSE and BSE have launched Commodity derivatives segment and thus are universal exchanges offering trading in all segments.

October 09, 2018: permitted foreign entities having actual exposure to Indian commodity markets, known as EFEs, to participate in the commodity derivatives Market.

October 16, 2018: directed exchanges to ensure that adequate samples of goods are collected and retained and also specified the minimum number of samples to be taken.

November 30, 2018: SEBI decided to extend the trade time within which recognized stock exchanges can set their trading hours for their commodity derivatives segment.

December 12, 2018: approved the proposal for allowing custodians to provide custodial services in goods underlying commodity derivative contracts. Pursuant to the above, amendments to relevant provisions in the SEBI (Custodian) Regulations, 1996 have been notified.

January 04, 2019: has directed all recognized stock exchanges to make additional disclosures on their website regarding commodity wise and category wise open interest and turnover.

January 16, 2019: on draft norms for design of commodity indices and draft product design for futures on commodity indices.

January 23, 2019: directed that the exchanges shall follow the policy of having uniform trading and delivery lot size for the commodity derivatives contracts and provided for exemption from the same only on stock exchange submitting detailed rationale for keeping different lot size for trading and delivery with respect to any contract.

February 11, 2019: specified a framework wherein the deposits placed by WSPs with WDRA for exchange/ clearing corporation specific outstanding electronic negotiable warehousing receipts (eNWRs) shall be considered by clearing corporations in the calculation of available FSD of the WSP towards required FSD under SEBI norms.

March 20, 2019: SEBI has specified that exchanges shall create an earmarked fund out of the regulatory fee foregone by SEBI and has given guiding principles for exchanges to follow for the purpose of utilisation of the fund.

May 21, 2019: Participation of Mutual Funds in Commodity Derivatives Market in India

May 22, 2019: Participation of Portfolio Managers in Commodity Derivatives Market in India

The market microstructure of commodity derivatives market has undergone huge transformation in the last decade. The various changeover is outlined below.

Table 3.1: Commodity Derivatives Market in India: Transformation from the year 2003 to year 2020

Year	2003	2020
Modern Exchanges	Absent	Six modern national level commodity exchanges
Institutional Brokers	Absent	High participation
Banks	Absent	Allowed
Mutual Fund	Absent	Allowed
Companies	Absent	Medium
Independent Clearing	Low	High
Electronic Trading	Absent	High tech
Settlement Guarantee Fund	Absent	Allowed
Usage of Warehouse Receipt	Absent	Allowed
Trading Volumes	Low	High
Products Available for Trading	Single Commodity	Multi Commodity
Governance of Exchanges Regulatory Body	Low governance FMC	High governance SEBI
Commodity Options Trading	Absent	Allowed
Category III: Alternative Investment Fund Foreign Companies	Absent	Allowed
EFEs (Foreign entities having exposure to Indian Commodity Markets)	Absent	Allowed
Participation of Portfolio Managers	Absent	Allowed
Source: Author's Compilation		

3.1.6 Major Commodity Exchanges

3.1.6.1 Commodity Exchanges of India

India has experienced phenomenal growth in the commodity and derivatives futures market since inception from the year 2003. At present, there are three national commodity exchanges and two stock exchanges operating in commodity derivatives in India. They are as follows:

Table 3.2 A: List of Exchanges Trading in Commodities in India

Sr. No.	Name of the Exchanges
A	NATIONAL EXCHANGES
1	Multi Commodity Exchange of India Ltd. (MCX)
2	National Commodity & Derivatives Exchange of India (NCDEX)
4	Indian Commodity Exchange Ltd. (ICEX)
5	NSE
6	BSE
Note: Trading in commodity futures segment at BSE commenced from October 01, 2018 Trading in commodity futures segment at NSE commenced from October 12, 2018	

Multi Commodity Exchange (MCX)

MCX an independent and de-mutualised multi commodity exchange has permanent recognition from Government of India for facilitating online trading, clearing and settlement operations for commodity futures markets across the country. Key shareholders of MCX are Financial Technologies (India) Ltd., State Bank of India, NARBARD, NSE, HDFC Bank, State Bank of Indore, State Bank of Hyderabad, State Bank Saurashtra, SBI Life Insurance Co. Ltd, Union Bank of India, Bank of India, Bank of Baroda, Canara Bank, Corporation Bank, headquartered in Mumbai, MCX is led by an Expert management team with deep domain knowledge of the commodity futures markets. Through the integration of dedicated resources, robust technology and scalable infrastructure, MCX has become world largest exchange in silver and gold. Inaugurated in November 2003, offers futures trading in the following commodity categories: Agri Commodities, Bullion, Metals-Ferrous & Non-ferrous, Pulses, Oils & Oilseeds, Energy, Plantations, Spices and Other Soft Commodities.

MCX has built strategic alliances with some of the largest players in commodities eco-system, namely, Bombay Bullion Association, Bombay Metal Exchanges, Solvent Extractors Association of India, Pulses Importers Association, Shetkari Sanghatana, United Planters Association of India and India Pepper and Spice Trade Association. Today MCX is offering spectacular growth opportunities and advantages to a large cross section of the participants including producers/Processors, Traders, corporate, Regional Trading Centres, Importers, Exporters, Cooperatives, Industry Associations, amongst others MCX being nation-wide commodity exchange, offering multiple commodities for trading with wide reach and penetration and robust infrastructure, is well placed to tap this vast potential.

National Commodity and Derivative Exchange Limited (NCDEX)

National Commodity & Derivatives Exchange Limited (NCDEX) is a professionally managed online multi commodity exchange promoted by ICICI Bank Limited, Life Insurance Corporation of India (LIC), National Bank for Agriculture and Rural Development(NABARD) and National Stock Exchange of India Limited (NSE), Punjab National Bank (PNB), CRISIL Limited, Indian Farmers Fertiliser Cooperative limited and Canara Bank by subscribing to the equity shares have joined the initial promoters as shareholders of the exchange. NCDEX is the only commodity exchange in the country promoted by national level institutions. This unique parentage enables it to offer a bouquet of benefits, which are currently in short supply in the commodity markets. The institutional promoters of NCDEX are prominent players in their respective fields and bring with them institutional building experience, trust, nationwide reach, technology and risk management skills.

Indian Commodity Exchange (ICEX)

Indian Commodity Exchange Limited (ICEX) is SEBI regulated online commodity derivative exchange. Headquartered at Mumbai, the exchange provides nationwide trading platform through its appointed brokers. Some of prominent shareholders are MMTC Ltd, Central Warehousing Corporation, Indian Potash Ltd, KRIBHCO, Punjab National Bank, IDFC Bank Ltd, Gujarat Agro Industries Corporation, Reliance Exchangenext Ltd, Bajaj Holdings & Investment Ltd., Gujrat State Agricultural Marketing Board, NAFED and Indiabulls Housing Finance Ltd. The exchange launched world’s first ever Diamond derivatives contracts. ICEX aims to provide futures trading products in India's economically relevant commodity. At present it offers futures contracts in Diamond. Providing desired price risk hedging solution to the trade through innovative contract designing forms core value of ICEX. This exchange is ideally positioned to leverage the huge potential of commodities market and encourage participation of actual users to benefit from the opportunities of hedging risk management and supply chain management in the commodities markets. ICEX is the first exchange in India to adopt hi-tech platform that ensures automatic and seamless switch-over from its Data Centre (DC) to the Disaster Recovery (DR) site with zero data loss in case of exigencies. The technology platform has highly optimized processing techniques, which enables the system to handle very large orders with latencies under 300 microseconds.

Stock exchanges trading in commodity derivatives in India are as follows.

Bombay Stock Exchange (BSE)

Established in 1875, BSE (formerly known as Bombay Stock Exchange), is Asia's first & the Fastest Stock Exchange in world with the speed of 6 micro seconds and one of India's leading exchange groups. Over the past years, BSE has facilitated the growth of the Indian corporate sector by providing it an efficient capital-raising platform. Popularly known as BSE, the exchange was established as 'The Native Share & Stock Brokers' Association' in 1875. In 2017 BSE become the first listed stock exchange of India. Today BSE provides an efficient and transparent market for trading in equity, currencies, debt instruments, derivatives, mutual funds and commodities. On 1st October 2018 BSE launches its commodity derivatives segment making it India's first Universal Exchange. Instruments available for trading at the exchange are futures in Crude oil, Gold, Silver, Copper, Cotton, Guar gum, Guar seed and Turmeric.

National Stock Exchange (NSE)

NSE was incorporated in the year 1992. It was recognised as a stock exchange by SEBI in April 1993 and commenced operations in 1994 with the launch of the wholesale debt market, followed shortly after by the launch of the cash market segment. The National Stock Exchange of India Limited (NSE) commenced trading in Commodity Derivatives with the launch of bullion futures on October 12, 2018. For 25 years, NSE shaped the equity market. NSE has now embarked a journey to shape the commodity market, with the introduction of futures on Commodity Derivatives. Instruments available for trading are Bullion and Energy futures namely Brent Crude Oil, Copper, Degummed soy oil, Gold and Silver.

3.1.6.2 Global Commodity Market

Globally commodities derivatives exchanges have existed for a long time. The CBOT and CME are two of the oldest derivatives exchanges in the world. The CBOT was established in 1848 to bring farmers and merchants together. Initially its main task was to standardize the quantities and qualities of the grains that were traded. Within a few years the first futures-type contract was developed. Speculators soon became interested in the contract and found trading in the contract to be an attractive to trading the underlying grain itself. In 1919, another exchange, the CME was established. Now commodity exchanges exist all over the world.

Table 3.2 B: List of Global Commodity Exchanges

Country	Exchange
United States of America	Chicago Board of Trade (CBOT)
	Minneapolis Grain Exchange
	New York Cotton Exchange
	New York Mercantile Exchange
	Kanas Board of Trade
	New York Board of Trade
Canada	The Winnipeg Commodity Exchange
Brazil, Sao Paulo	Brazilian Mercantile & Futures Exchange
Australia	Sydney Futures Exchange Ltd.
People's Republic of China	Dalian Commodity Exchange
	Shanghai Metal Exchange
Japan	Tokyo Commodity Exchange
Malaysia	Kuala Lumpur Commodity Exchange
New Zealand	New Zealand's Exchange
Singapore	Singapore Commodity Exchange Ltd.
Italy	Italian Derivatives Market
Netherlands	Amsterdam Exchange Option Traders
Russia	Moscow Exchange
	SPIMEX/ St. Petersburg International Mercantile Exchange
United Kingdom	London International Financial Futures Options Exchange
	The London Metal Exchange
Source: Author's Compilation	

SECTION II

PROFILE OF SELECT SAMPLE COMMODITIES

The section begins with a brief profile of each select sample Commodity It also states information on global production, countries dominating in production of the said commodity, Indian scenario in terms of volume of production, consumption, exports and imports information. Further, a trend in growth of nominal price of each sample commodity is shown in trend graph.

3.2 Profile of Select Sample Commodities

Agricultural Commodities

3.2.1 Cardamom

Cardamom is known as the “Queen of Spices”. The origins points of cardamom are not properly identified, yet it is trusted that it grew in southern India as wild herbs in the rainfall forests of the Western Ghats. Cardamom discovers, its first specify in the Charak Samhita (an early content on Ayurveda) mentioned somewhere close to the second century BC and second century AD. The Charak Samhita says that cardamom is a significant component in Ayurvedic medicines for digestive disorders, dental infections, etc. Afterward, the flavour discovers says in many Sanskrit records as being utilized in rituals and functions. Cardamom is part of Ginger family (Zingiberaceae) which is growing around 6-10 feet and also highly priced and exotic spice in the global market. Cardamom is generally utilized as a spice for its aroma and flavour. The commercial value of cardamom is derived from its fruit (capsule) that is used as a flavouring agent and spice. The cardamom oil is used in processed foods, tonics, liquors and perfumes and also it is versatile spice because used in salty and sweet food.

Market factors influencing commodity cardamom are as follows.

1. Major characteristics that indicate quality of the cardamom
2. Production status in competing countries like Guatemala
3. Annual production in the country
4. Weather conditions in the country
5. Domestic consumption demand

The major trading centres in India in which cardamom is traded is located in Kerala, Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra. Also, cardamom is traded in Indian commodity exchanges namely, Indian Commodity Exchange Ltd. (ICEX) and Multi

Commodity Exchange of India Ltd. Details of Contract specifications are given in Annexure III.

The largest cardamom producing country is Guatemala followed by India. The global production of cardamom is around 55,000 tonnes per annum (table 3.3)

Table 3.3: Global Production of Cardamom (in tonnes)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Guatemala	38453	35000	30000	36000	35475	36197	38330	38387
India	14000	16000	18000	23890	17990	20640	12940	11235
Total	52453	51000	48000	59890	49990	54640	44940	49622
Source: Spices Board of India								

The major exporter countries of this famous spice are Guatemala, India, Costa Rica, Indonesia, Brazil, Nigeria and Thailand. The major importer countries are Saudi Arabia, Kuwait, United Arab Emirates, China, Japan, Hong Kong, Netherlands, Singapore and United States of America. (Table 3.4)

Table 3.4: Global Exports of Cardamom (in tonnes)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	209-20
Guatemala	35989	38453	28000	34000	31000	35819	36818	36890
India	2372	3600	3795	5500	3850	5680	2850	1850
Total	38361	42953	31795	39500	34850	37680	35850	38740
Source: Spices Board of India								

In India, the planting period of the cardamom plantation is from august to march and is harvested in around the 3rd year of the time of plantation in the months of October and November. The domestic production of cardamom is gradually increase during the period 2012-13 to 2018-2019. (Table 3.5)

Table 3.5: Production, Imports, Exports and Consumption of Cardamom in India (in tonnes)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	2000	18,000	23890	19625	20640	18,000	12950	11235
Import	14000	2,285	850	1720	2000	2,285	353	470
Export	495	3,795	5500	3850	5680	3,795	2850	1850
Consumption	2372	18,500	18,000	18000	17000	18,500	13000	13500
Source: Spices Board of India								

The major states in India that produce cardamom are Kerala, Karnataka and Tamil Nadu. Kerala is the major producer of cardamom with 10075 tonnes of total production, out of 11235 tonnes production in 2019-2020. (Table 3.6)

Table 3.6: Major States Producing Cardamom in India (in tonnes)

Particulars	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Kerala	**11350**	**16000**	**21500**	**17215**	**18350**	**11535**	**10075**
Karnataka	**1800**	**1000**	**1440**	**1435**	**1450**	**690**	**620**
Tamil Nadu	**850**	**1000**	**950**	**975**	**850**	**715**	**540**
Total	**14000**	**18000**	**23890**	**19625**	**20650**	**12940**	**11235**
Source: Spices Board of India							

India exports cardamom to Saudi Arabia, UAE, USA, Kuwait, Japan, etc. (Table 3.7)

Table 3.7: Major Exporting Destinations of Cardamom for India (in tonnes)

Particulars	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Saudi Arabia	**3098**	**2800**	**3969**	**2500**	**2923**	**1210**	**18**
UAE	**555**	**422**	**493**	**494**	**1084**	**1191**	**860**
USA	**39**	**43**	**119**	**96**	**214**	**118**	**224**
Kuwait	**117**	**86**	**198**	**153**	**196**	**660**	**175**
Japan	**46**	**36**	**70**	**55**	**59**	**218**	**119**
Total (includes others)	**4650**	**3795**	**5500**	**3850**	**5680**	**2850**	**1850**
Source: Spices Board of India							

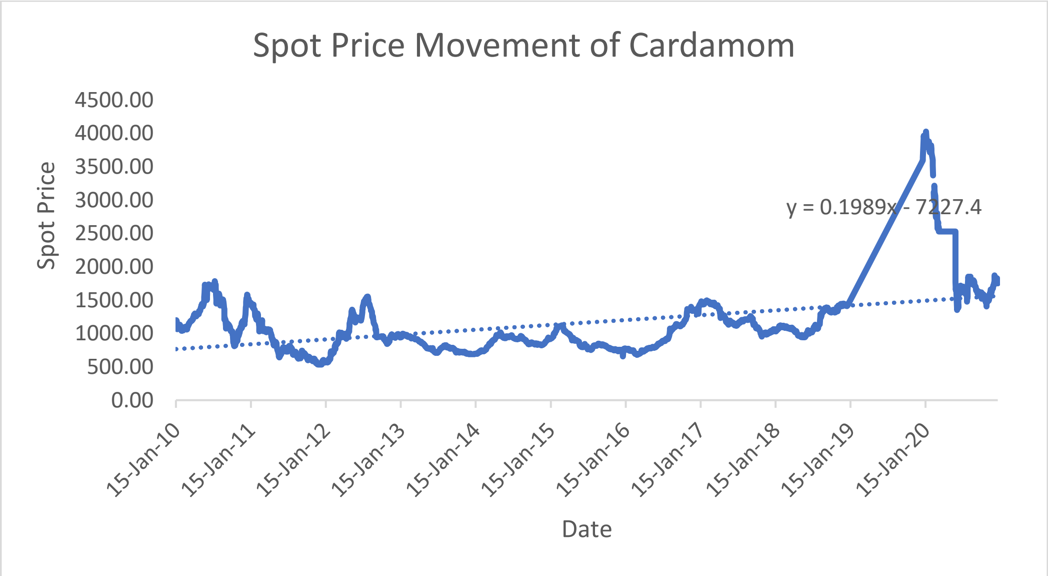


Figure 3.2: Spot Price Movement of Cardamom

Source: Author’s Compilation

Daily changes in price of cardamom from January 2009 to December 2020 can be seen in figure 3.2. The spot prices of cardamom are highly volatile. Although the average price around Rs.1000 per kg, the prices often go up to Rs. 1800 per kg and down by Rs. Rs. 530 per kg.

3.2.2 Cotton

The cotton is utilized for its fragment component of fabric from 5000 BC, have been traced out in the Indus Valley Civilization and Mexico. In India, cotton was found around 1000 BC at Hallus in Karnataka. Cotton is widely cultivated for the fibre because around 35% of the world textile industry is depended on the cotton fibre. The benefit of cotton is not only limited to clothes and its benefit extended via by-products also namely cotton seed, cotton seed oilcake, and cotton oil. Cotton oil was ranked 5 th among edible oil in the global and its oilcake is used as food for livestock. Cotton is classified into three classes, they are a grade, staple, and character. According to grade classification cotton range from rough to premium and also its colour function, Staple stated its fibre length and character denotes its strength and uniformity of fibre.

Cotton is used to manufacture textile and garments throughout the world. Cotton fibre obtained from the plant is first processed to remove proteins from it. The remainder left is a natural polymer having characteristics like strong, durable and absorbent and it is spun into threads for further use.

Market factors influencing commodity cotton are as follows.

1. Relationship with other competitive fibres.
2. World demand for consumer textile and demand from the cattle-feed industry in the country.
3. Discovering of new cotton markets.

4. Introduction of new and developed technology.
5. Fluctuations in domestic cotton production.
6. Delays in the arrival of cottonseed for crushing.
7. Policies of the government regarding the cotton sector.
8. Import-export scenario in the country.
9. Fluctuation in currency value.

The major international trading centres in which cotton is traded include:

1. New York Board of Trade (NYBOT)- New York.
2. Shanghai Commodity Exchange- China.

The cotton trading centres in India are located in Maharashtra, Andhra Pradesh, Gujarat, Rajasthan, Punjab, Haryana, Tamil Nadu, Uttar Pradesh and West Bengal. Also, cotton and its derivatives are traded in Indian commodity exchanges namely, NCDEX, MCX and Details of Contract specifications are given in Annexure III.

Global production of cotton shows a stable figure of 1,20,000 bales for the period 2009-10 to 2019-20. (Table 3.8)

Table 3.8: Global Production, Imports and Exports of Cotton (in 000's of 480 lb bales)

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	1,23,156	1,14,555	1,23,156	123910	120376	119217	96162	106679	123784	119013	121983
Imports	38,287	35,767	38,287	47663	41230	36065	35444	37697	41146	42359	40026
Exports	38,294	35,411	38,294	46461	41110	35948	34701	37852	41408	41228	40740
Source: USDA (United States Department of Agriculture) PSD											

Annual production and consumption of cotton in India is stable for the period 2009-10 to 2019-2020. The states in India producing cotton crop are Maharashtra, Gujarat, Andhra Pradesh, Haryana, Punjab, Rajasthan, Karnataka, Tamil Nadu and Madhya Pradesh. (Table 3.9)

Table 3.9: Consumption, Production, Imports and Exports in India (in 000's of 480 lb bales)

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Consumption	19,450	20,500	20750	22750	24500	24750	24350	24150	24000	24500	20000
Production	23,000	24,500	28500	31000	29500	25900	27000	29000	26500	29500	29500
Imports	480	450	1187	675	1226	1072	2736	1677	1800	1226	2300
Exports	6,550	5,000	7761	9261	4199	5764	4550	5182	3500	4199	3250
Source: USDA (United States Department of Agriculture) PSD											

The world's top five cotton producing countries are India, China, United States, Pakistan and Brazil. They account for almost 77% of the global production. (Table 3.10)

Table 3.10: Major Cotton Producing Countries (in 000's of 480 lb bales)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
World	123910	120376	119217	96162	106679	123784	119013	121983
India	28500	31000	29500	25900	27000	29000	26500	29500
China	35000	32750	30000	22000	22750	27500	27750	27250
United States	17314	12909	16319	12888	17170	20923	18367	19913
Pakistan	9300	9500	7180	5920	7020	9220	12750	6200
Brazil	6000	8000	10600	7000	7700	8200	7600	13400
Source: USDA (United States Department of Agriculture) PSD								

The major consumer countries of cotton in the world include China, India, Pakistan, Bangladesh and turkey. (Table 3.11)

Table 3.11: Major Cotton Consuming Countries (in 000's of 480 lb bales)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
World	107627	109384	112499	113496	116383	122882	120346	102127
China	36000	34500	34500	36000	38500	41000	39500	33000
India	20750	22750	24500	24750	24350	24150	24000	20000
Pakistan	10775	1042]	10625	10325	10325	10925	10725	9200
Bangladesh	4710	5310	5810	6310	6810	7510	7410	6500
Turkey	6050	6300	6400	6700	6550	7450	6800	6600
Source: USDA (United States Department of Agriculture) PSD								

The major importing countries of cotton in the world are Bangladesh, Vietnam. China, Turkey and Indonesia (Table 3.12).

Table 3.12: Major Cotton Importing Countries (in 000's of 480 lb bales)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
World	47663	41230	36065	35444	37697	41146	42359	40026
Bangladesh	5000	5300	5750	6375	6800	7600	7200	7000
Vietnam	2410	3200	4275	4600	5500	7000	6900	7136
China	20327	14122	8284	4406	5032	5710	9640	23000
Turkey	3692	4246	3675	4218	3679	4024	3499	4577
Indonesia	3137	2989	3345	2941	3391	3498	3050	2600
Source: USDA (United States Department of Agriculture) PSD								

The major exporting countries of cotton in the world are United States, India, Brazil and Australia (Table 3.13).

Table 3.13: Major Cotton Exporting Countries (in 000's of 480 lb bales)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
World	46461	41110	35948	34701	37852	41408	41228	40740
United States	13026	10530	11246	9153	14917	16279	14763	15527
India	7761	9261	4199	5764	4550	5182	3500	3250
Brazil	4307	2230	3910	4314	2789	4174	6014	8937
Australia	6168	4852	2404	2828	3731	3915	3632	1360
Source: USDA (United States Department of Agriculture) PSD								

Table 3.14: Trading Activities of Cotton at MCX from the year 2009 to 2020

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	506042	1011410	3316
2010	1571093	5013965	16332
2011	1568917	6659252	21550
2012	2289139	12470449	40620
2013	1609806	6153777	19979
2014	977344	2680333	10001
2015	1325306	4448358	17241
2016	716521	2334906	9015
2017	644127	2775663	10884
2018	857969	4613484	18021
2019	845463	4475650	17414
2020	319886	1447808	5611.66
Source: MCX			

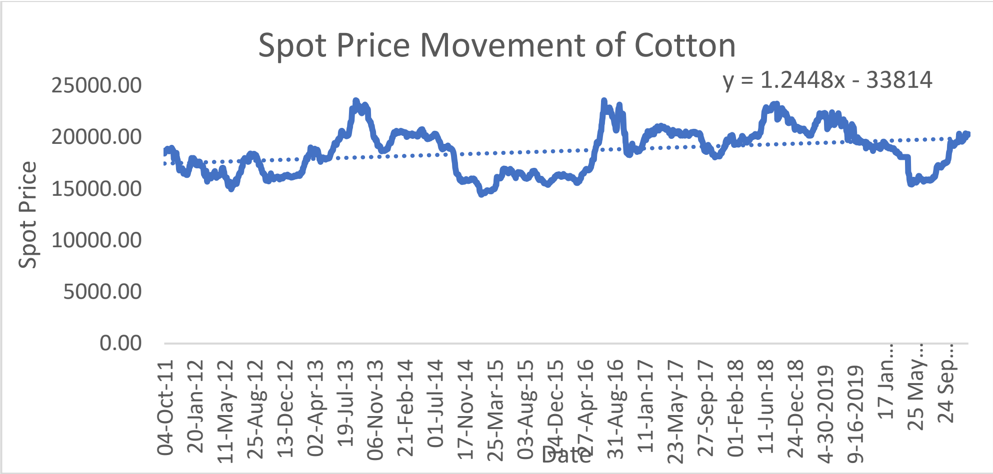


Figure 3.3: Spot Price Movement of Cotton

Source: Author's Compilation

The price found fluctuating from Rs. 14300 to Rs. 23,500 per kg leaving the cotton cultivation highly risky venture in India. (Figure 3.3)

3.3.3 Crude Palm Oil (CPO)

Palm oil is a fatty edible vegetable oil, yellowish in colour, derived from the flesh and the kernel of the fruit of the oil palm tree. Palm oil is basically edible oil and almost 90% of the world production is used in for this purpose. The rest 10% of production accounts to the industrial uses. Palm oil used in the manufacturing of soaps, ointments, cosmetics, detergents, and lubricants and also as cooking oil. Commercial palm oil is used in various forms such as crude palm oil, crude Palmolive, refined bleached deodorized (RBD) palm oil, RBD Palmolive and palm kernel oil.

Human utilization of palm oil may date as far back as 5,000 years; in the late 1800s, archaeologists found a substance that they initially found as palm oil in a tomb at Abydos dating back to 3,000 BCE. It is trusted that Arab brokers conveyed palm oil to Egypt. Palm oil is extracted from Mesocarp fruit as an edible vegetable oil. Palm oil is normally reddish in colour due to a high beta-carotene content. Palm oil is a commonly available oil in the tropical area of Africa, Southeast Asia, and Brazil and is widely utilized for cooking purpose.

Globally, palm oil mainly is used in the food industry because of its high oxidative stability (saturation) and lower cost and easy to frying.

Market factors influencing commodity crude palm oil are as follows.

1. World demand and supply fluctuations of the edible oils.
2. Domestic demand and supply fluctuations of other oils and oilseeds.
3. Seasonal cycles, as April to December is the peak production period.
4. Import policies of the importing nations.

The major crude palm oil markets in the world include:

- Bursa Malaysian Derivatives (BMD)- largest futures market for crude palm oil.
- Indonesia

Crude palm oil markets in India are located in Gujarat, Maharashtra, Andhra Pradesh, Tamil Nadu, West Bengal and Madhya Pradesh. Details of Contract specifications are given in Annexure III.

Global production, imports and export of Crude Palm Oil shows an increasing trend during the period 2009-10 to 2019-20. (Table 3.15)

Table 3.15: Global Production, Imports and Exports of CPO (in 000' tonnes)

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	45,862	47,260	50,261	56378	59304	61780	58901	65267	70610	74080	72771
Imports	34,751	35,424	37,991	42105	41900	44788	42839	45927	46451	50806	47389
Exports	35,632	36,202	38,820	43050	43194	47390	43837	48924	48569	52759	49107
Source: USDA (United States Department of Agriculture)											

Consumption and production of CPO in India shows a stable figure from 2009 to 2020. Domestic production is less than consumption and hence CPO is imported from other countries.

Table No 3.16: Consumption, Production and Imports of CPO in India (in 000' tonnes)

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Consumption	9150	9100	9350	9270	9805	9150	9100	9350	9270	9805	9060
Production	180	200	200	200	200	180	200	200	200	200	200
Imports	9139	8860	9341	8608	9700	9139	8860	9341	8608	9700	8550
Source: USDA (United States Department of Agriculture)											

The major producer countries of CPO in the world are Indonesia, Malaysia, Thailand, Colombia and Nigeria. Nearly 55% of global production is contributed by Indonesia followed by Malaysia (30%) and these two countries combined contribution was more than 85% of global production (Table 3.17).

Table 3.17: Major CPO Producing Countries (in 000' tonnes)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
World	56378	59304	61780	58901	65267	70610	74080	72771
Indonesia	28500	30500	33000	32000	36000	39500	41500	42500
Malaysia	19321	20161	19879	17700	18858	19683	21000	19000
Thailand	2135	2000	2068	1804	2500	2780	2900	2800
Colombia	974	1041	1110	1268	1099	1633	1625	1529
Nigeria	970	970	940	955	990	1025	1015	1015
Source: USDA (United States Department of Agriculture)								

The major consuming countries of crude palm oil in the world are Indonesia, India, European Union, China and Malaysia. India holds a very small share of palm oil production in the world figures (Table 3.18).

Table No 3.18: Major CPO Consuming Countries (in 000' tonnes)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
World	55817	57449	58223	59682	61559	66495	72547	71409
Indonesia	8035	8750	7220	9270	9160	11000	12625	13680
India	8240	8302	9150	9100	9350	9270	9805	9060
European Union	6930	6600	6900	6600	6800	6900	7000	6770
China	6389	5700	5700	4800	4750	5100	7012	6262
Malaysia	2451	2869	2946	3000	2587	3233	3554	3275
Source: USDA (United States Department of Agriculture)								

The largest exporter of crude palm oil is Indonesia (55%) followed by Malaysia (34%) (Table 3.19).

Table 3.19: Major CPO Exporting Countries (in 000' tonnes)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
World	43050	43194	47390	43837	48924	48569	52759	49107
Indonesia	20373	21719	25964	22906	27633	26967	29200	27500
Malaysia	18524	17344	17403	16667	16313	16472	18000	16700
Guatemala	346	411	453	614	718	800	812.00	810
Colombia	430	600	316	420	502	697	750	770
Papua New Guinea	564	556	607	580	664	635	640	565
Source: USDA (United States Department of Agriculture)								

The major importers of crude palm oil in world include India, European Union, China, Pakistan and Bangladesh (Table 3.20).

Table 3.20: Major CPO Importing Countries (in 000' tonnes)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
World	42105	41900	44788	42839	45927	46451	50806	47398
India	8364	7820	9139	8860	9341	8608	9700	8550
European Union	6812	6969	6935	6717	7219	7057	7150	6650
China	6589	5573	5696	4689	4881	5320	6900	6400
Pakistan	2245	2725	2826	2720	3075	3095	3500	3175
Bangladesh	1508	1573	1280	1511	1347	1637	1650	1550
Source: USDA (United States Department of Agriculture)								

Table 3.21: Trading Activities of Crude Palm Oil at MCX from the year 2009 to 2020

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	506042	1011410	3316
2010	1571093	5013965	16332
2011	1568917	6659252	21550
2012	2289139	12470449	40620
2013	1609806	6153777	19979
2014	977344	2680333	10001
2015	1325306	4448358	17241
2016	716521	2334906	9015
2017	644127	2775663	10884
2018	635079	3758481	14681
2019	616164	3590146	13969
2020	1028974	7755921	30061
Source: MCX			

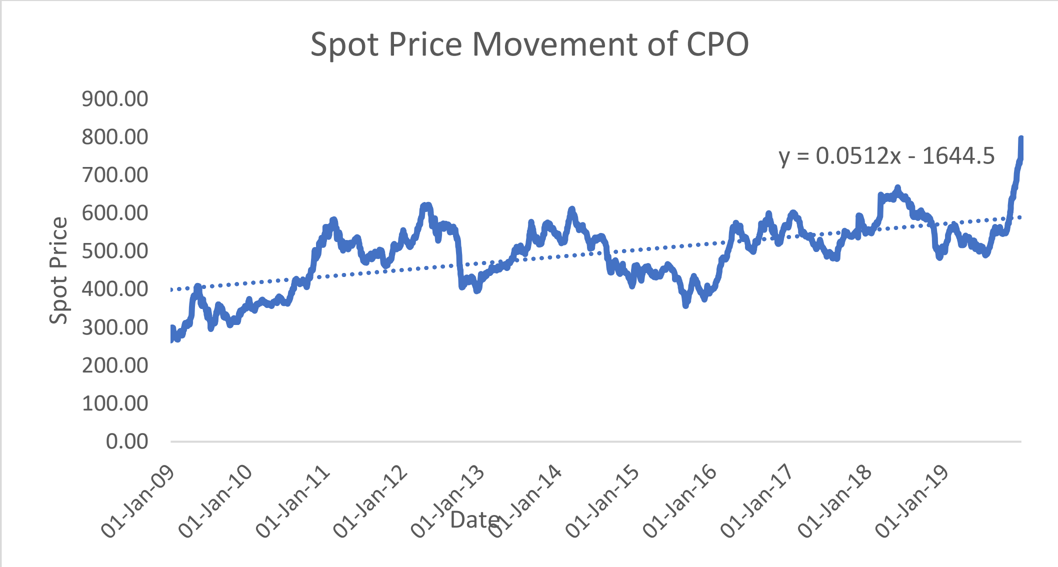


Figure 3.4: Spot Price Movement of CPO

Source: Author's Compilation

The spot prices are widely fluctuating around Rs. 260 per kg to Rs. 650 per kg. the prices are touching peak level of Rs. 600 per kg at least once in off season in every year (Figure 3.4).

3.2.3 Mentha Oil

Mentha oil is extracted from Mentha arvensis leaves (a Japanese mint) by steam distillation of menthol. Prior to World War II, cultivation of menthol was controlled solely by Japan and China. Afterward, Japanese and Chinese settlers in Brazil, during this period cultivation is expanded from 5 tons in 1941 to 3,000 tons by the 1960s. Mentha was first presented in India somewhere in the range of 1958 and 1964 by the Regional Research Laboratory, Jammu Tawi. Presently, two types of Menthol are available in India namely crystals and flakes. And also, different size and shapes of Menthol are available as Flakes (powder), small crystals, and large crystals. The sowing period of Mentha begins amid February–March each year. The yield takes 90 days to develop (vegetative) and produces its first blossoms at that point. The harvesting period of Mentha is between May and June. Mentha leaf is the business part of the plant, including new flower buds, which contain Mentha oil.

Mentha oil is extremely useful in a wide variety of industries namely food industry, pharmaceutical and also in perfumery and flavouring industries. Also, the constituents and derivatives of Mentha oil like mint and menthol are used widely.

The world-wide production of Mentha oil was around 48,000 tonnes and Indian market alone contribute to almost 78% of global production. India is leading exporter of Mentha oil. Production of mentha oil is seen fluctuating from 34,000 tonnes to 38,000 tonnes during the period.

Table 3.22: Production, Exports and Consumption of Mentha Oil in India (Tonnes)

Particulars	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	37000	40000	38000	30000	32000	33000	34000	37000
Exports	20039	24500	25750	23250	22300	21500	23000	22725
Consumption	14000	13000	12000	13500	12500	13000	13500	13550
Source: Spices Board of India								

India mainly exports Mentha Oil to China, USA, Netherlands, Singapore and Germany (Table 3.23).

Table 3.23: Mentha Oil Export Destination for India (Tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
China	9526	14095	14305	9518	9360	10310	10827
U. S	3695	3905	6824	4860	3130	3792	3559
Netherlands	796	1150	609	639	951	1230	710
Singapore	1446	1087	1125	1892	711	842	1170
Germany	795	1060	909	1155	707	929	707
France	459	508	529	817	668	586	533
Japan	176	224	389	877	484	595	548
U. K	532	618	558	544	463	442	404
Phillipines	169	271	241	263	217	192	316
Total (Incl. Others)	20039	24500	25750	21150	22300	21500	21610
Source: Spices Board of India							

Table 3.24: Trading Activities of Mentha Oil at MCX from the year 2009 to 2020

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	506042	1011410	3316
2010	1571093	5013965	16332
2011	1568917	6659252	21550
2012	2289139	12470449	40620
2013	1609806	6153777	19979
2014	977344	2680333	10001
2015	1325306	4448358	17241
2016	716521	2334906	9015
2017	644127	2775663	10884
2018	433095	2317064	9051
2019	266008	1314555	5115
2020	42050	241176	935
Source: MCX			

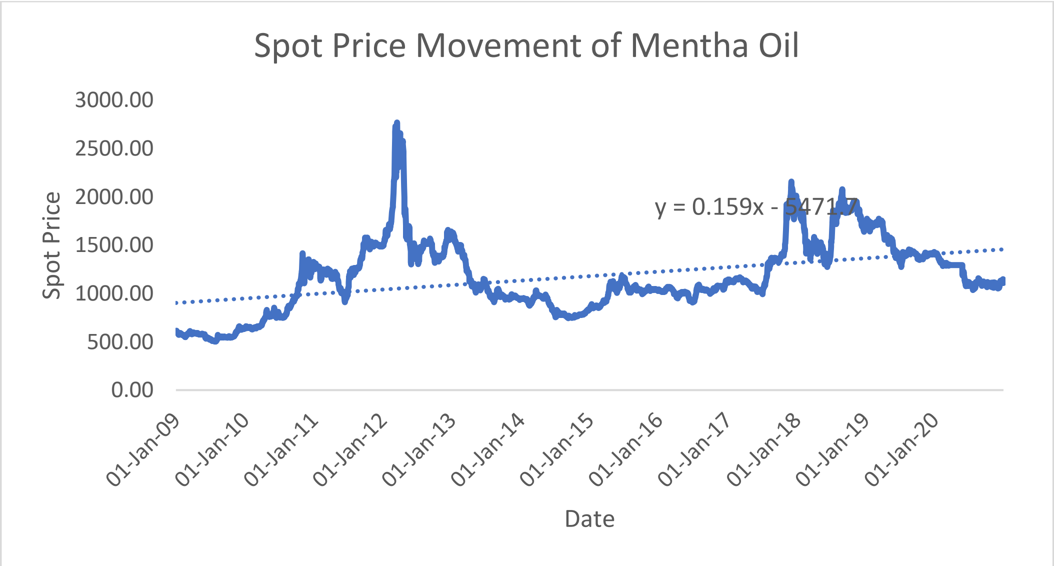


Figure 3.5: Spot Price Movement of Mentha Oil

Source: Author's Compilation

Spot price of mentha oil ranges from Rs. 500 per kg to Rs. 1500 per kg. during the period 2009-2020 with a peak price of Rs. 2800 per kg. in the year 2012 (figure 3.5)

Non-Agricultural Commodities

Base Metal

3.2.5 Aluminium

Aluminium is a substantial component in the group of boron with a symbol as Al and classified as non-ferrous metal. Old Greeks and Romans utilized aluminium salts as colouring mordant and as astringents for dressing wounds. It is soft, shiny white and ductile metal. It makes up around 8% by weight of the world's strong surface and after oxygen and silicon, the third most inexhaustible of all components in the worlds. On account of its solid partiality to oxygen, it isn't found in the natural state however just in consolidated structures, for example, oxides or silicates. The metal gets its name from a lumen, the Latin name for alum. Aluminium the second place in the list of the largest consumed metals in the world after steel. Aluminium is hypothetically 100% recyclable with no loss of its common characteristics. Aluminium is used in Defence, packaging (cans), consumer electronics industries and transportation and also the ratio of strength-to-weight is very high in aluminium. Therefore, the benefit of aluminium is extended to the car, train carriages, and aircraft. Transportation and construction sector consume more than 50 percent of total aluminium productions.

Market factors influencing commodity aluminium are as follows.

1. Domestic demand and supply
2. International prices
3. Interferences of government and various associations.
4. Import duties
5. Price fluctuations of input materials like power, freight etc.

The major trading centres of aluminium in the world are:

1. London Metal Exchange (LME)
2. Tokyo commodity Exchange (TOCOM)
3. Shanghai Futures Exchange (SHFE)
4. New York Mercantile Exchange (NYMEX)

In India, aluminium is also traded at various commodity exchange namely MCX and NCME. Details of Contract specifications are given in Annexure III.

Global production and consumption of aluminium shows an increasing trend from 36900 thousand tonnes in the year 2009-10 to 63697 thousand tonnes in 2019-20. The major aluminium consuming countries are United States, Japan China, Germany, France, Korea, Italy, India, Canada, Austria, Denmark, Netherlands, Norway, Sweden, Switzerland (Table 3.25).

Table 3.25: Global Production and Consumption of Aluminium ('000 tonnes)

Particulars	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	36900	40800	49166	52290	53926	57890	58900	59400	60000	64336	63697
Consumption	34810	39720	48583	52576	54639	57722	60922	68700	68700	60524	62270
Source: USGS, World Aluminium (International Aluminium Institute)											

Indian market for aluminium has expanded since a few years and is directing towards further growth in coming years. Both public and the private sector are indulged in the production of alumina and aluminium. The Indian scenario shows that the aluminium production ranges from 1349 thousand tonnes in 2010-11 to 3656 thousand tonnes in 2019-20 (Table 3.26).

Table 3.26: Production, Imports, Exports of Aluminium in India ('000 tonnes)

Particulars	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	1349	1525	1720	1516	1598	1628	1746	1843	1966	3656
Imports	183.8	240.7	1326	1348	1595	1671	1751	1958	2318	2152
Exports	233.8	284.9	567	707	1033	1153	1547	2012	2338	2371
Sources: Indian Bureau of Mines, Ministry of Commerce & industry, GOI										

Large deposits of bauxite are located in the continents like North America, South America, Africa, Australia and Asia and small deposits in Europe. China is the largest producer of aluminium followed by Russia, Canada, India and UAE.

Table 3.27: Major Producers of Primary Aluminium (000 tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
World	49200	51900	53926	57890	58900	59400	60000	64000
China	23500	26500	28300	31400	31900	32300	33000	36000
Russia	4024	3601	3300	3530	3560	2600	2600	3600
Canada	2781	2969	2858	2880	3210	3210	2900	2900
India	1700	1703	1939	2355	2720	3270	3700	3700
UAE	1820	1864	2330	2400	2500	2600	2600	2700
Source: USGS Mineral Commodity Summaries								

Major importing countries are USA, Germany, Japan, France and China (Table 3.28).

Table 3.28: Major Importing Countries (USD billion)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
USA	16.0	15.7	17.1	17.9	18.7	23.4	24.2	22.3
Germany	16.1	16.1	17.1	15.8	14.9	18.7	19.9	17.5
Japan	8.3	8.7	8.8	8.0	6.9	8.3	9.3	8.0
France	6.8	7.0	7.1	6.5	6.3	6.9	7.5	7.2
China	9.6	7.7	8.0	6.9	5.9	6.6	9.1	0.9
Total	154.4	154.5	165.4	154.8	128.7	154.9	177.0	159.8
Source: UN Comtrade Database								

Major exporting countries are China, Germany, USA, Canada, Russian Federation (Table 3.29).

Table 3.29: Major Exporting Countries (USD billion)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
China	18.6	20.0	22.6	23.8	21.2	22.6	6.9	0.6
Germany	15.4	15.9	16.6	15.2	14.6	16.4	17.8	16.6
USA	12.8	13.1	12.7	12.0	12.2	11.6	12.6	10.9
Canada	8.6	8.5	8.9	8.2	8.1	9.8	10.0	8.3
Russian Federation	7.3	7.1	6.3	7.1	6.0	6.7	6.3	5.8
Total	155.6	157.7	167.4	158.6	137.6	150.9	159.9	135.1
Source: UN Comtrade Database								

Table 3.30: Trading Activities of Aluminium at MCX from the year 2009 to 2019

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	610478	2686354	8807
2010	1866181	9358679	30484
2011	1566038	8749792	28316
2012	2798277	1516821	49407
2013	2536187	13680327	44416
2014	1998332	11577230	43198
2015	2229672	11865118	45988
2016	1861151	1003185	38733
2017	1840691	11928599	46778
2018	2973523	21854017	85367
2019	1097131	7616560	29636
2020	482861	2798776	10847
Source: MCX			

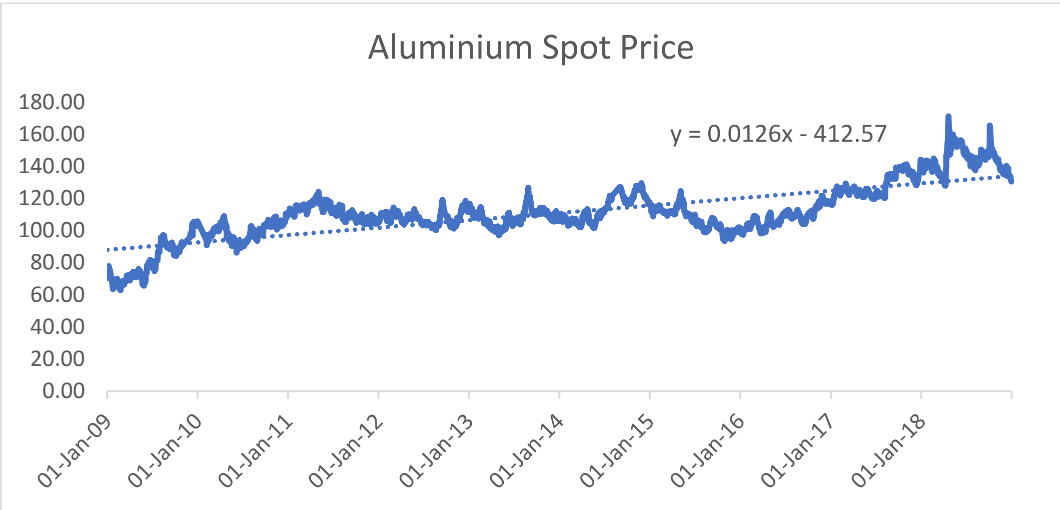


Figure 3.6: Spot Price Movement of Aluminium

Source: Author's Compilation

Spot market prices of Aluminium shows a gradual raise from Rs. 60 per kg to Rs. 350 per kg (figure 3.6)

3.2.6 Copper

Copper is highly ductile and malleable element and very good conductor of electricity; hence it is used in electrical appliances as a thermal and electrical conductor and in building wires. Copper is also one of the earliest metals used by people as coins and ornaments. Worldwide metal consumption, copper was ranked third, behind steel and aluminium. Copper resources are available in both land and sea, estimated at 1.6 billion and 0.7 billion tonnes respectively but the good news is that approximately one-third of copper is recycled copper. Copper is a unique metal, utilized for modern applications because of its properties and also erosion safe and antimicrobial. Copper is one of the most recycled metals compared to other metals. It is basically utilized for an industrialized reason like control links and wires, Engineering, AC and refrigeration, Telecom, Construction, Power, Transportation, Consumer Durable, etc. Market factors influencing commodity copper are as follows.

1. Price fluctuations of copper in London Metal Exchange.
2. Production level of copper in the world.
3. Growth prospects of the major copper consuming countries of the world.
4. Growth prospects of the various consuming sectors in the market.

Major copper trading centres in world include:

1. London Metals Exchange (London)
2. New York Mercantile Exchange (New York)
3. Shanghai Futures Exchange (China)

In India, Copper is traded at various commodity exchanges namely MCX and NMCE. Details of Contract specifications are given in Annexure III.

Global production of copper shows an increasing trend from 15954 thousand tonnes in the year 2010-11 to 20531 thousand tonnes in 2019-20. The consumption of this metal is concentrated in the highly industrialized countries (Table 3.31).

Table 3.31: Global Mine Production of Copper ('000 tonnes)

Particulars	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**
Production	**15954**	**16116**	**16691**	**18185**	**18431**	**19149**	**20386**	**20097**	**20557**	**20531**
Source: International Copper Study Group										

The copper production in India gradually grown from 665 thousand tonnes (2012-13) to 848 thousand tonnes in 2017-18. Thereafter, there was a decline in copper production (408 thousand tonnes) in the year 2019-20. The demand for copper was about 500 thousand tonnes allowing an export of around 400 thousand tonnes for the period 2012-13 to 2017-18 and then decline in the following years (Table 3.32).

Table 3.32: Production, Import and Export of Copper in India (000 tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	665	644	766	790	796	848	457	408
Import	245	305	356	471	507	553	680	732
Export	332	333	460	416	453	511	135	141
Source: Ministry of Mines; Ministry of Commerce & Industry								

Although copper ore is found throughout the world, the major countries that produce copper ore are Chile, Peru, China, United States, Australia, Congo, Zamia. Global copper production is dominated by Chile with 5600 thousand tonnes out of global production of 20,000 thousand tonnes in 2019-20.

Table 3.33: Major Countries in Copper Mine Production (000 tonnes)

Country	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Chile	5750	5760	5550	5500	5800	5600
Peru	1380	1700	2350	2450	2400	2400
China	1760	1710	1900	1710	1600	1600
United States	1360	1380	1430	1260	1200	1300
Australia	970	971	948	860	950	960
Congo (Kinshasa)	1030	1020	846	1090	1200	NA
Zambia	708	712	763	794	870	NA
World	18500	19100	20100	20000	21000	20000
Sources: USGS Mineral Commodity Summaries						

Table 3.34: Trading Activities of Copper at MCX from the year 2009 to 2020

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	29602264	74762138	245121
2010	31341022	107574568	350405
2011	34011335	138750284	449030
2012	32520309	138582416	451408
2013	19758713	83940701	272534
2014	7101939	29785631	111140
2015	11051908	38924667	150870
2016	10963338	36216832	139833
2017	9074084	36816171	144377
2018	11388536	50541272	197426
2019	6926216	43821622	170512
2020	4204615	51280635	198762
Source: MCX			

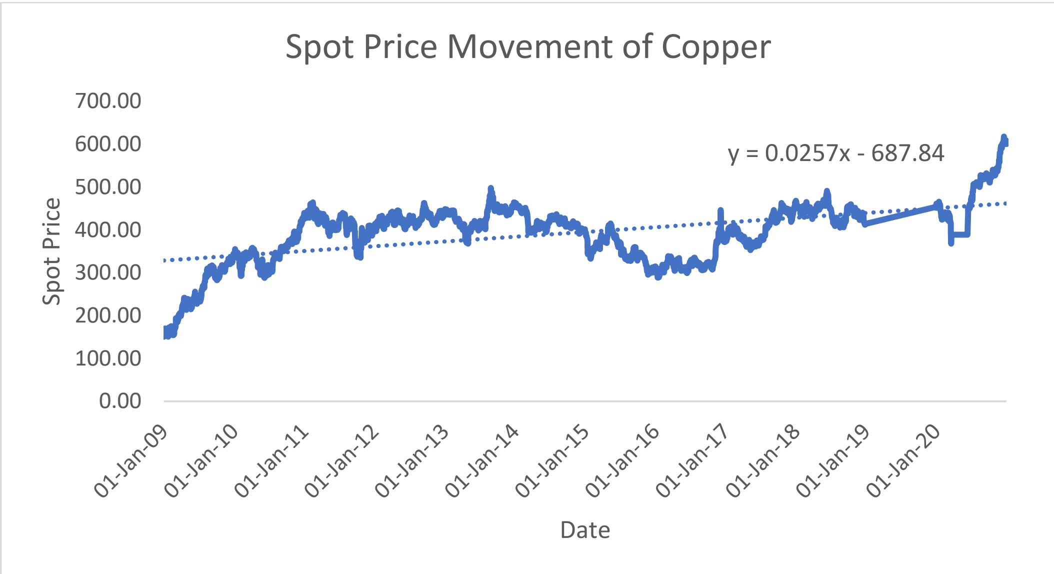


Figure 3.7: Spot Price Movement of Copper

Source: Author's Compilation

Copper prices in spot market moved from Rs. 150 per kg in 2009 to Rs. 600 in 2020 (Figure 3.7).

3.2.8 Lead

Lead has been used for thousands of years since it is very simple to extract from the earth and also easy to shape and work. Initially, Romans peoples used lead in the form of funnels, drinking vessels, and latches. Lead is a polished, gray-blue metal that easily changeable into dull grey shading. Galena is the foremost lead mineral and it's normally found with zinc, silver, and copper metals. It can be reused, without loss of its physical or substance properties and 60% of lead production is happening by the recycling process. Lead consumes only a little amount of energy for production compared to other metal. Lead is used in motorcycle, automobile, bicycle, and electric cars and its density provides supreme protection from radiation for that reason, lead is used in nuclear installations, laboratories, and hospital. Annually, around 80 % of global lead production is used in the batteries as a lead acid. Details of contract specifications are given in Annexure III.

The global production of lead is averaging around 4800 thousand tonnes per annum (Table 3.35).

Table 3.35: Global Mine Production and Consumption of Lead ('000 tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	4902	5244	4947	4850	4689	4713	4685	4650
Consumption	10583	11149	10998	10941	11141	11740	11729	11913
Source: International Lead and Zinc Study Group, USGS								

India's lead production ranges from 118 thousand tonnes to 181 thousand tonnes during 2012-13 to 2019-20.

Table 3.36: Production, Import and Export of Lead in India ('000 tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	118	123	127	145	139	168	198	181
Import	239	238	295	269	307	352	360	349
Export	47	80	76	89	181	160	177	175
Sources: Indian Bureau of Mines, Ministry of Commerce & Industry, GOI								

Top five countries in lead mine production are China, Australia, US, Peru, Mexico. About 50% of worlds lead production comes from China alone (Table 3.37).

Table 3.37: Major Countries in Mine Production ('000 tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
China	2800	2900	2340	2400	2340	2150	2100	2100
Australia	622	711	652	500	453	459	450	430
US	345	340	367	335	346	310	260	280
Peru	249	266	316	310	314	307	300	290
Mexico	210	210	254	250	232	243	240	240
Source: USGS Mineral Commodity Summaries								

Table 3.38: Trading Activities of Lead at MCX from the year 2009 to 2020

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	3369969	15571103	51052
2010	6209683	30539652	99477
2011	4819298	26991828	87352
2012	6856608	38532093	125511
2013	6699878	41581762	13500
2014	2755898	17757351	66258
2015	3577653	20534652	79591
2016	3965074	25029421	96638
2017	3805164	28782397	112872
2018	3980880	30492980	119113
2019	2455481	17941762	69812
2020	888506	4999079	19376
Source: MCX			

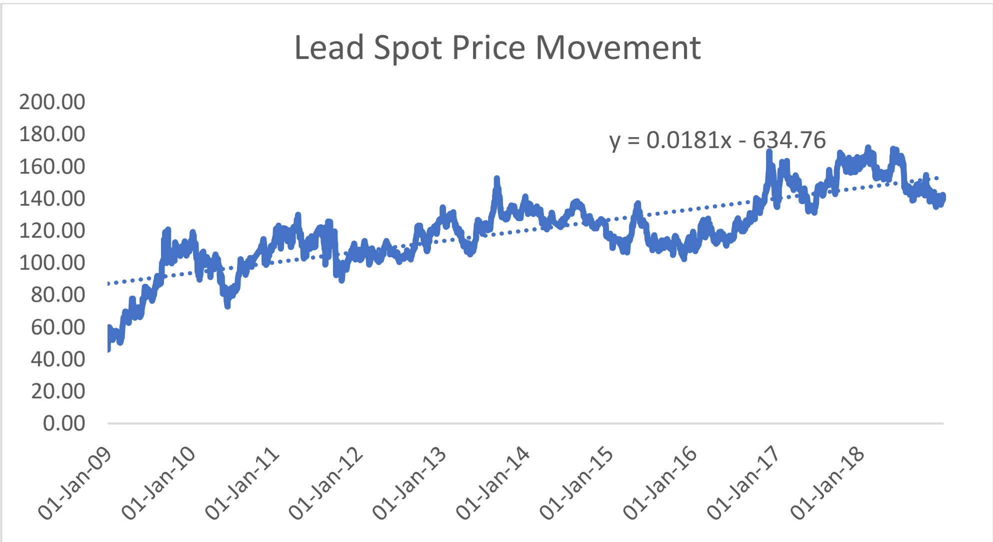


Figure 3.8: Spot Price Movement of Lead

Source: Author's Compilation

Spot market prices of lead in India shows a gradual raise from Rs. 45 per kg to Rs. 160 per kg during 2009 to 2020 time period (figure 3.8).

3.2.7 Nickel

Nickel is a silver-white metal and fifth most commonly available element on the earth. But, the greater part of the nickel is out of reach in the centre of the earth. Approximately, global consumes 3000 nickel alloys in the day-to-day life. Around 65% of nickel manufacturing is utilized to make stainless steel. Another 20% is utilized in other steel and non-ferrous composites, regularly for specific industrial, aviation, and military applications. Around 9% is utilized in plating and 6% for different utilizations, including coins, gadgets, batteries, etc. There is no alternative metal for nickel in most of the industry because of increasing cost or weakening performances. The significant characteristics of nickel are fought against corrosion and oxidation, high melting point, the simplicity of the store by electroplating, etc.

The major sectors that constitute the demand for the metal are:

1. Stainless steel sector accounts for the maximum demand for the metal i.e., 65% of the total demand.
2. 20% share of demand arises from the other stell and alloys sector.
3. The plating sector accounts for 9% of the demand for nickel.
4. The remaining is used to make coins and other chemicals.

Market factors influencing commodity Nickel are as follows:

1. World supply of nickel from the scrap
2. Discovery of new mines
3. Situation in the various industries that contribute to the demand of the metal
4. Rise in the world stainless stell consumption

The most important and the biggest market that trades in nickel is London Metal Exchange (LME). Also, nickel is traded in the Indian commodities market like MCX. Details of Contract specifications are given in Annexure III.

The global production of nickel has gradually increased (2410 thousand tonnes) in the year 2012-13 to (2700 thousand tonnes) in the year 2019-20 (Table 3.39).

Table 3.39: Global Mine Production and Consumption of Nickel ('000 tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	2410	2660	2450	2280	2090	2160	2300	2700
Consumption	1668	1787	1920	1882	2033	2192	2328	2464
Sources: USGS Mineral Commodity Summaries; International Nickel Study Group								

In India, mine production of Nickel is absolutely zero, therefore, Nickel is imported. The imports range around 100 to 157 thousand tonnes per year. India does not have any resources nor it indulges in the mine as well as plant production of the Nickel. Hence it has to totally depend on imports (Table 3.40).

Table 3.40: Production, Import and Export of Nickel in India ('000 tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	0	0	0	0	0	0	0	0
Import	102	100	100	130	133	122	157	173
Export	21	26	47	37	8	1	1	1
Sources: Indian Bureau of Mines, Ministry of Commerce & Industry, GOI								

Indonesia, Philippines and New Caledonia dominates nickel mine production worldwide.

Table 3.41: Major Countries in Mine Production of Nickel ('000 tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
World	2410	2660	2450	2280	2090	2160	2300	2700
Indonesia	101	134	177	130	199	345	560	800
Philippines	318	316	523	554	347	366	340	420
New Caledonia	132	164	178	186	207	215	210	220
Canada	212	223	235	235	236	214	160	180
Australia	246	234	245	222	204	179	170	180
Sources: USGS Mineral Commodity Summaries								

Table 3.42: Trading Activities of Nickel at MCX from the year 2009 to 2020

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	9792850	18977263	62220
2010	17929207	45022922	146654
2011	15126553	39900309	129127
2012	15414792	36220979	117983
2013	8745308	19405942	63006
2014	7172186	18897295	70512
2015	10012617	18754010	72689
2016	8750039	14225906	54926
2017	9881186	17056398	66887
2018	11093792	2510437	98063
2019	10270404	30952466	120437
2020	3726369	58316067	226031
Source: MCX			

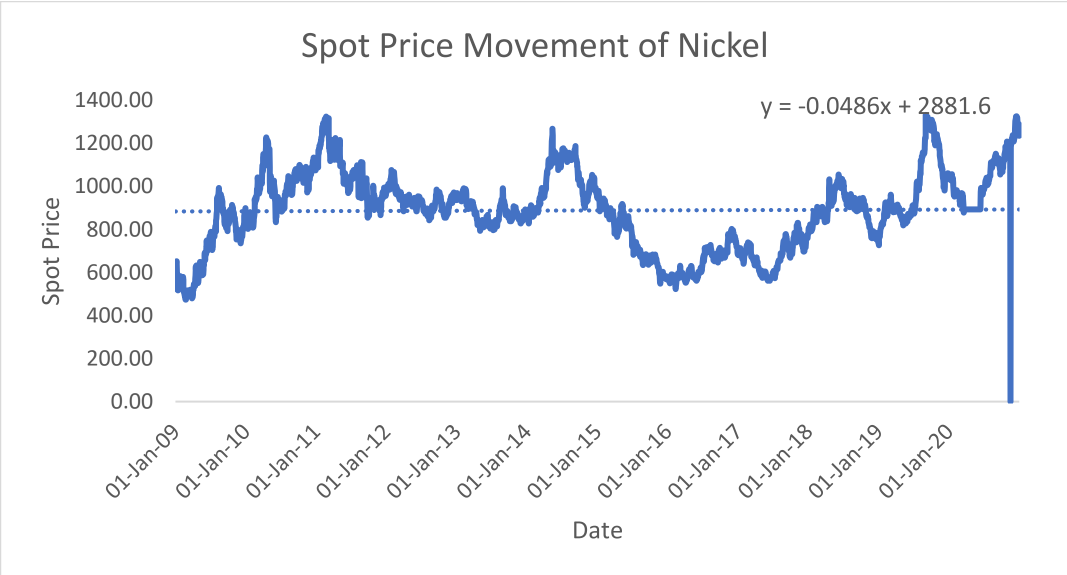


Figure 3.9: Spot Price Movement of Nickel

Source: Author's Compilation

The spot price of nickel is fluctuating from Rs. 600 per kg to Rs. 1200 per kg (figure 3.9).

Energy Sector

3.2.9 Crude Oil

Crude oil is also known as "Black Gold" and "Mother of all Commodities" because of its worthiness and significant varieties of by-product. Crude oil is a mixture of a various complex component of hydrocarbons which is extracted from the upper part of earth's crust. Approximately, one-third of global energy was depended on the crude oil. The market value of the crude oil is graded by two factors namely density (measured in API Gravity) and Sulphur content (it may be sweet or sour based on the level of Sulphur). Around, 48% of oil reserves are kept in the Middle East countries followed by North America and 80% of crude oil is transported through marine in the huge tanker and inland pipelines. Crude oil is utilized as an energy source for planes, boats, trucks, cars, and trains and also used in the other products namely lubricants product for all machines, bottles, plastics for toys, etc. Crude oil is a yellowish black mineral oil that is extracted from under the surface of the earth. This oil consists of a number of hydrocarbon compounds. This mixture of hydrocarbons remains in the liquid form under the normal atmospheric temperature and when distilled, a number of by-products can also be extracted. Crude oil can be of different types depending upon its origin and its relative weight. Brent crude oil is one of the most important types of crude oil and also considered as a benchmark in context of the price fixation of the other types.

Market factors influencing commodity crude oil are as follows.

1. Production of the major oil producing countries
2. Various climatic or political supply fluctuations
3. World oil demand
4. Fluctuations in the value of dollar
5. Imports from World oil organizations like API, DOE
6. Refinery Fire

The major trading centres of crude oil in the world are:

1. New York Mercantile Exchange (NYMEX)
2. International Petroleum Exchange of London (IPE)
3. Tokyo Commodity Exchange (TOCOM)

In India, Crude Oil is traded at various commodity exchanges namely MCX and NCDEX. Details of Contract specifications are given in Annexure III.

Global production of crude oil shows a stable increasing trend from 80278/day thousand barrels in 2010-11 to 95192 thousand barrels/day in 2019-20. The total crude oil production of about 50% comes from OPEC countries and remaining from non-OPEC countries. The world consumption of crude oil is also increasing at the same rate as crude oil production. The consumption has reached 98272 thousand barrels/day in the year 2019-20 (Table 3.43).

Table 3.43: Global Crude Oil Production and Consumption ('000 barrels/day)

Particulars	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	80278	82095	86,183	86,606	88736	91547	91822	92502	94718	95192
Consumption	84714	87382	90,675	92,114	93194	95048	96737	98406	99843	98272
Source: BP Statistical Review 2020, Ministry of Petroleum & Natural Gas, EIA										

The production of crude oil in India has increased very marginally from 754 thousand barrels/day in 2010-11 to 826 thousand barrels/day in 2019-20. To meet the consumption requirements India largely depends on imports. The imports show almost 100% rise from 2928 thousand barrels/day 5379 thousand barrels/day in 2019-20. The major oil reserves in India are situated at Mumbai high, Upper Assam (Assam), Cambay (Gujarat), Krishna-Godavari basin (Andhra Pradesh), Cauvery basin (Tamil Nadu), Nagaland and Arunachal Pradesh.

Table 3.44: Production, Imports and Consumption of Crude Oil in India ('000 barrels/day)

Particulars	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	754	826	906	906	905	893	874	884	869	826
Imports	2928	3254	4,168	4,370	4155	4380	4945	4947	5223	5379
Consumption	3211	3319	3,685	3,727	3914	4245	4654	4870	5156	5271
Source: BP Statistical Review 2020, Ministry of Petroleum & Natural Gas, EIA										

The major producing crude oil countries of the world include US, Saudi Arabia, Russian Federation, Iran and Iraq (Table 3.45).

Table 3.45: Major Producing Countries of Crude Oil ('000 barrels/day)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
US	**8,894**	**10,073**	**11773**	**12773**	**12340**	**13135**	**15311**	**17045**
Saudi Arabia	**11,635**	**11,393**	**11519**	**11998**	**12406**	**11892**	**12287**	**11832**
Russian Federation	**10,642**	**10,780**	**10860**	**11007**	**11269**	**11255**	**11438**	**11540**
Iran	**3,819**	**3,615**	**3714**	**3853**	**4586**	**5024**	**4715**	**3535**
Iraq	**3,116**	**3,141**	**3239**	**3986**	**4423**	**4533**	**4614**	**4779**
World	**86,183**	**86,606**	**88736**	**91547**	**91822**	**92502**	**94718**	**95192**
Source: BP Statistical Review 2020								

The major consumer countries of crude oil include US, China, India, Japan and Saudi Arabia (Table 3.46)

Table 3.46: Major Consuming Countries of Crude Oil ('000 barrels/day)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
US	**18,490**	**18,961**	**19106**	**19531**	**19687**	**19958**	**20456**	**19400**
China	**10,230**	**10,734**	**11239**	**11986**	**12304**	**12840**	**13525**	**14056**
India	**3,685**	**3,727**	**3914**	**4245**	**4654**	**4870**	**5156**	**5271**
Japan	**4,702**	**4,516**	**4303**	**4151**	**4019**	**3975**	**3854**	**3812**
Saudi Arabia	**3,462**	**3,470**	**3764**	**3886**	**3875**	**3838**	**3724**	**3788**
World	**90,675**	**92,114**	**93194**	**95048**	**96737**	**98406**	**99843**	**98272**
Source: BP Statistical Review 2020								

India is one of the non-OPEC countries much dependent on its imports to fulfil the domestic consumption demand as it has a much lower level of production. India imports crude oil from Middle East, West Africa, South & Central America, Other Asia Pacific (Table 3.47).

Table 3.47: Major Sources of Crude Oil for India (Million Tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Middle East	123	125	121	115	136	134	147	133
West Africa	27	27	29	34	29	26	28	30
South & Central America	23	32	34	29	28	25	23	19
Other Asia Pacific	5	5	6	5	7	6	5	5
Mexico	4	5	4	6	6	7	9	10
World	193	203	210	195	212	211	227	222
Source: BP Statistical Review 2020								

Table 3.48: Trading Activities of Crude Oil at MCX from the year 2009 to 2020

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	41092821	121020964	396790
2010	41537053	150743390	491020
2011	54753658	242044737	783316
2012	57790229	289229240	942114
2013	39558169	220009452	714316
2014	20731880	111401090	415675
2015	47788400	148829932	576860
2016	53256420	150073409	579434
2017	35357630	116211467	455731
2018	36629307	159901341	624614
2019	61637503	247284962	962198
2020	479050	146882995	569313
Source: MCX			

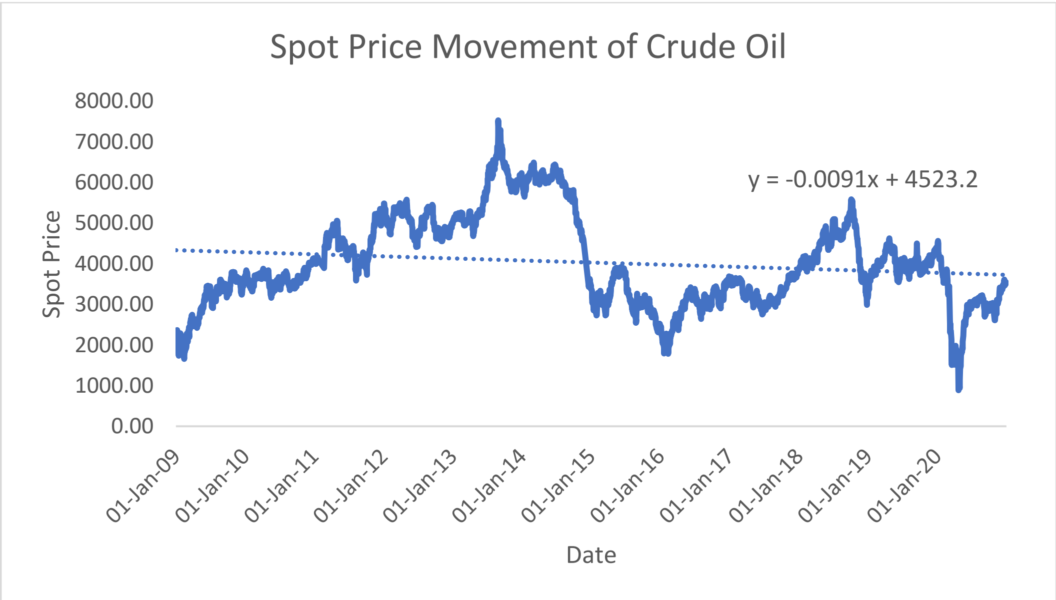


Figure 3.10: Spot Price Movement of Crude Oil

Source: Author's Compilation

Spot prices of crude oil is mostly influenced by the forex rates. Prices of crude oil ranges from Rs. 4000 per barrel to Rs. 5000 per barrel during the period 2009 - 2020, with peak price of Rs. 7500 per barrel at the end of the year 2013 (Figure 3.10).

3.2.10 Natural Gas

Natural gas is a flammable mixture of hydrocarbon gases and compared to other energy sources it is safest, cleanest and most useful energy sources. Burning natural gas is quite clean, as it released about 30% to 40% of low carbon dioxide than coal and petroleum. Around 500 BC, the potential of natural gas is identified by the Chinese by heating the sea water through natural gas for the purpose of separating the salt from seawater. Then 1785, Britain as a first country, commercialized the natural gas which is extracted from the coal and used for lighthouses and street light. Compressed Natural Gas (CNG) is produced by the compressed gas at a pressure of 250 bars and it is used in the public transport vehicles as a fuel. But natural gas is primarily utilized in businesses, factories and homes for cooking, cooling and heating and also used in the manufacturing of anti-freeze, ammonia, glass, steel, paint, etc.

Market factors influencing commodity natural gas are as follows.

1. Demand and Supply scenario of OPEC nations
2. Fluctuation in the value of dollar.
3. Demand level from the importing countries.
4. Weather conditions in the gas producing countries.
5. Domestic demand from the various sectors of the country.
6. Government policies and regulations.

The major commodity exchange in which natural gas is traded is New York Mercantile Exchange (NYMEX). Natural gas was not traded in India until sometime ago, when natural gas was introduced in the country in MCX. Details of Contract specifications are given in annexure III.

The global production of natural gas is gradually rising from 2976 billion cubic metre in 2010-11 to 3929 billion cubic metre in 2019-20.

Table 3.49: Global Natural Gas Production and Consumption (Billion cubic metre)

Particulars	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	2976	3193	3352	3404	3431	3502	3542	3678	3868	3989
Consumption	2950	3169	3338	3384	3393	3466	3550	3654	3849	3929
Source: BP Statistical Review 2020, Ministry of Petroleum & Natural Gas										

In India, the domestic production of natural gas was around 27 billion cubic metre and consumption was 60 billion cubic metres for the year 2019-20. About 50 % of requirements are met by Imports. The imports are quickly picking up from 13 billion cubic metre in 2010-11 to 33 billion cubic metre by the end of 2019-20.

Table 3.50: Production, Consumption and Imports of Natural Gas in India (Billion cubic metre)

Particulars	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	39	51	30	32	29	28	27	28	27	27
Consumption	51	62	39	32	49	48	51	54	58	60
Imports	13	12	71	49	19	20	24	26	31	33
Source: BP Statistical Review 2020, Ministry of Petroleum & Natural Gas										

USA, Russia, Iran, Qatar and Canada are the top five producers of natural gas. The top three countries contributing to more than 42% of global production. The major producers of Natural Gas include Russia, Iran, Qatar, Saudi Arabia, United Arab Emirates, United States of America, Nigeria, Algeria, Venezuela and Iraq. The major exporters of Natural Gas include Russia, Canada, European Union, Algeria, Norway, Netherlands, Turkmenistan, Indonesia, USA and Malaysia (Table 3.51).

Table 3.51: Major Producing Countries of Natural Gas (Billion cubic metre)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
US	681	685	705	740	727	746	832	921
Russian Federation	592	605	591	584	589	636	669	679
Iran	166	167	175	184	199	220	239	244
Qatar	157	178	170	175	174	172	175	178
Canada	141	141	159	161	172	178	185	173
Total	3352	3404	3431	3502	3542	3678	3868	3989
Source: BP Statistical Review 2020								

Table 3.52: Major Consuming Countries of Natural Gas (Billion cubic metre)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
US	723	741	722	744	749	739	817	847
Russian Federation	416	413	422	409	421	431	454	444
China	151	172	188	195	209	240	283	307
Iran	162	163	173	184	196	210	226	224
Japan	117	117	125	119	116	117	116	108
Total	3338	3384	3393	3466	3550	3654	3849	3929
Source: BP Statistical Review 2020								

India imports natural gas from Qatar, Nigeria, Equatorial Guinea, Australia, UAE and others (Table 3.53).

Table 3.53: Major Sources of Natural Gas for India (Million Tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Qatar	16.1	15.3	16.2	13.5	14.0	13.2	14.8	13.2
Nigeria	2.1	0.9	1.2	3.1	2.7	3.6	4.0	3.6
Equatorial Guinea	0	0	0.0	0.0	1.4	1.2	NA	NA
Australia	0	0	0.0	1.2	1.2	2.5	2.0	1.4
UAE	0	0	0.1	0.2	0.7	0.5	0.5	3.6
Source: BP Statistical Review 2020								

India is not a major producer of natural gas. Currently India produces over 40,000 million cubic meters of natural gas annually. The production in the country is in the hands of both the private and the public sector companies, majority of the production being done off shore.

The list of the major states involved in the production of Natural Gas include Gujarat, Assam, Andhra Pradesh, Tamil Nadu, Tripura and Arunachal Pradesh.

Table 3.54: Major Producing States in India (in Million Standard Cubic Metre)

States	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
A. Onshore	8877	9012	8797	9237	9858	10639	10756	10549
Assam & Arunachal Pradesh	2951	2909	2992	3054	3155	3249	3317	3187
Gujarat	2032	1657	1527	1490	1580	1607	1402	1342
Tripura	647	822	1140	1332	1430	1440	1554	1473
Rajasthan	685	982	1178	1338	1277	1442	1483	1883
Tamil Nadu	1206	1304	1192	1011	983	1207	1208	1097
Andhra Pradesh	1248	1171	541	619	868	959	1082	912
West Bengal (CBM)	101	156	224	389	555	531	350	306
Madhya Pradesh (CBM)	3	6	2	1	6	200	357	345
Jharkhand (CBM)	3	3	2	2	3	4	4	5
B. Offshore								
Mumbai High + Eastern Offshore	18102	17968	17272	16406	16883	17791	19042	18576
Private / JVCs	13700	8428	7589	6605	5155	6338	3075	2059
C. Total (A&B)	40679	35407	33657	32249	31897	32649	32873	31184
Source: Petroleum Policy and Analysis Cell (PPAC) Ministry of Petroleum and Natural Gas								

Table 3.55: Trading Activities of Natural Gas at MCX from the year 2009 to 2020

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	11124491	27497924	90157
2010	11176937	27919327	90942
2011	9882119	23293743	75384
2012	27886670	54440421	177330
2013	23828800	63916587	207521
2014	15628773	53091806	198103
2015	13501292	28541408	110625
2016	15355328	33443154	129124
2017	13281057	32791809	128595
2018	13846265	38713279	151223
2019	13846265	38713279	151223
2020	46106898	95485395	370098
Source: MCX			

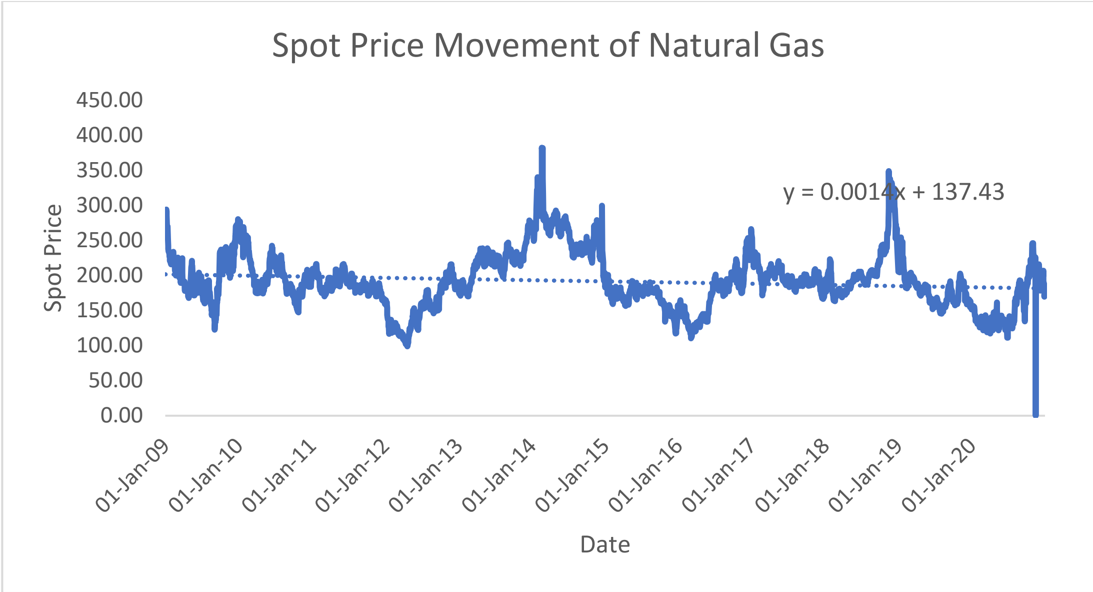


Figure 3.11: Spot Price Movement of Natural Gas

Source: Author's Compilation

The spot price of natural gas is fluctuating from Rs. 150 per kg to Rs. 350 per kg (3.11).

Bullion Commodities

3.2.10 Gold

Gold is a brilliant yellow precious metal that is resistant to air and water corrosion. It is very soft and pure metal (24 kt). Gold is the most malleable and ductile metal found on earth. That is why it is expensive and it is an alloyed with other metals, usually copper and silver to make it less expensive and harder. Gold is traded as a commodity but primarily it is monetary asset. It counts up to more than 65% of golds total accumulated holdings when it comes to 'value of investment' by central bank reserves, private players and high-carat jewellery. The gold prices are moving upwards due to reduction in production level as compared to the demand and also due to the weakening economy of the U.S. Gold is the earliest metal used by people and remains as one of the most important valued metals since ancient occasions. Egypt and Nubia had mines to make them significant gold-producing territories of the world. Like different precious metals, gold is estimated by troy weight and by grams. When it is alloyed with different metals the term carat or karat is utilized to show the measure of gold present, in it 24 carats being pure gold and lower appraisals relatively less. Gold and silver jewellery form a major component of the gifts given to women at the time of marriage in the Hindu, Jain and Sikh Community. Hence gold plays an important role in marriage and religious festivals in India. The average gifts estimated would be more than 100 grams of gold per marriage. This has led to the making the gold market to the size of 500 tonnes on an average ten million marriage per annum. Temple system in India also occupies a significant position where gold is used to prepare idols and devotees offer gold in temple. Thus, we can say that major portion of the gold demand in India lies in the current and cultural systems.

Market factors influencing commodity gold are as follows.

1. Reclaimed scrap and official gold loans (Above ground supply from sales by Central banks)
2. Producer/Miner hedging interest.
3. World macro-economic factors- US Dollar, Interest rate.
4. Comparative returns on stock markets
5. Domestic demand based on monsoon and agricultural output.

Major gold trading centres in world include:

1. London (Clearing house)
2. New York (home of futures trading)
3. Zurich (physical turntable)
4. Istanbul, Dubai, Singapore and Hong Kong Tokyo
5. Mumbai (India's liberalised gold regime)

Hong Kong Gold Market, Zurich Gold Market, London Gold Market and New York Market are the 24-hour gold markets. In India, gold is traded in Mumbai and Ahmedabad. It is also traded in three of India's major exchanges namely MCX, BSE and NSE. Details of contract specifications are given in Annexure III.

Global mine production of gold is showing slow increasing trend of 2062 tonnes in 2010-11 to 3464 tonnes in 2019-20 (Table 3.56).

Table 3.56: Global mine production of Gold (Tonnes)

Particulars	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Mine Production	2062	2102	2917	3076	3203	3290	3399	3447	3501	3464
Source: World Gold Council, GFMS, US Geological Survey										

The demand for gold in India was 941 tonnes in 2010-11 which has come down to 446 tonnes by year 2019-20. Much of its requirements are met from imports (Table 3.57).

Table 3.57: Imports and Demand for Gold in India (Tonnes)

Particulars	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Imports	958	843	876	899	914	558	879	756	647	344
Demand	941	914	959	833	857	676	771	760	690	446
Source: World Gold Council, GFMS, US Geological Survey										

Top five gold producing countries are China, Australia, Russia, United States, South Africa and Canada. (Table 3.58)

Table 3.58: Major Gold Mine Producing Countries (Tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
China	405	430	450	450	453	426	400	420
Australia	252	268	274	278	290	301	310	330
Russia	218	230	247	252	253	270	295	310
United States	235	228	210	214	222	237	210	200
South Africa	154	160	152	145	145	137	120	90
Canada	107	124	152	153	165	164	185	180
Source: World Gold Council, USGS Mineral Commodity Surveys								

World's largest gold consuming countries are China and India. (Table 3.59)

Table 3.59: Major Gold Consuming Countries (Tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
China	856	1346	1005	996	929	972	994	848
India	914	959	833	857	666	771	760	690
United States	160	188	165	191	210	159	158	151
Germany	119	143	111	126	121	117	107	107
Source: World Gold Council, USGS Mineral Commodity Surveys								

In 2019-2020 World Gold Council Report shows that the United States is having maximum official gold holding reserves of 75% (8133 tonnes) of the total Global reserves. India's Holding gold reserves are 6 percent (633 tonnes) with 12th rank among other nations (Table 3.60).

Table 3.60: Global Reserves (Gold) of Central Government (Tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
United States	8133	8133	8133	8133	8133	8133	8133	8133
Germany	3391	3387	3384	3381	3378	3372	3367	3366
Italy	2452	2452	2452	2452	2452	2452	2452	2452
France	2435	2435	2435	2436	2436	2436	2436	2436
China	1054	1054	1054	1762	1843	1843	1927	1948
India	558	558	558	558	558	558	618	633
World	31681	31854	32031	32749	33293	33735	32640	32833
World Gold Council								

Table 3.61: Trading Activities of Gold at MCX from the year 2009 to 2020

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	12144967	184997191	606548
2010	12052225	219874783	716204
2011	12655760	314713353	1018489
2012	10287609	305672442	995675
2013	8944603	256385614	832420
2014	3971634	110666518	412934
2015	3947175	104039990	403255
2016	4093572	121083681	467504
2017	2296957	66468954	260662
2018	2256202	69353299	270911
2019	3626278	128005659	498076
2020	3668580	172369899	668100
Source: MCX			

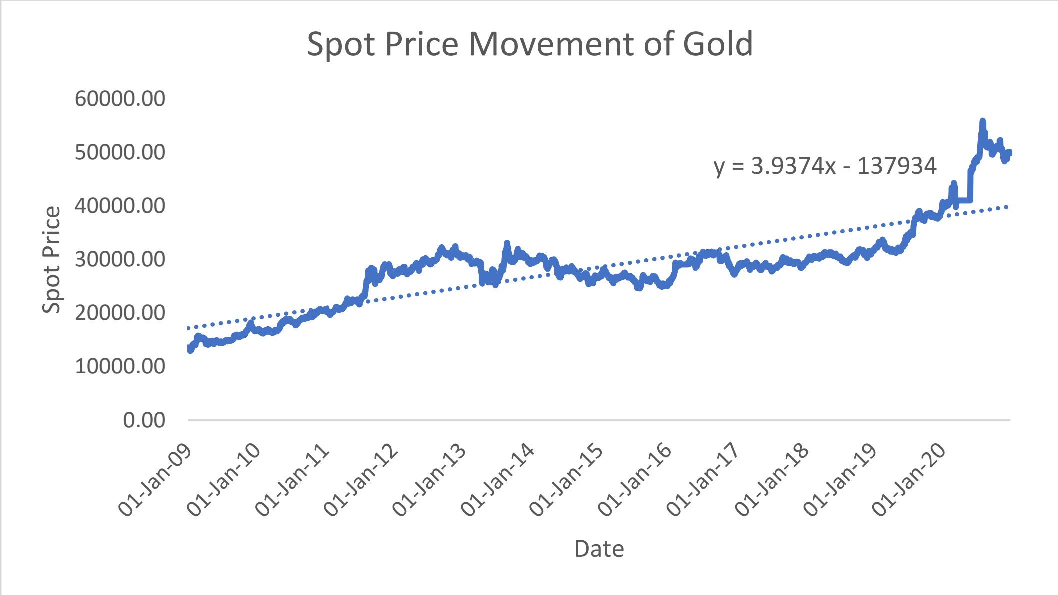


Figure 3.12: Spot Price Movement of Gold

Source: Author's Compilation

Spot prices of gold increased from Rs. 13,600 per an ounce in the year 2009 to Rs. 48650 during 2020 (Figure 3.12).

3.2.12 Silver

Silver (Chemical symbol-Ag) is also known as a Brilliant Grey-White Metal. Silver and gold are used as a medium for currency in ancient days. Anatolia (modern-day Turkey) is the first to mine silver and the primary sources of silver are lead, lead-zinc, silver, and silver-nickel. Silver has incalculable applications in science, industries, etc. Demand for Silver comes from Photography, Industrial and Silver Ornaments. Together, they demand for Silver is more than 95% of annual consumption. Silver is used in mirrors, conductors, electrical contacts, as a catalyst in chemical reactions and also used for manufacturing of dental alloys, Coins, etc. Commercial type of silver is expected at least 99.9% purity grade and 99.99% grade also available in the Indian market.

Market factors influencing commodity silver are as follows.

1. Price movements of other metals
2. Income level of the rural sector of the economy
3. Available supply verses fabrication demand
4. Fluctuation in deficits and interest rates
5. Inflation

The major silver trading centres in world include

1. London
2. Zurich
3. New York (COMEX)
4. Chicago (CBOT)
5. Hong Kong
6. Tokyo Commodity Exchange (TOCOM)

In India, Silver is traded at Delhi, Indore, Rajasthan, Madhya Pradesh, Uttar Pradesh and Gujarat. Also, Silver is traded in the Indian Commodity Exchange like MCX and BSE. Details of Contract specifications are given in Annexure III

Global production of silver was showing a slow upswing trend (20292 tonnes) in 2010-11 to (26019 tonnes) in 2019-20 (Table 3.62).

Table 3.62: Global Mine Production of Silver (Tonnes)

Particulars	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Mine Production	20292	20746	24625	25621	26993	27798	27789	27276	26616	26019
Source: World Silver Survey 2020										

Silver production in India moved from 131 tonne in 2010-11 to 671 tonnes in 2019-20. Demand for silver is very high in India which is mostly met by imports (Table 3.63).

Table 3.63: Production and Imports of Silver in India (Tonnes)

Particulars	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Production	131	280	333	261	374	436	526	658	633	671
Imports	1866	1752	5304	6237	7249	2793	5110	6958	5566	2218
Source: World Silver Survey 2020										

The major producers of silver include Mexico, Peru, Australia, China, Russia, Chile. (Table 3.64).

Table 3.64: Major Silver Producing Countries (Tonnes)

Country	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Mexico	5358	5513	5767	5975	5796	6055	6116	5919
Peru	3547	3754	3821	4291	4625	4587	4508	4210
China	3401	3529	3484	3503	3569	3502	3574	3443
Russia	1412	1381	1448	1588	1450	1305	1350	1320
Chile	1195	1218	1597	1504	1501	1319	1311	1189
World	24625	25621	26993	27798	27789	27276	26616	26019
Source: World Silver Survey 2020								

Table 3.65: Trading Activities of Silver at MCX from the year 2009 to 2020

Year	Traded Contract (Lots)	Total Value (Lacs)	Avg. Daily Turnover (Lacs)
2009	11555501	82891095	271774
2010	16440533	159664842	520080
2011	24434544	408239010	1321161
2012	17284529	297774497	969949
2013	11754822	173915829	564661
2014	5692481	71127129	265399
2015	5957382	64865456	251416
2016	5572254	69174486	267082
2017	3918104	46692471	183107
2018	4145954	47932655	187236
2019	5489992	69252137	269463
2020	7839040	131633213	510206
Source: MCX			

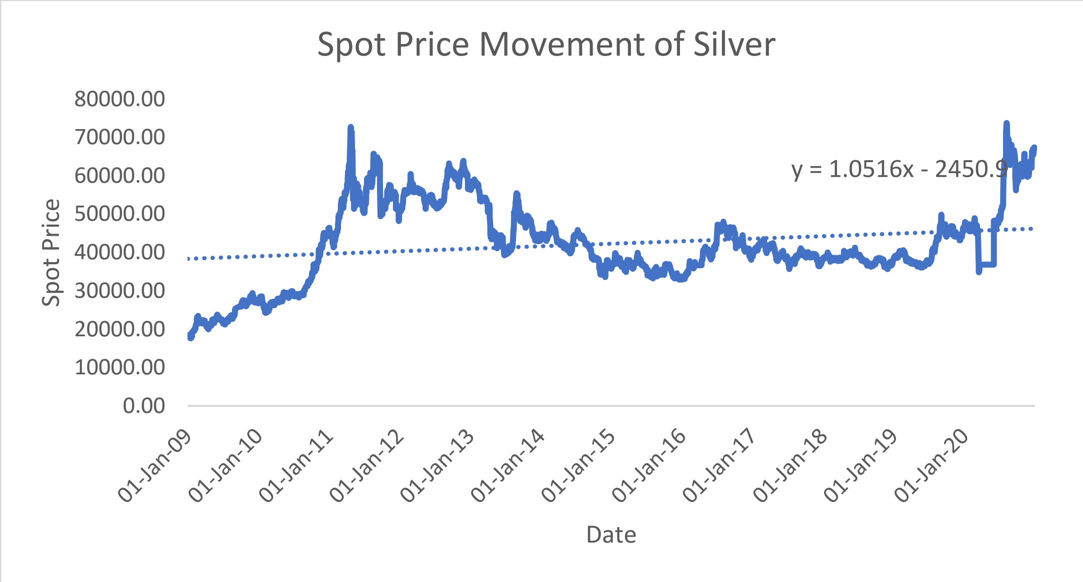


Figure 3.13: Spot Price Movement of Silver

Source: Author's Compilation

The spot price of silver gradually moved from Rs. 18300 per kg in 2009 to highest value of Rs. 71,300 in 2011 and stabilized at Rs. 38,100 in year 2017 and then increased to Rs. 70,000 by the year 2020(figure 3.13).

SECTION III

3.3 GROWTH OF COMMODITY DERIVATIVES MARKET IN INDIA

This section deals with the development and growth of commodity derivatives market in India. The topics presented under the section are value and volume of trade in Indian commodity derivatives market, market share of commodity exchanges, share of major group of commodity futures traded, number of commodities permitted for derivatives trading, trends in MCX COMDEX and NCDEX Nkrishi, participants share in Indian commodity futures market and share of top ten commodities traded in agriculture and non-agriculture segment for the year 2019-20.

3.3.1 Value of Commodity Futures Traded at Exchanges

Commodity derivatives futures market witnessed huge increase in value and volume in trade after reforms in trading, clearing and settlement process and risk management. The table 3.66 presents the total traded value of trade in Indian commodity derivatives futures market from the year 2004-05 to the year 2019-20.

Table 3.66: Value of Commodity Futures Traded in India (2004-2005 to 2019-2020)

Sr. No.	Year	Value (Rs. In Lakhs Crores)
3	2004-2005	5.72
4	2005-2006	21.55
5	2006-2007	36.77
6	2007-2008	40.65
7	2008-2009	52.49
8	2009-2010	77.64
9	2010-2011	119.48
10	2011-2012	181.26
11	2012-2013	170.46
12	2013-2014	101.44
13	2014-2015	61.68
14	2015-2016	66.96
15	2016-2017	64.99
16	2017-2018	60.20
17	2018-2019	73.78
18	2019-2020	92.25
(Source: FMC & SEBI Annual Reports)		

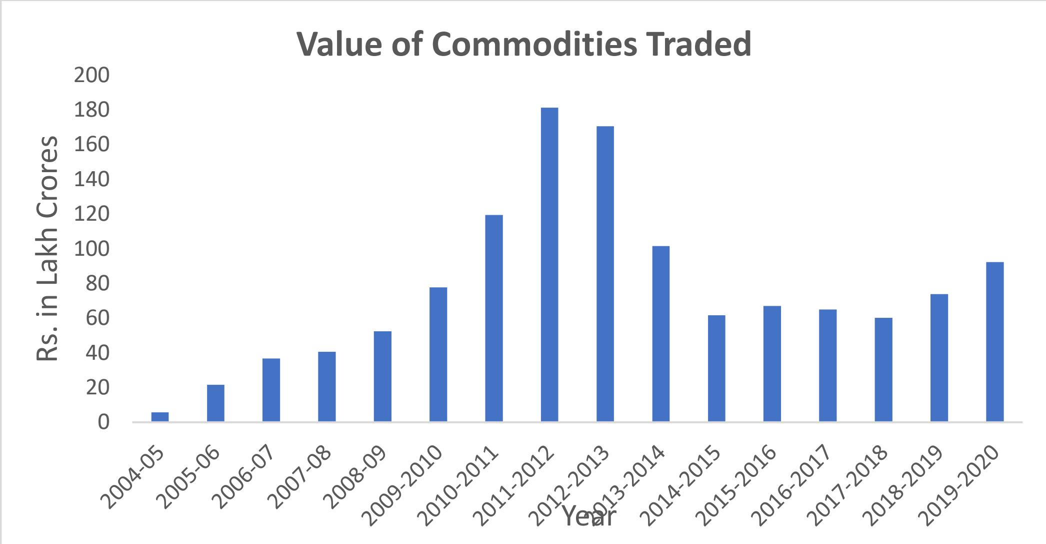


Figure 3.14: Value of Commodities Futures Traded in India (2004-05 to 2019-20)

Source: Author's Compilation

The above table 3.66 and figure 3.14 depicts the growth of commodity derivatives futures trading in terms of traded value. The consistent growth observed in Indian commodity derivative market since the year 2004-05 to year 2009-10. Subsequently, there was sharp increase in turnover in commodity futures market. The commodity trading in terms of value increased manifold from Rs. 5.76 lakh crore in the year 2004-05 to its peak level to Rs. 181.26 lakh crores in the year 2011-2012. The year 2011-12 has witnessed highest trade of Rs. 181.26 lakh crore. The growth in commodity derivatives market in terms of value traded has been primarily propelled by Multi Commodity Exchange, Mumbai (MCX) and National Commodity Derivative Exchange, Mumbai (NCDEX). As it is clearly exhibited from the table that the commodity derivatives market is gaining significance very meaningfully during the study period. The total value of trade dropped marginally to Rs.170.46 lakh crores in the year 2012-2013 for the first time and subsequently to Rs. 101.44 lakh crores in the year 2013-2014 and to Rs. 61.68 and 66.96 lakh crores in the year 2014-2015 and 2015-2016 respectively. The reason for such a significant decrease may be on account of NSEL payment crises and introduction of Commodity Transaction Tax (CTT) which was levied on non-farm and processed farm contracts such as gold, silver, crude oil, cotton, soya oil and sugar. In the year 2019-20 the aggregate turnover at all the exchanges in commodity derivatives segment increased by 25% percent to Rs. 92.25 lakh crores from Rs. 73.78 lakh crores.

3.3.2 Volume of Commodity Futures Traded at Indian Commodity Exchanges

The following table 3.67 presents the total traded volume in Indian Commodity Derivatives Market.

Table 3.67: Volume of Commodity Futures Traded in India (2004-2005 to 2019-2020)

Sr. No.	Year	Volume (In lakh tonne)
1	2004-05	1942
2	2005-06	6789
3	2006-07	6129
4	2007-08	5573
5	2008-09	7195
6	2009-10	10142
7	2010-11	12805
8	2011-12	14025
9	2012-13	14510
10	2013-14	8832
11	2014-15	6861
12	2015-16	11380
13	2016-17	9197
14	2017-18	8216
15	2018-19	8082
16	2019-2020	8933
(Source: FMC & SEBI Annual Reports)		

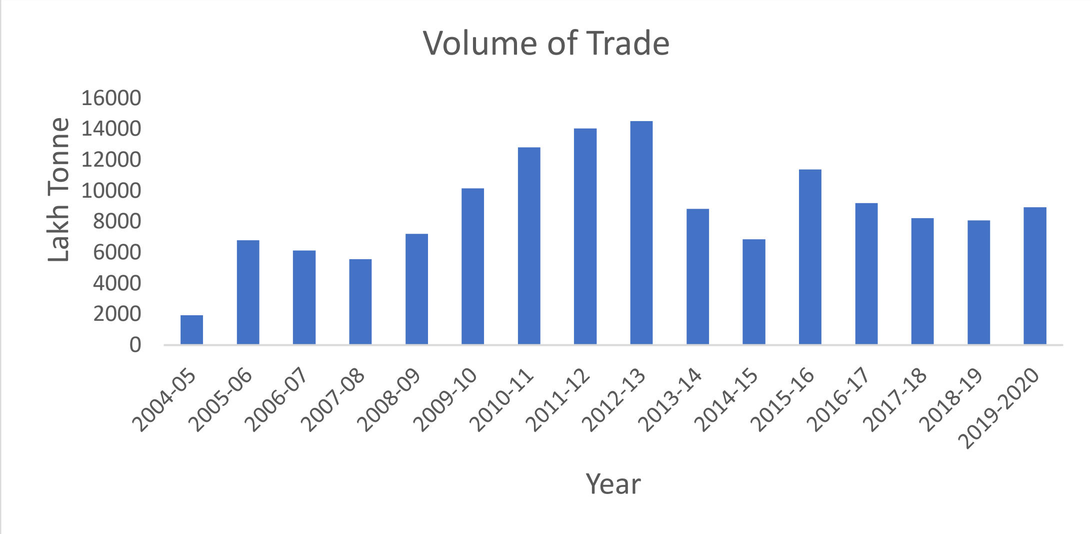


Figure 3.15: Volume of Commodity Futures Traded in India (2004-05 to 2019-20)

Source: Author's Compilation

The above table 3.67 and figure 3.15 represents the growth of commodity derivatives trading in terms of volume. The consistent growth witnessed in Indian commodity derivative market since the year 2004-05 has continued till 2012-13. The volume of trading dropped marginally to 6861 lakh tonnes in the year 2014-2015. The aggregate volume at all the exchanges in commodity derivatives segment dropped to 8082 lakh tonnes in the year 2018-19 from 8216 lakh tonnes (2017-18). Period from 2009-10 to 2012-13 is characterised by high trading volume market depts and the period from year 2013-14 to 2019-20 is a period when futures trading volume and depth were relatively low. For the past decade, the Indian commodity derivatives market has shown enormous growth in terms of both volume and value of the commodity derivatives traded.

3.2.3 Market Share of Commodity Exchanges in Derivative Trading in India

The adjoining table 3.68 highlights the market share of commodity derivative exchanges from the year 2004-2005 to year 2019-2020.

Table 3.68: Market share of Commodity Exchanges to the Total Value of Commodity Derivatives traded in India (Per Cent)

Commodity Exchange	2004-05	2005-06	2005-06	2005-06	2005-06	2009-10	2010-11	2010-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
MCX	28.88	44.62	47.09	74.22	87.41	82.34	82.36	86.05	87.00	84.89	84.48	84.13	90.25	89.55	91.79	94.2
NCDEX	46.59	49.5	27.41	21.73	10.21	11.82	11.81	9.99	10.00	11.30	14.73	15.22	9.18	9.79	7.21	4.8
NMCE	2.45	0.85	2.95	0.71	1.17	2.94	1.83	1.48	1.00	1.51	0.58	0.43	0.44	0.57	0.19	—
ACE	—	—	—	—	—	—	0.25	0.76	1.00	0.46	—	—	—	—	—	—
ICEX	—	—	—	—	—	1.76	3.16	1.42	1.00	0.84	—	—	—	0.04	0.32	0.4
UCX	—	—	—	—	—	—	—	—	—	0.72	—	—	—	—	—	—
NBOT	10.22	2.49	21.98	2.21	0.65	0.78	0.43	—	—	—	—	—	—	—	—	—
Rajkot Ltd.	—	—	—	—	—	—	—	—	—	—	0.05	0.02	0.01	—	—	—
COC,Hapur	—	—	—	—	—	—	—	—	—	—	0.13	0.16	0.12	0.05	—	—
IPSTAKochi	—	—	—	—	—	—	—	—	—	—	0.001	0.001	—	—	—	—
Others	11.86	2.54	0.57	1.13	0.56	0.36	0.16	0.30	0.01	—	0.028	0.039	—	—	0.99	0.6
(Source: FMC & SEBI Annual Reports)																

Table 3.68 presents market share of the commodity exchanges for the period of 16 years (2004-05 to 2019-20). The growth witnessed in trading in commodity market has been primarily propelled by national commodity exchanges more specifically Multi Commodity Exchange (MCX) Mumbai, and National Commodity Derivatives Exchange (NCDEX) Mumbai. Initially NCDEX was the largest commodity exchange in India. Subsequently, MCX appeared as the largest commodity derivatives exchange from year 2006-2007 accounting for more than 90% market share in recent years followed by the exchange NCDEX in the commodity derivatives market in India. As the largest commodity exchange in India, the growth of MCX is comparable with some of the international commodity

derivatives exchanges such as Dow Jones AIG Commodity Index (DJAIG) and Reuters/Jefferies Commodity Research Bureau (RJCRB). MCX and NCDEX, together contribute to more than 99% of the market share.

Exchange-wise break up of turnover shows that MCX dominated the value traded in pan-India commodity derivative trading with 94.2% share in the overall turnover, up from the 91.2% share recorded in the year 2018-19. The turnover at MCX was Rs. 86,89,517 crores in 2019-20 as compared to Rs. 67,72,373 crores, a rise of 28.3% share. On the other hand, NCDEX's share decreased to Rs. 4,42,009 crore (4.8% share) from Rs. 5,31,588 crore (7.2% share) recorded during the last year. Though the turnover increased at BSE (41.6%), NSE (84.7%) and ICEX (7.4%) over the previous year, their combined contribution to the aggregate turnover of all exchanges was one per cent.

3.2.4 Share of Major Group of Commodities Traded at the Commodity Exchanges in India

The table 3.69 presents the share of major group of commodity derivatives being traded at the commodity exchanges under the broad group of segments viz., agriculture, bullion, energy and metal.

Table 3.69: Share of Major Group of Commodities Traded in Derivatives Market (Per Cent)

Group	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2010-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20
Agriculture	68.2	35.3	35.8	23.1	11.9	15.7	12.18	12.11	13	16	16.77	17.37	29.77	28.83	28.83	6.3
Metal	—	01	—	—	—	23.2	22.5	15.98	19	17	20.77	22.48	31.44	35.15	22.73	17.1
Energy	0.3	8.4	6.3	12.3	31.4	20.3	19.34	15.74	22	24	26.83	28.93	27.02	22.73	35.15	42.7
Bullion	31.5	56.2	57.9	64.6	56.7	40.8	45.98	56.17	46	43	35.63	31.22	11.77	12.29	12.29	33.5
(Source: FMC & SEBI Annual Reports)																

The above table 3.69 depicts the group wise share of the commodities being traded at derivatives market since the year 2004-2005 to 2019-2020. It is observed that initially when commodity derivatives trading got introduced the major share of trading was from agriculture sector followed by bullion. Subsequently, from the year 2005-2006 onwards till the year 2007-08, major share of trading was from bullion followed by agriculture, and energy sector. The highest percentage share of the commodities traded in the year 2016-17 and 2017-18 was from metal followed by agriculture, energy and bullion. In the year 2018-2019 energy retained the highest share of 35.15% followed by agriculture, metals and bullion. Even though India is an agricultural surplus economy, trading in non-agricultural commodities have dominated derivatives market since the year 2005-06 to 2019-20. In the year 2019-20, non-agricultural commodities accounted for 93.7% of the total turnover of commodity derivatives traded, while the balance 6.3 % was contributed by agricultural commodities.

3.2.5 Turnover of Indian Commodity Exchanges

The following tables represents the turnover of commodity futures at MCX, NCDEX, NMCE, and Regional Commodity Exchanges of India.

Turnover of Commodity Derivatives Futures Traded at MCX since the year 2010-11 to 2019-20

Table 3.70 A: Trends in Commodity Derivatives Futures at MCX

Period	No of Trading days	Agriculture		Metals		Bullion		Energy		Total	
		Volume	Rs. Crore	Volume	Rs. Crore	volume	Rs. Crore	Volume	Rs. Crore	Volume	Rs. Crore
2010-11	307	27,242	1,14,152	1,24,163	25,08,858	710	51,69,268	6,31,870	20,49,224	7,83,986	98,41,502
2011-12	310	32,465	1,97,781	1,18,499	27,09,758	1,011	99,63,667	7,30,401	27,25,889	8,82,377	1,55,97,095
2012-13	305	32,926	2,70,295	1,51,396	31,40,109	723	78,07,063	8,16,378	36,63,589	10,01,423	1,48,81,057
2013-14	310	20,877	1,71,391	85,674	17,26,336	400	42,63,195	4,21,354	24,50,527	5,28,305	86,11,449
2014-15	255	13,504	1,10,268	62,083	12,74,213	240	21,53,427	4,04,556	16,45,799	4,80,383	51,83,707
2015-16	257	13,961	1,21,699	89,331	15,05,004	234	20,70,147	8,07,702	19,37,345	9,11,229	56,34,194
2016-17	260	15,947	1,39,312	93,078	17,53,887	207	20,40,270	6,74,225	19,32,191	7,83,457	58,65,661
2017-18	254	11,648	1,14,082	95,153	21,12,532	164	13,63,703	5,74,029	17,92,678	6,80,995	53,82,996
2018-19	257	9,662	1,01,233	1,11,475	25,25,601	169	15,13,817	6,71,698	24,50,777	7,93,004	65,91,428
2019-20	259	17.89	1,00,919	375.97	15,68,294	508	29,15,534	2,054.81	38,13,027	2,956.9	83,97,775
Source: MCX											

Table 3.70 B: Broad Group-Wise Commodity Futures share in Turnover at MCX

Period	Agriculture	Metals	Bullion	Energy	Total %
2010-11	1.2	25.5	52.5	20.8	100
2011-12	1.3	17.4	63.9	17.5	100
2012-13	1.8	21.1	52.5	24.6	100
2013-14	2.0	20.0	49.5	28.5	100
2014-15	2.1	24.6	41.5	31.7	100
2015-16	2.2	26.7	36.7	34.4	100
2016-17	2.4	29.9	34.8	32.9	100
2017-18	2.1	39.2	25.3	33.3	100
2018-19	1.5	38.3	23.0	37.2	100
2019-20	1.2	18.67	34.72	45.41	100
Source: MCX					

The above tables show the total turnover of commodity futures traded at Multi Commodity Exchange (MCX) and group-wise percentage share in total turnover. In the year 2011-12, the total turnover at MCX increased to Rs. 1,55,97,095 crore compared to Rs. 98,41,502 crores in the previous year, bullion with the highest share of 64% in total turnover. The turnover at MCX was Rs. 86,89,517 crores in the year 2019-20 as compared to Rs. 67,72,373 crores, a rise of 28.3% share. Non- agricultural commodities constitute 98.8% in the total turnover at the MCX in the year 2019-2020.

Turnover of Commodity Derivatives Futures at NCDEX since the year 2010-11 to 2019-20

Table 3.71 A: Trends in Commodity Derivatives Futures at NCDEX

Period	No of Trading days	Agri		Metals		Bullion		Energy		Total	
		Volume	Rs. Crore	Volume	Rs. Crore	volume	Rs. Crore	Volume	Rs. Crore	Volume	Rs. Crore
2010-11	307	3,37,770	11,09,740	8,998	36,761	1.5	70,928	65,316	1,93,173	4,12,084	14,10,602
2011-12	310	3,86,759	16,64,095	4,182	30,422	2.3	29,438	26,570	86,248	4,17,514	18,10,204
2012-13	304	3,47,242	15,57,146	782	8,235	0.1	1,084	8,594	31,960	3,56,617	15,98,426
2013-14	309	2,74,283	11,38,862	3	58	0.1	6,233	257	1,175	2,74,544	11,46,328
2014-15	255	1,94,255	8,70,863	2	7	1.4	32,708	107	485	1,94,365	9,04,063
2015-16	257	2,13,632	9,98,811	0	0	0.6	20,778	0	0	2,13,633	10,19,588
2016-17	260	1,25,082	5,96,530	0	0	1.2	322	0	0	1,25,084	5,96,852
2017-18	248	1,33,172	5,89,499	NA	NA	NA	NA	NA	NA	1,33,172	5,89,499
2018-19	248	1,20,125	5,31,414	NA	NA	NA	NA	NA	NA	1,20,125	5,31,414
2019-20	247	130.80	4,41,967	NA	NA	NA	NA	NA	NA	130.80	4,41,967
Source: NCDEX NA: Not applicable											

Table 3.71 B: Broad Group-Wise Commodity Futures share in Turnover at NCDEX

Period	Agriculture	Metals	Bullion	Energy	Total %
2010-11	78.7	2.6	5.0	13.7	100
2011-12	91.9	1.7	1.6	4.8	100
2012-13	97.4	0.5	0.1	2.0	100
2013-14	99.3	0.01	0.5	0.1	100
2014-15	96.3	0.001	3.6	0.1	100
2015-16	97.9	0.001	2.1	0.0	100
2016-17	99.9	0.0	0.1	0.0	100
2017-18	100.0	NA	NA	NA	100
2018-19	100.0	NA	NA	NA	100
2019-20	100.0	NA	NA	NA	100
Source: NCDEX NA: Not applicable					

Table 3.71 gives the snapshot of volume and value of commodity derivatives being traded at the exchange NCDEX and group- wise commodity futures share in the total turnover. In the year 2011-12 total turnover increased to Rs. 18,10204 as compared to the previous year (Rs. 14,10,602). Thereafter, the total turnover at NCDEX started decreasing. Futures turnover at NCDEX witnessed a fall of 9.9% to Rs. 5,31,414 crores during the year 2018-19 as compared to 1.2% decline in the year 2017-18. NCDEX recorded Rs. 4,41,967 crore turnover in the year 2019-20. The fall in total turnover at NCDEX is due to low trading volume in major agriculture commodities namely Chana, Soya oil, Guar Seed, Soyabean, Gaur gum, etc. It is observed, that at the exchange agriculture has the highest share in the total turnover of 99.9% followed by bullion at 0.1 per cent in the year 2016-17. By the year 2017-18 100% share of commodity derivatives futures was contributed by agriculture commodities.

Turnover of Commodity Derivatives Futures at NMCE since the year 2010-11 to 2019-20

Table 3.72 A: Trends in Commodity Futures at NMCE

Period	No of Trading days	Agriculture		Metals		Bullion		Total	
		Volume	Rs. Crore	Volume	Rs. Crore	volume	Rs. Crore	Volume	Rs. Crore
2010-11	306	27,683	1,29,431	4,666	72,372	1.17	16,608	32,350	2,18,411
2011-12	309	27,852	1,33,636	6,965	1,11,318	0.11	23,396	34,817	2,68,351
2012-13	304	21,016	1,07,012	3,918	63,940	0.02	6,182	24,934	1,77,134
2013-14	310	30,255	1,32,447	827	13,927	0.02	6,445	31,082	1,52,819
2014-15	246	8,334	36,040	NA	NA	NA	NA	8,334	36,040
2015-16	244	6,028	29,368	NA	NA	NA	NA	6,028	29,368
2016-17	247	5,564	28,442	NA	NA	NA	NA	5,564	28,442
2017-18	246	7,512	34,591	NA	NA	NA	NA	7,512	34,591
2018-19	120	3,080	13,675	NA	NA	NA	NA	3,080	13,675

******Consequent upon merger of NMCE with ICEX, all contracts of NMCE were transferred to ICEX w.e.f. September 24, 2018. NA: Not applicable Source:NMCE***

Table 3.72 B: Broad Group-Wise Commodity Futures Share in Turnover at NMCE

Period	Agriculture	Metals	Bullion	Total %
2010-11	59.3	33.1	7.6	100
2011-12	49.8	41.5	8.7	100
2012-13	60.4	36.1	3.5	100
2013-14	86.7	9.1	4.2	100
2014-15	100.0	NA	NA	100
2015-16	100.0	NA	NA	100
2016-17	100.0	NA	NA	100
2017-18	100.0	NA	NA	100
2018-19	100.0	NA	NA	100

Trading at NMCE was discontinued from 24th Sept. 2018 as the Exchange was merged with ICEX. Source: NMCE NA: Not applicable

Table 3.72 A and B presents the volume and value of commodity derivatives futures traded at NMCE and broad group of commodities share in total turnover. At NMCE, the total turnover is contributed entirely by agriculture sector. At NMCE rapeseed/mustard seeds were the most traded agricultural commodities followed by Isabgul seeds. There has been fall in the total turnover over the years at Rs. 13,675 crores in the year 2018-19 as compared to Rs. 2,18,411 crores turnover in the year 2010-11. Trading at NMCE was discontinued in the year 2018 and was merged with ICEX due to fall in the total turnover.

Table 3.73: Turnover of Commodity Futures at Erstwhile Regional Commodity Exchanges (Volume '000 tonnes & Value in ₹ crore)

Period	No. of Trading Days	Volume ('000 tonnes)	Turnover (₹ crore)
Rajkot Commodity Exchange Ltd			
2010-11	295	15,09,735	5,643
2011-12	300	12,63,045	5,221
2012-13	296	20,52,905	7,697
2013-14	297	13,71,080	5,407
2014-15	242	7,70,780	3,163
2015-16	247	3,91,640	1,976
2016-17	164	2,08,085	759
Hapur Commodity Exchange Ltd.			
2013-14	299	27,80,800	9,767
2014-15	240	23,10,512	8,521
2015-16	245	24,73,418	11,190
2016-17	227	17,02,468	7,924
2017-18	185	7,65,968	2,934
Source: SEBI			

Regional commodity exchanges recorded decreasing trends in the derivatives market from the year 2010-11 to 2017-18. At the Rajkot Commodity Exchange, the commodity specific exchange for Castor seed, the total turnover was Rs. 759 crores in the year 2016-17, a drop of 61.6% from Rs. 1,976 crores in the year 2015-16. IPSTA, the commodity specific exchange for black pepper, recorded nil turnover for the year 2016-17 as compared to Rs. 63.1 crores for the year 2015-16. Hapur Commodity Exchange, the commodity specific exchange for Rape/Mustard seed, the total turnover was Rs.2,934 crore for the year 2017-18, lower by 63% from Rs.7,923 crores in previous year. Commodity regional exchanges had to exit derivatives market due to their inability to achieve the minimum net worth norm after merger of the erstwhile regulator the Forward Markets Commission (FMC) with Sebi in September 2015. Trading at Hapur Commodity Exchange discontinued in the year 2018.

Table 3.74: Turnover of Commodity Derivatives Futures at BSE (Volume '000 tonnes & Value in ₹ crore)

Period	No. of Trading days	Agri		Metals		Bullion		Energy		Total	
		Volume	Value	Volume	Value	Volume	Value	Volume	Value	Volume	Value
2018-19	128	0.79	4,719	0.0002	1.0	0.8	28,080	1.1	4.3	2.6	32,804
2019-20	259	6,826	36,316	0	0	0.5	8,837	423	1,247	7,250	46,439
Trading in commodity futures segment at BSE commenced from October 01, 2018. Source: BSE											

Table 3.75: Trends in Commodity Derivative Futures at NSE (Volume '000 tonnes & Value in ₹ crore)

Period	No. of Trading days	Agriculture Metals		Bullion Energy		Total		Open interest	
		Volume	Value	Volume	Value	Volume	Value	Volume (Lots)	Value
2018-19	120	0.15	3,375	0.001	69	0.15	3,444	159	7
2019-20	259	NA	NA	0.66	5,774	0.80	589	1.46	6,362
Trading in Commodity Futures segment commenced at NSE from October 12,2018. Source: BSE NA: Not applicable									

Table 3.76: Product Segment – Wise Percent Share in Commodity Futures Turnover at BSE

Period	Agriculture	Metals	Bullion	Energy	Total %
2018-19	14.4	0.003	85.6	0.013	100
2019-20	6.2	0.1	91.0	2.7	100
Source: BSE					

Table 3.77: Product Segment – Wise Percent Share in Commodity Futures Turnover at NSE

Period	Agriculture	Metals	Bullion	Energy	Total %
2018-19	NA	NA	83	7	100
2019-20	NA	NA	90.8	9.3	100
Source:NSE					

At BSE, trading in commodity derivatives futures segment commenced from October 1st 2018. At BSE trading in non-agricultural commodities accounted for 85.6% (77.5% was contributed by gold futures) to the total turnover, while the remaining 14.4% was contributed by agricultural commodities. Trading in commodity futures segment at NSE commenced from October 12th 2018. At NSE, only non-agriculture commodities were traded during the year. Gold futures accounted for 82.4% share in total turnover of the commodity derivative segment, followed by silver futures and brent crude oil futures.

3.2.6 Number of Commodities Permitted for Derivatives Trading at Commodity Exchanges in India

The table 3.78 highlights the number of commodities permitted for derivatives trading since the year 2010-2011 to 2019-2020

Table 3.78: Exchange-Wise Statistics on Number of Commodities Permitted for Derivatives Trading

MCX						
Period	Futures					Total
	Agriculture	Metals	Bullion	Energy	Gems & Stones	
2010-11	23	8	3	8	NA	42
2011-12	23	8	3	7	NA	41
2012-13	23	8	2	7	NA	40
2013-14	13	6	2	2	NA	23
2014-15	10	5	2	2	NA	19
2015-16	7	5	2	2	NA	16
2016-17	7	5	2	2	NA	16
2017-18	9	6	2	2	NA	19
2018-19	9	6	3	2	NA	20
2019-20	9	5	3	2	NA	19

NCDEX						
Period	Futures					Total
	Agriculture	Metals	Bullion	Energy	Gems & Stones	
2010-11	28	6	3	7	NA	44
2011-12	26	5	4	7	NA	42
2012-13	21	2	2	3	NA	28
2013-14	26	2	2	3	NA	33
2014-15	25	2	2	3	NA	32
2015-16	20	2	2	1	NA	25
2016-17	20	2	2	1	NA	25
2017-18	22	2	1	1	NA	26
2018-19	19	2	1	1	NA	23
2019-20	21	NA	NA	NA	NA	21

NMCE						
Period	**Futures**					**Total**
	Agriculture	**Metals**	**Bullion**	**Energy**	**Gems & Stones**	
2010-11	17	5	2	NA	NA	24
2011-12	21	5	2	NA	NA	28
2012-13	14	5	2	NA	NA	21
2013-14	14	5	1	NA	NA	20
2014-15	14	NA	NA	NA	NA	14
2015-16	13	NA	NA	NA	NA	13
2016-17	13	NA	NA	NA	NA	13
2017-18	0	NA	NA	NA	NA	0
2018-19	11	NA	NA	NA	NA	11

Regional Exchange - Rajkot Commodity Exchange Ltd. (exited in Jan 2018)						
Period	**Futures**					**Total**
	Agriculture	**Metals**	**Bullion**	**Energy**	**Gems & Stones**	
2010-11	1	NA	NA	NA	NA	1
2011-12	1	NA	NA	NA	NA	1
2012-13	1	NA	NA	NA	NA	1
2013-14	1	NA	NA	NA	NA	1
2014-15	1	NA	NA	NA	NA	1
2015-16	1	NA	NA	NA	NA	1
2016-17*	1	NA	NA	NA	NA	1
2017-18	NA	NA	NA	NA	NA	0
2018-19	NA	NA	NA	NA	NA	0

Regional Exchange - Hapur Commodity Exchange Ltd. (exited in June 2018)						
Period	**Futures**					**Total**
	Agriculture	**Metals**	**Bullion**	**Energy**	**Gems & Stones**	
2010-11	1	NA	NA	NA	NA	1
2011-12	1	NA	NA	NA	NA	1
2012-13	1	NA	NA	NA	NA	1
2013-14	1	NA	NA	NA	NA	1
2014-15	1	NA	NA	NA	NA	1
2015-16	1	NA	NA	NA	NA	1
2016-17	1	NA	NA	NA	NA	1
2017-18	NA	NA	NA	NA	NA	0
2018-19	NA	NA	NA	NA	NA	0

ICEX						
Period	**Futures**					**Total**
	Agriculture	**Metals**	**Bullion**	**Energy**	**Gems & Stones**	
2010-11	5	3	4	2	NA	14
2011-12	4	3	4	2	NA	13
2012-13	3	3	4	2	NA	12
2013-14	4	3	4	2	NA	13
2014-15	NA	NA	NA	NA	NA	0
2015-16	NA	NA	NA	NA	NA	0
2016-17	NA	NA	NA	NA	NA	0
2017-18	NA	NA	NA	NA	1	1
2018-19	12	1	NA	NA	1	14
2019-20	10	1	NA	NA	1	12

BSE						
Period	**Futures**					**Total**
	Agriculture	**Metals**	**Bullion**	**Energy**	**Gems & Stones**	
2018-19	3	1	2	1	NA	7
2019-20	7	1	2	1	NA	14

NSE						
Period	**Futures**					**Total**
	Agriculture	**Metals**	**Bullion**	**Energy**	**Gems & Stones**	
2018-19	NA	1	2	1	NA	4
2019-20	NA	0	2	1	NA	3
Source: MCX, NCDEX, ICEX, BSE, NSE						

The above table 3.78 shows the number of commodities permitted at commodity exchanges in India. Over the years, the total number of permitted commodities has declined at the Indian commodity exchanges. The total number of permitted commodities at the exchange MCX for the year 2010-11 was 42. Gradually, the total number of permitted commodities declined to 19 in the year 2019-20. While, total number of commodities traded at NCDEX was 44 during the year 2010-11 as compared to 21 in the year 2019-20.

NMCE, one of the first commodity derivatives exchanges, was merged with ICEX in the year 2018-19. Post-merger, all the agricultural commodity contracts traded at NMCE were migrated to the ICEX platform, leading to significant surge in number of permitted as well as traded commodities at the exchange ICEX. At BSE, both agricultural as well as non-agricultural commodities are permitted to trade, NSE provides trading in only non-agricultural commodities.

3.2.7 Trends in MCXCOMDEX and NCDEX Nkrishi Index since the year 2010-11 to 2019-20

Table 3.79 provides a snapshot of the trends in MCXCOMDEX and NCDEX Nkrishi Index

Table 3.79: Trends in MCXCOMDEX and NCDEX Nkrishi Index

Period	MCXCOMDEX Index				NKrishi Index (Earlier known as NCDEX Dhaanya)			
	High	Low	Close	Daily Volatility (%)	High	Low	Close	Daily Volatility %)
2010-11	3,603	2,567	3,504	0.71	1,189	987	1,106	0.71
2011-12	4,006	3,286	3,926	0.92	2,404	1,102	2,357	0.82
2012-13	4,069	3,578	3,789	0.60	2,906	2,307	2,352	0.77
2013-14	4,799	3,352	3,925	0.93	2,627	2,120	2,602	0.66
2014-15	4,046	2,775	2,915	0.80	2,785	2,379	2,479	0.69
2015-16	3,290	2,447	2,731	0.95	3,043	2,479	2,861	0.79
2016-17	3,435	2,674	3,243	0.73	3,412	2,869	3,081	0.60
2017-18	3,730	2,966	3,663	0.61	3,205	2,795	3,037	0.69
2018-19	4,172	3,312	3,739	0.84	3,590	2,838	3,414	0.81
2019-20	10,951	7,663	8,256	1.0	3,674	2,841	3,180	0.8

Note: Volatility is calculated as standard deviation of natural log of daily return in the Index for the respective period; Source: MCX, NCDEX

The broad performance of the Indian commodity derivatives market can be determined from the movement of the benchmark indices namely MCXCOMDEX and NCDEX NKrishi. MCXCOMDEX is a composite index of three subindices i.e., MCX Energy, MCX Metal and MCX Agricultural indices, NCDEX Dhaanya is represented by ten agricultural commodities. During the year 2015-16, MCXCOMDEX decreased to 6.3% and NCDEX Dhaanya gained 15.3%. Volatility, in annualized terms, declined for both the indices during the year 2016-17. The annualized volatility was 10.6% for NCDEX Dhaanya and 11.7% for MCXCOMDEX for the year 2016-17 as compared to 12.7% and 15.3% respectively in the year 2015-16.

The benchmark commodity indices namely MCXCOMDEX and NKrishi Index (earlier known as Dhaanya Index), recorded growth in the year 2018-19. MCX COMDEX, which is a composite index representing metal, agriculture and energy, moved up by 2.1%, while, the NKrishi - the agricultural commodity index, increased by 12.4% during the year. An increase in MCXCOMDEX was because of rise in MCXMETAL (3.4%) and MCXAGRI (2%). During the year 2018-19, NKrishi Index moved up for 7 out of 10 commodities namely Chana, Barley, Castor Seed, Cotton, Cotton Seed Oilcake, Guar Seed, Coriander. An upward movement by these grains was partially offset by decreasing trend in soybean, Turmeric, Rape/Mustard Seed during the year. The annualised volatility for MCX COMDEX for the year 2018-19 was 13.4% as compared to 9.8% for the previous year. As regards NKrishi Index, the annualised volatility moved up to 12.9 % during the year, as compared to 10.9% in the year 2017-18.

3.2.8 Share of Participants in Commodity Derivatives Market

Table 3.80 presents share of market participants in total turnover of commodity derivatives market.

Table 3.80: Participant-Wise Percentage Share in Total Turnover of Commodity Futures

MCX						
Period	Futures Turnover (Percentage Share)					
	Agriculture Commodities			Non-Agriculture Commodities		
	Proprietary	Client	Hedgers	Proprietary	Client	Hedgers
2010-11	35.3	64.7	0.0	50.7	49.3	0.0
2011-12	37.2	62.8	0.0	45.8	54.2	0.0
2012-13	43.3	56.7	0.0	42.8	57.2	0.0
2013-14	39.8	60.2	0.0	33.0	67.0	0.0
2014-15	41.6	58.4	0.0	33.0	67.0	0.0
2015-16	44.9	55.1	0.0	23.4	76.6	0.0
2016-17	35.3	64.7	0.0	19.6	80.4	0.0
2017-18	35.4	64.6	0.0	20.6	79.4	0.0
2018-19	38.2	61.8	0.0	27.6	72.4	0.0
2019-20	38.3	61.7	0.0	36.9	63.1	0.0
Source: MCX						

NCDEX						
Period	Futures Turnover (Percentage Share)					
	Agriculture Commodities			Non-Agriculture Commodities		
	Proprietary	Client	Hedgers	Proprietary	Client	Hedgers
2010-11	35.7	63.9	0.4	92.4	7.6	0.0
2011-12	37.6	62.1	0.3	84.9	15.1	0.0
2012-13	42.3	57.2	0.5	92.3	7.7	0.0
2013-14	41.3	58.1	0.5	57.7	42.3	0.0
2014-15	46.2	53.1	0.7	74.0	26.0	0.0
2015-16	49.2	50.5	0.3	79.3	20.7	0.0
2016-17	41.6	58.2	0.3	73.6	26.4	0.0
2017-18	41.0	58.8	0.2	Na	Na	0.0
2018-19	44.1	55.5	0.4	Na	Na	0.0
2019-20	46.9	52.3	0.8	Na	Na	0.0
Source: NCDEX						

NMCE						
Period	Futures Turnover (Percentage Share)					
	Agriculture Commodities			Non-Agriculture Commodities		
	Proprietary	Client	Hedgers	Proprietary	Client	Hedgers
2010-11	16.5	83.5	0.0	21.7	78.3	0.0
2011-12	5.2	94.8	0.0	7.7	92.3	0.0
2012-13	5.8	94.2	0.0	6.0	94.0	0.0
2013-14	5.3	94.7	0.0	5.7	94.3	0.0
2014-15	5.9	94.1	Na	Na	Na	Na
2015-16	4.0	96.0	Na	Na	Na	Na
2016-17	4.9	95.1	Na	Na	Na	Na
2017-18	2.1	97.9	Na	Na	Na	Na
Source: NMCE						

ICEX						
Period	Futures Turnover (Percentage Share)					
	Agriculture Commodities			Non-Agriculture Commodities		
	Proprietary	Client	Hedgers	Proprietary	Client	Hedgers
2010-11	57.1	42.9	0.0	79.6	20.4	0.0
2011-12	74.5	25.5	0.0	88.9	11.1	0.0
2012-13	28.0	47.0	0.0	43.0	57.0	0.0
2013-14	43.9	56.1	0.0	29.6	70.4	0.0
2017-18	Na	Na	0.0	64.5	35.5	0.0
2018-19	19.0	81.0	0.0	58.3	41.7	0.0
2019-20	56.3	43.7	0.0	70.5	29.4	0.0
Source: ICEX						

BSE						
Period	**Futures Turnover (Percentage Share)**					
	Agriculture Commodities			**Non-Agriculture Commodities**		
	Proprietary	**Client**	**Hedgers**	**Proprietary**	**Client**	**Hedgers**
2018-19	**NA**	**NA**	**0.0**	**93.0**	**7.0**	**0.0**
2019-20	**65.5**	**34.5**	**0.0**	**82.1**	**17.9**	**0.0**
Source: BSE						

NSE						
Period	**Futures Turnover (Percentage Share)**					
	Agriculture Commodities			**Non-Agriculture Commodities**		
	Proprietary	**Client**	**Hedgers**	**Proprietary**	**Client**	**Hedgers**
2018-19	**83.9**	**16.1**	**0.0**	**18.9**	**81.1**	**0.0**
2019-20	**0.0**	**0.0**	**0.0**	**45.3**	**54.7**	**0.0**
Source: MCX, NCDEX, NMCE, ICEX, BSE, NSE; NA: Not Applicable						

At MCX, majority of the turnover was reported by client trades in agricultural segment as well as non- agricultural segment followed by proprietary trades. NCDEX recorded higher client turnover in agricultural segment whereas, proprietary trades contributed high turnover in non-agricultural segment. At NMCE, more than 90% of the turnover was from the client and the rest was from proprietary trades for agriculture segment. ICEX also recorded higher client turnover in agricultural segment (92.8%) as well as non-agricultural segment. At BSE and NSE, majority of the turnover was reported by proprietary trades. During the year, BSE recorded 93%, while NSE accounted for 82.1% of turnover from proprietary trade.

3.2.9 Top Ten Futures Contracts Traded in Derivatives Market

Following is the list of top ten agricultural commodities traded in the derivatives market for the financial year 2019-20

Table 3.81: Top Ten Agricultural Commodities Traded in the Year 2019-20

Name of the Commodity	Annual Traded Volume ('000 tonnes)	No. of Contracts Traded	Annual Turnover in Futures and Options (Crore)	Share in Total Agri Turnover of all Exchanges (%)
Guar Seed	**21,366**	**3,746**	**89,418**	**15.3**
Soybean	**16,031**	**3,191**	**62,614**	**10.7**
Castorseed	**11,138**	**2,219**	**60,420**	**10.3**
Refined Soy Oil	**7,463**	**1,493**	**60,032**	**10.3**
CPO	**8,159**	**816**	**60,032**	**8.99**
Cotton	**3,984**	**962**	**48,228**	**8.25**
Chana	**11,069**	**1,107**	**47,914**	**8.2**
Cotton seed oil cake	**16,807**	**1,681**	**39,604**	**6.77**
Guar Gum	**4,923**	**985**	**38,602**	**6.6**
RM seed	**6,651**	**665**	**26,875**	**4.6**
Total	**1,07,591**	**16,864**	**5,26,240**	**90**
Source: SEBI Annual Report 2019-2020				

At present, agricultural futures contracts are available for trading at MCX, NCDEX, ICEX and BSE while non-agricultural commodity derivatives are traded at MCX, ICEX, BSE and NSE. At the exchange level, contribution of agricultural derivatives contracts was Rs. 4,42,009 crores by NCDEX which is 75.6% of total agricultural derivatives turnover of Rs. 5,84,598 crores across all the exchanges. MCX recorded a turnover of Rs. 1,00,919 crores in agricultural futures contracts, a share of 17.3%. It was followed by BSE and ICEX whose contribution was 6.2% and 0.9% respectively. Agricultural commodity futures turnover at ICEX recorded significant decrease of 63.8% over previous year’s combined turnover of ICEX and erstwhile NMCE. Out of 25 commodities/their variants traded on exchange platforms, the top ten agricultural commodities together contributed 90% to overall agricultural derivatives turnover in the year 2019-20. The guar seed futures contracts had the highest share of 15.3% in overall turnover, followed by Soybean (10.7%), Castor Seed (10.3%), Refined Soy Oil (10.3%) and Crude Palm Oil (9.0%)

The list of top ten non- agricultural futures contracts traded for the financial year 2019-20 is as follows.

Table 3.82: Top Ten Non-Agricultural Commodities traded in the Financial Year 2019-2020

Name of the Commodity	Annual Traded Volume ('000 tonnes)	No. of Contracts Traded	Share in Total Non-Agri turnover of all Exchanges (%)
Gold	**14,229**	**19,33,267**	**22.4**
Silver	**37,238**	**11,61,531**	**13.4**
Sub Total (Bullion)	**51,467**	**30,94,799**	**35.8**
Crude Oil	**185,378**	**34,80,260**	**40.3**
Natural Gas	**23,337**	**4,59,428**	**5.3**
Sub-total (Energy)	**208,715**	**39,39,688**	**45.6**
Copper	**7,794**	**4,55,993**	**5.3**
Zinc	**11,357**	**4,47,145**	**5.2**
Nickel	**10,154**	**4,21,941**	**4.9**
Lead	**5,417**	**1,71,198**	**2**
Aluminium	**2,906**	**74,321**	**0.9**
Steel	**245**	**7,438**	**0.1**
Sub-Total (Metals)	**37,874**	**15,78,035**	**18.3**
Diamonds (Gems & Stones)	**78,395**	**27,720**	**0.3**
Total	**3,76,451 8**	**86,40,241**	**100**
Source: SEBI Annual Report 2019-2020			

During the year 2019-20, there were total top eleven non-agricultural commodities on which derivatives products were traded. Among exchanges, MCX had both futures and ‘options on futures’ contracts while BSE, ICEX and NSE offered only futures contracts. The non-agricultural segment (futures and options of all exchanges) turnover of Rs. 86,40,241 crores accounted for 93.7% of total turnover of Rs. 92,24,839 crores during the year 2019-20, up from 91.2% in previous year. At exchange level, MCX solely accounted for 99.4% share in non-agricultural commodity derivatives turnover. Of the non-agricultural turnover, the share of energy segment accounted for 45.6%, followed by bullion (35.8%), metals (18.3%) and Gems & Stones (0.3%). At commodity level, crude oil contracts accounted for 40.3% of non-agricultural turnover, followed by gold (22.4%), Silver (13.4%).

3.4 Conclusion

The current chapter focuses on understanding the market structure and progressive growth in commodity markets which has witnessed a notable change over the past decade. The last decade has witnessed innumerable developments in the commodity derivative trading in India. There has been tremendous change in the volume of trade as well as value of trade. Indian commodity markets have undergone enormous restructuring and transformation because of core reforms initiated in the year 2003.

Broadly, the commodities market exists in two forms in India, the Over-The-Counter (OTC) Market and the Exchange-Based Market (Derivatives Market). Spot markets are essentially OTC markets and participation is restricted to people who are involved with that commodity, such as the farmer, processor and wholesaler. A majority of the derivatives trading takes place through the exchange-based markets with standardized contracts and settlements. A proper hierarchal structural system with regulators has been created for commodity trading in India. It contains three- tier structure of trading functions. The Indian Commodity Market can be divided into three layers to control the functioning of the commodity market in India. First and the top most layer consist of the Government of India (Ministry of Consumer Affairs), second layer or the middle layer consist of Forward Market Commission (FMC) which is now merged with SEBI (Securities and Exchange Board of India) and third layer consists of Commodity Exchanges.

The commodity derivatives futures traded in commodity exchanges was regulated by the Government under Forward Contracts Regulations Act, 1952 and the rules framed there under. The regulator for the commodities trading was the FMC up to the year 2015, which was merged with the capital market regulator SEBI. Presently SEBI is controlling and managing all futures market trading activities along with the investor's protection measures.

To strengthen the market and deepen the activities, SEBI has recently permitted option trading in commodities.

India is one of the top producers of a large number of commodities, and also has a long history of trading in commodities and related derivatives. The volume of trade in commodity futures has grown sharply over the past decade as well as prices of commodities have increased simultaneously. Commodity markets in India witnessed a remarkable change in the past decade. While one can notice a phenomenal growth in initial years of establishment of national exchanges up to 2005-06, a stable growth is recorded averaging to 40% per annum up to 2011-12. There is a sudden decline in volumes and trade transactions since 2013-14 which is often attributed to the introduction of Commodity Transaction Tax on non - agricultural futures transactions and a major scam noticed in the functioning of National Spot Exchange Ltd., (NSEL) in July, 2013. The mega fraud of NSEL has sent shock waves across derivatives exchanges indicating the poor regulatory infrastructure of commodity markets. The loss of confidence of traders and investors ultimately resulted in sharp decline in total transactions and accordingly the quantity of total transaction and value of futures transactions reported a rise and fall. The NSEL failure made FMC to function under the control of Ministry of Finance from the Ministry of Consumer Affairs. Govt. of India and subsequently led to merger of FMC with SEBI in the year 2015.

The popularity of derivative securities can be gauged from the data of an increase in the total turnover of major commodity exchange MCX and NCDEX. There are two exchanges that dominate the commodity derivatives market in India, the MCX and the NCDEX, while both the exchanges trade all types of commodities, the MCX is more renowned for the trading of non-agricultural commodities, while the NCDEX is more renowned for the trading of agricultural commodities. In the year 2019-2020, MCX derivatives trade comprises of 98.8% share in non-agricultural commodities. At NCDEX, 100% share was accounted by agricultural commodities. In 2017, MCX introduced commodity options contract by launching gold options, since then, the exchange has expanded its options universe and now includes copper, crude oil, zinc and silver contracts. NCDEX started options trading in the year 2018, announcing the launch of option contract in Gur seed futures, a commodity which contributes to over a fifth of the exchange total annual turnover.

The values depict that turnover in NCDEX has decreased manifolds from Rs. 14,10,602 crores to Rs. 4,41,967 crores in the time period of ten years whereas the trading volume has registered uptrend in the turnover of MCX. MCX is presently the largest commodity derivatives exchange in India in terms of trading volumes. With regard to the trading pattern, though there are more than 100 commodities being traded at MCX, but only four commodities contribute to more than 80% of total trade volume. The major traded commodities at MCX are gold, silver and crude oil. Among the agricultural commodities being traded the major volume is contributed by Gur Seed, Soyabean, Castor seed, Refined Soya oil, CPO and Cotton, whose market size is considerably small making them exposed to market manipulations.

The share of agricultural commodities which was recorded the highest with 70% in 2004-05 in the first year of introduction of commodity trading in India, has gradually declined to 30% in the year 2018-19. On the other hand, the share of non -agricultural commodities gradually rose from 30% to 70% over the years with a dominating role of Energy (35%) and Metal (23%). In the year 2019-20, non-agricultural commodities accounted for 93.7% of the total turnover of commodity derivatives traded, while the balance 6.3 % was contributed by agricultural commodities. Analysis of volume contributions on the major national commodity derivatives exchanges revealed that majority of the trade has been concentrated in few commodities and major volume has been contributed by non -agricultural commodities namely bullion, energy and metals. Agricultural commodities have small market size in commodities like Gur Seed, Soyabean, Castor Seed, CPO, Cotton, Channa etc. There is no wide spread involvement of all the stake holders in the commodity derivatives markets. The actual benefits of commodity derivatives could have been achieved only when all the stake holders in commodity derivatives market including consumers, traders and producers trade actively in all the major commodities.

CHAPTER IV

EFFECTIVENESS OF COMMODITY DERIVATIVES MARKET IN PRICE DISCOVERY

4.1 Introduction

Price discovery is a primary function of the derivatives market. It is the disclosing of information about the future spot market prices through the derivatives futures market. In other words, it refers to the use of futures price for forecasting spot market transactions. The significance of price discovery is dependent on a close relationship among spot and futures price. The level to which the futures market performs this function well can be measured from the causal relation between spot and futures price. If information is first reflected in the futures price and subsequently in the spot price (futures price should lead spot price) which indicate that the futures market performs the function of price discovery.

Evans (1978); Working (1962) stated that price discovery and risk management are the two major contributions of derivative market to the organisation of economic activity. (Gardbade & Silber, 1983; Working, 1948) Risk transfer denotes to hedgers using derivatives contracts to transfer price risk to other instruments in the market. Price discovery refers to use of futures prices for pricing spot market transactions.

Schreiber & Schwartz (1986); working (1948) Price discovery is the process where information is formed and transmitted across the markets and the market price reach at equilibrium level. It also offers information to all the market participants. The significance of both these contributions depends upon a close relationship among the prices of (spot) commodities and futures contracts. When the two markets for the same asset are faced with the similar information arriving simultaneously, the two markets should react in a similar manner and at the same time. If the two markets do not react simultaneously then one market will lead the other market. When such a lead- lag relation occurs in the case of price adjustments, the leading market is regarded as contributing to the price discovery function (Bose, 2008).

Zhong, Darrat, & Otero (2004) stated that under efficient markets, new information is reflected simultaneously into the futures and spot market. In other words, financial market pricing theory states that market efficiency is a function of how quick and how much the information is reflected in market prices. (Zapata, Fortenbery and Armstrong, 2005) according to the authors, the frequency at which prices display market information is the rate at which this information is disseminated to the market participants. In reality, institutional factors such as transaction costs, liquidity and other market restrictions may produce lead- lag relationship between price fluctuation in the two markets. The markets that provide less trading cost and more liquidity as advocated by Fleming, Ostdiek, and Whaley (1996) is expected to play a more important role in price discovery. The price discovery between spot and futures price series occurs either in unidirectional way or bi-directional way, depending on the market under study.

Futures market should be able to generate prices that express future expectations on spot prices, and should be able to transmit that information effectively across the market (Tomek,1980; Working,1948). The essence of the price discovery function of future markets depends on whether new information is reflected first in changed spot price or in changed futures prices (Hoffman,1931). Effective price discovery requires the direct participation by several players in the commodity markets namely farmers, producers, wholesalers, intermediaries, consumers, investors, etc. In India, the majority of farmers primarily produce mainly for consumption, and so do not generally participate in commodity markets. Commodity markets in India are generally dominated by speculating brokers and traders. In fact, often trading in futures market is banned because price become too speculative (Nath

& Lingareddy, 2008). Function of price discovery also depends on physical market infrastructure, storage costs, handling costs, tax rates, transportation cost and other factors. The poor flow of information would be expected to affect the price discovery function.

Several theoretical arguments relating to the causal relationship among spot and futures markets are given below. Four alternative situations may arise:

1. Futures prices tend to influence (lead) spot prices.
2. Spot prices tend to lead futures prices.
3. Bidirectional feedback (causality) relationship exists between spot and futures prices.
4. No causal relationship.

The focus of the study is to determine whether the spot market leads the futures market or vice versa or whether bidirectional causality exists among the two markets. The existence of lead-lag relationship may indicate how well the two markets are associated with each other. It also provides information on how quickly one market reacts to the new information from the other market. This information is vital for the investors in their decision-making process.

If both the markets are equally efficient in disseminating information, then spot and futures prices will move together. However, if one market is faster in disseminating information than the other market then a lead-lag relationship will exist between them. The first objective of the study is to examine the causal relationship between the spot and the futures markets. The causal relationship is tested in the current chapter.

4.2 Empirical Results and Discussion

The purpose of this chapter is to analyse the causal relationship among spot close price and futures close price of twelve commodities and four market indices from the exchange Multi

Commodity Exchange (MCX). The study has considered commodities from the exchange MCX, as it is one of the largest commodity exchanges in India. In this study four market indices representing different sectors (MCXCOMDEX, MCXAGRI, MCXMETAL, MCXENERGY), four agricultural commodities (Cardamom, Cotton, Crude Palm Oil and Mentha Oil), four Base metals (Aluminium, Copper, Nickel and Lead), two commodities from Energy (Crude Oil and Natural Gas) and two commodities from bullion (Gold and Silver) are selected. Data ranging from 1st January 2009 to 31st December 2020 is analysed. For each price series Descriptive Statistics and Unit Root Test (Augmented Dickey Fuller) are performed to check the data structure and normality in order to proceed for further testing and apply econometric models such as Johansen's Co-integration Test, Granger Causality Test, Vector Error Correction Model (VECM).

For each commodity, three types of contracts are usually traded simultaneously. Near month contract, mid-month contract and far month contract. (Garbade and Silber, 1983) stated that the prices of near month contract can objectively be used as an efficient predictor of the spot prices, provided that the value of basis on the maturity date of one month contract becomes Zero. The daily data on near month contract is used to represent the commodity future price for the whole period. The well-known justification behind the use of near month contract is that it is the most actively traded contract. The more actively traded an instrument is, more is the information contained in its price. A near month contract constantly displays more trading volume than those contracts of other maturities. A contract becomes "nearby" at the beginning of the previous contract's expiration month, thereby avoiding the often-noted expiration effect.

The study analyses the near-month contracts because these are highly liquid and the most active contracts. The near-month futures time series is prepared based on a rolling basis. The daily closing prices of futures and spot of sample commodities have been transformed into

‘Natural Logarithm, that is, ***ln*** of daily closing prices’ to reduce the heteroscedasticity in data. Daily Returns on all the sample commodities, both in futures and spot markets, are computed as continuously compounded return, i.e., natural logarithmic differences of lagged price series.

4.2.1 Spot and Futures Price Co-Movement of Commodities

Price discovery is a fundamental function of the futures market. It is the revealing of information about future spot market prices through the futures market and refers to the use of futures price for predicting spot market transactions. The significance of price discovery depends upon a close relationship between futures and spot price. The extent to which future market performs this function well can be measured from the temporal relation between futures and spot price. If information is reflected first in futures price and subsequently in spot price, futures price should lead spot price, indicating that the futures market performs the price discovery function. To assess the relationship between spot and future prices of commodities, graphical representation of the spot and future prices is one of the ways to give an indication of the direction of relationship between them. The following is the graphical representation of data. The daily closing prices of spot and futures of twelve commodities namely Cardamom, Cotton, Mentha Oil, CPO, Aluminium, Copper, Lead, Nickel, Crude Oil, Natural Gas, Gold and Silver are used for the study. The graphical representation of data also helps to identify whether the data series are stationary or not. Here the x axis represents the year and y axis represents the prices of commodities.

Figure 4. 1: Spot and Futures Price Movement of Cardamom from MCX (1st Jan. 2009- 31st December 2020)

Source: Author's Compilation

Daily spot price of Cardamom and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. At the starting of the graph, we can observe huge gaps between the spot and the futures prices and throughout the graph there is some difference between the same. This states that hedging effectiveness would not be very high and there is basis risk involved.

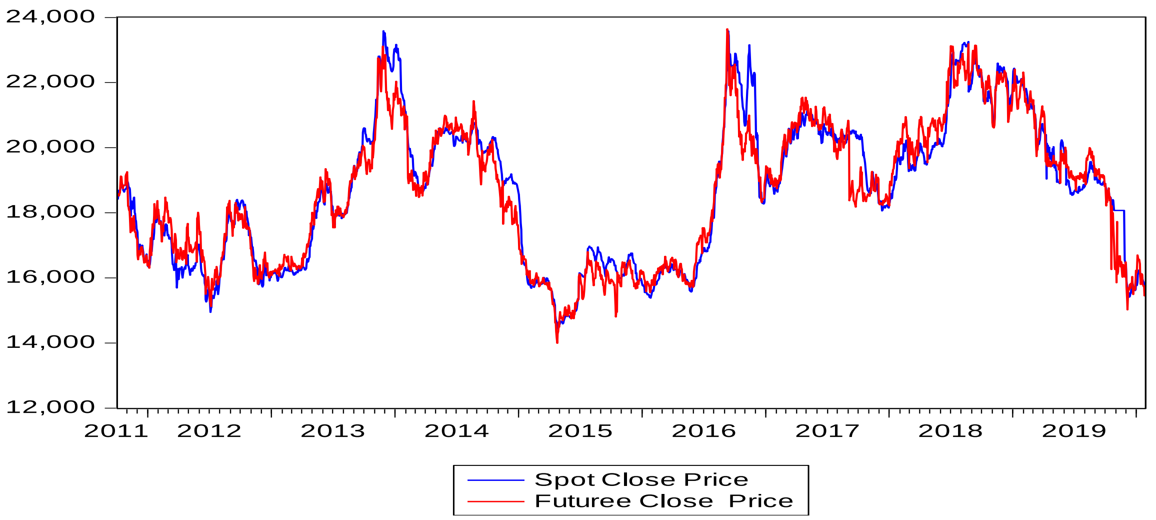


Figure 4.2: Spot and Futures Price Movement of Cotton from MCX (1st January 2009- 31st December 2020)

Source: Author's Compilation

Daily spot price of Cotton and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. Though there is large observation, the spot and futures prices do not move very close to each other stating that there may be a basis risk involved which can lead to lower hedging effectiveness.

Figure 4.3: Spot and Futures Price Movement of Crude Palm Oil (CPO) from MCX (1st January 2009-31st December 2020)

Source: Author's Compilation

Daily spot price of CPO and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. From the graph, it is observed that the spot and the futures prices move very close to each other during the study period.

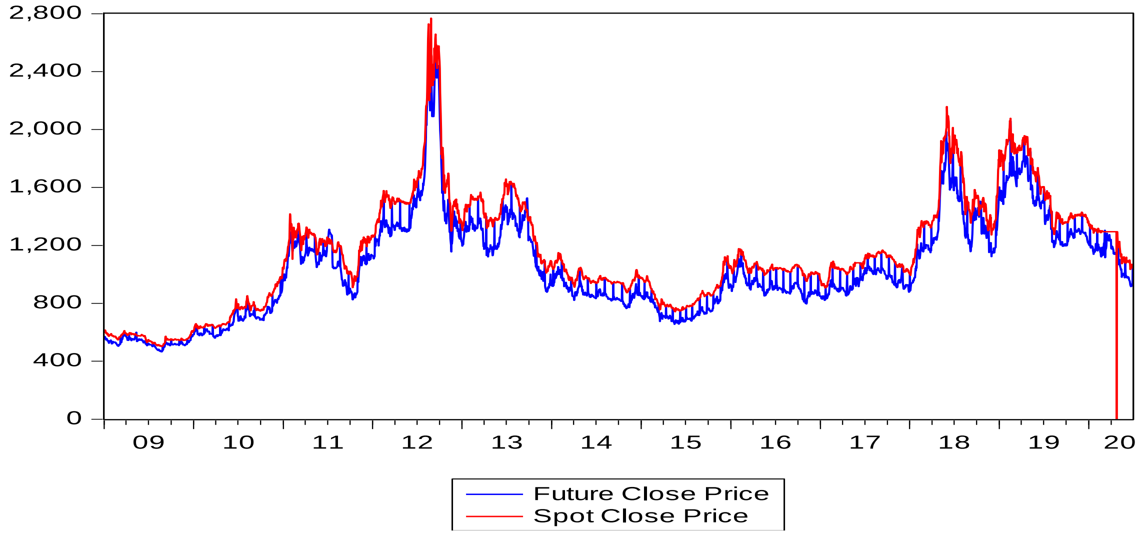


Figure 4.4: Spot and Futures Price Movement of Mentha Oil from MCX (1st January 2009- 31st December 2020)

Source: Author's Compilation

Daily spot price of Mentha Oil and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. At the starting of the graph, we can observe huge gaps between the spot and futures prices and throughout the graph there is some difference between the same. This states that the hedging effectiveness would not be very high and there is basis risk involved.

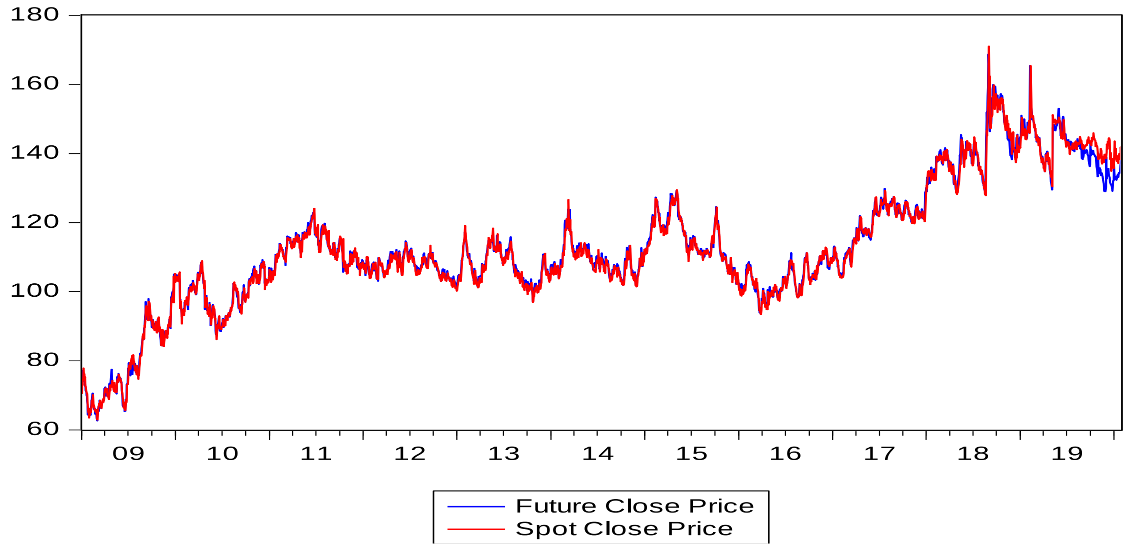


Figure 4.5: Spot and Futures Price Movement of Aluminium from MCX (1st January 2009 to 31st December 2020)

Source: Author's Compilation

Daily spot price of Aluminium and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. From the graph, it is observed that the spot and the futures prices move very close to each other during the study period, but at the end of the graph we find that futures prices and spot prices are not moving together. This may lead to lower hedging effectiveness.

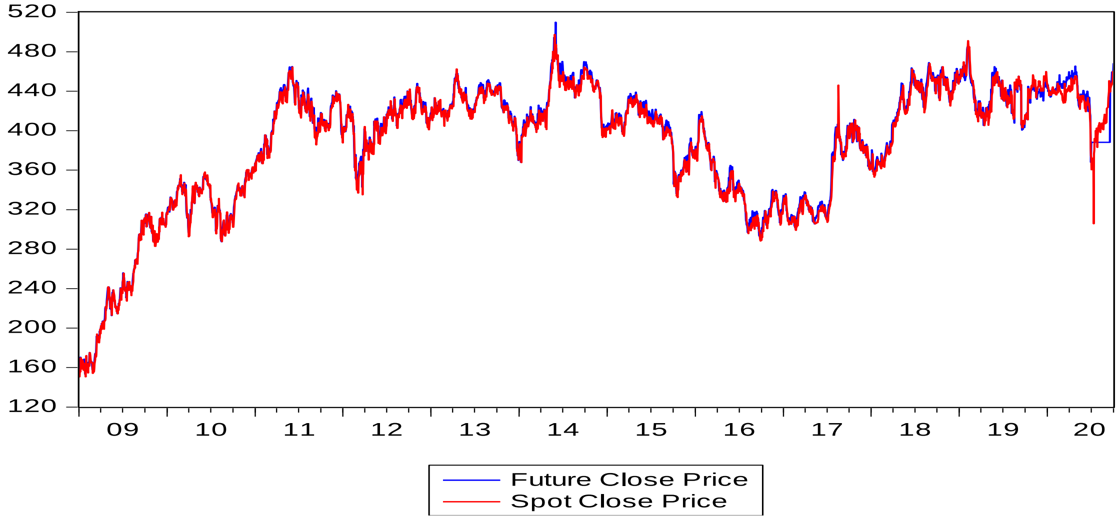


Figure 4.6: Spot and Futures Price Movement of Copper from MCX (1st January 2009 to 31st December 2020)

Source: Author's Compilation

Daily spot price of Copper and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. The spot and futures prices move very close to each other, except in the year 2020 where spot price is much lower than the future price.

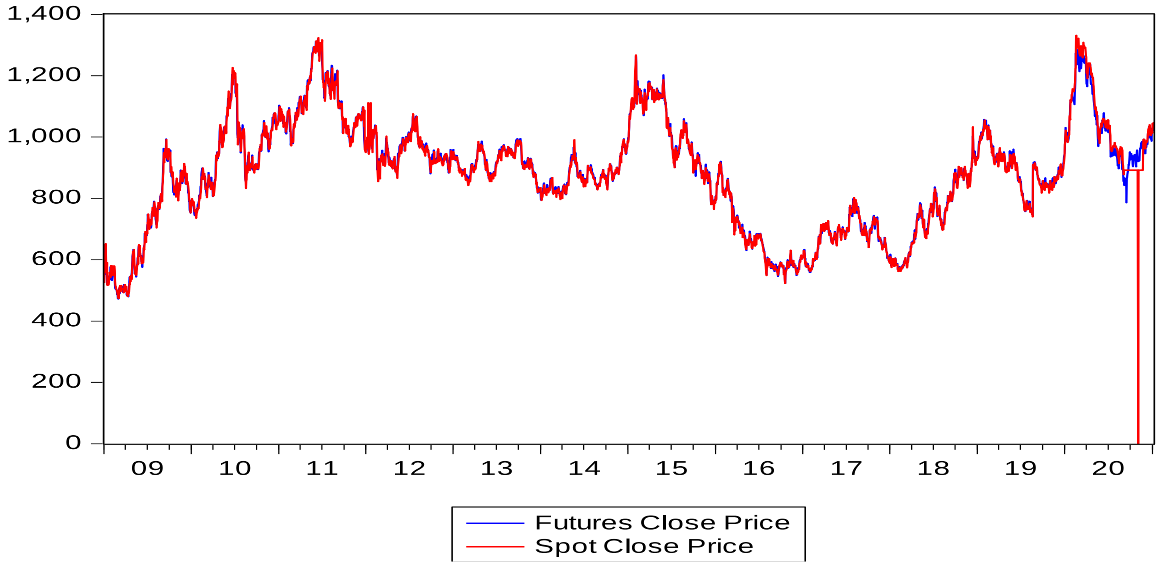


Figure 4.7: Spot and Futures Price Movement of Nickel from MCX (1st January 2009 to 31st December 2020)

Source: Author's Compilation

Daily spot price of Nickel and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. From the graph, it is observed that the spot and the futures prices move very close to each other during the study period, but at the end of the graph we find that futures prices and spot prices are not moving together. This may lead to lower hedging effectiveness.

Figure 4.8: Spot and Futures Price Movement of Lead from MCX (1st January 2009 to 31st December 2020)

Source: Author's Compilation

Daily spot price of Lead and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. From the graph, it is observed that the spot and the futures prices move very close to each during the study period, but at the end of the graph we find that futures prices and spot prices are not moving together. This may lead to lower hedging effectiveness

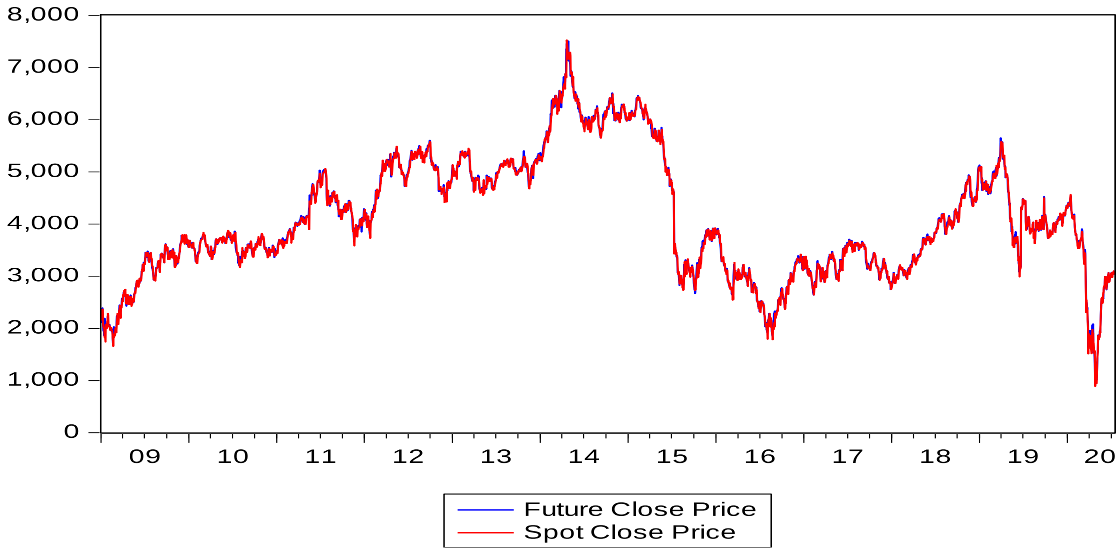


Figure 4.9: Spot and Futures Price Movement of Crude Oil from MCX (1st January 2009 to 31st December 2020)

Source: Author's Compilation

Daily spot price of Crude Oil and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. From the graph, it is observed that the spot and the futures prices move very close to each other throughout the sample period.

Figure 4.10: Spot and Futures Price Movement of Natural Gas from MCX (1st January 2009 to 31st December 2020)

Source: Author's Compilation

Daily spot price of Natural Gas and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. From the graph, it is observed that the spot and the futures prices move very close to each other throughout the sample period.

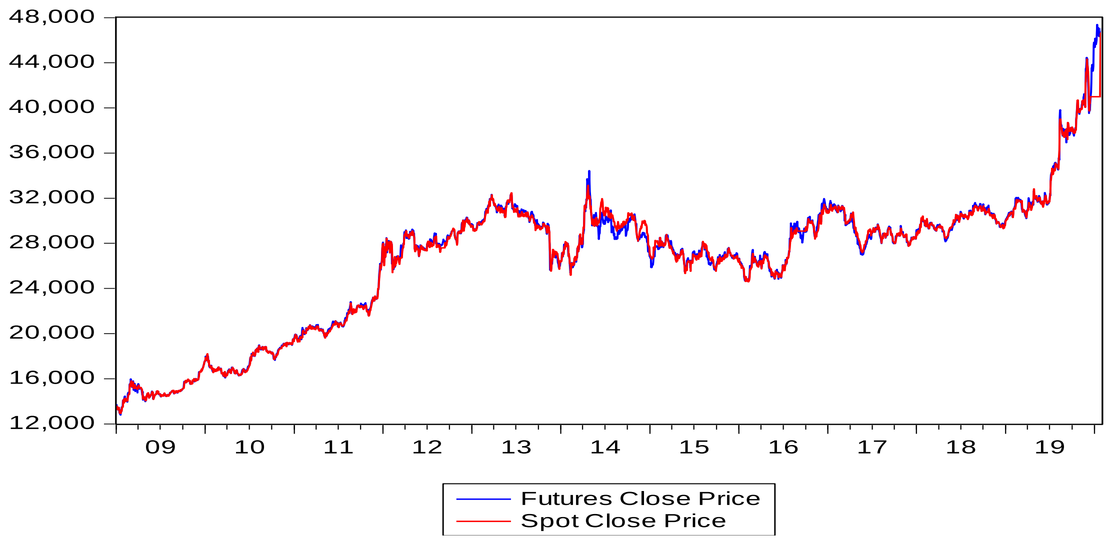


Figure 4.11: Spot and Futures Price Movement of Gold from MCX (1st January 2009 to 31st December 2020)

Source: Author's Compilation

Daily spot price of Gold and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. It is observed that the spot and the futures prices don not move very close to each other from the year 2014 stating that there may be a basis risk involved which can lead to lower hedging effectiveness.

Figure 4.12: Spot and Future Price Movement of Silver from 1st January 2009 to 31st December 2020

Source: Author's Compilation

Daily spot price of silver and its futures contracts from MCX for a period of 1st January 2009 to 31st December 2020 has been considered. Though there is large observation, the spot and futures prices do move very close to each other.

The above figures from 4.1 to 4.12 depicts how spot prices move in relation to futures prices or how futures prices move in relation to spot prices. Hence all the figures above indicates that the spot and futures price series of commodities namely Cardamom, Cotton, Crude Palm Oil, Mentha Oil, Aluminium, Copper, Nickel, Lead, Crude Oil, Natural Gas, Gold and Silver move together on the exchange MCX during the study period 1st January 2009 to 31st December 2020.

Graphical representation of the futures and spot prices explains co-movement of both the price series. It is evident that there are periods of high relation between the markets. However, it can also be seen that there are periods of high variance between the price series which means low interrelation between the markets. It is evident from the graphs, that it is doubtful, that there exists relation between spot and futures markets for all commodities. Futures markets should ideally help in price discovery by absorbing specific market information and adjusting them with demand and supply equilibrium, weather forecasts, government policies, market dynamics, inflation rates. However, in real life, matters are less reassuring as to whether futures prices in India satisfy the goal of efficient price discovery or rather it misdirects the prices. From the review of literature, it clearly indicates towards parallel existence of two contrasting results of relationship and no relationship between the spot and futures commodity markets. Given such and many other contradictory opinions in regard to the commodity spot and futures market interrelations, many findings have been concluded by researches and experts and evidences have been arrived at both for and against.

4.2.2 Descriptive Statistics

It is essential to know the basic characteristics of data before applying any statistical test or econometric model on time series data. To know the data structure, distribution pattern and also the performance of the commodity, which is used in the present study to summarize and describe the data series. Descriptive Statistics presents the summary statistics of mean, median, standard deviation, skewness, kurtosis and Jargue-Bera statistics. Table 4.1 presents the descriptive statistics of daily returns of spot and futures prices of commodity market indices.

Table 4.1: Descriptive Statistics of Daily Returns of Spot and Futures prices of Commodity Market Indices

Descriptive Statistics	MCX COMDEX		MCX AGRI		MCX ENERGY		MCX METAL	
	SR	FR	SR	FR	SR	FR	SR	FR
Mean	0.021	0.021	0.031	0.020	0.010	0.010	0.029	0.028
Median	0.025	0.037	0.000	0.007	0.055	0.066	0.033	0.043
Maximum	6.297	5.438	6.417	6.476	7.729	7.296	7.301	5.549
Minimum	-5.465	-4.982	-23.994	-21.479	-7.801	-7.800	-8.561	-8.541
Std. Dev.	1.145	0.844	1.302	0.933	1.626	1.597	1.030	0.892
Skewness	-0.069	-0.166	0.109	-4.298	0.060	0.021	-0.280	-0.448
Kurtosis	8.315	6.198	53.092	109.09	5.495	5.262	11.298	9.395
Jarque-Bera	3321	1215.6	294832	1331.7	732	601.6	8128	4902
P-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*

Note: * Indicates significance at 1% level. Probability values are in Parenthesis; SR= Spot Return FR= Future Return; Source: Author's Compilation

From the above table, it can be seen that there is a positive return for all market indices, which implies that the price series had increased during the study period. The volatility nature of the stocks is evident from the statistics of standard deviation of daily price return series. Standard deviation of MCXENERGY index is comparatively more than other market indices. The analysis of skewness reveals that the returns of indices MCXCOMDEX, MCXAGRI and MCXMETAL are negatively skewed. Negative skewness indicates a distribution with an asymmetric tail extending toward more negative values. Whereas, return of index MCXENERGY is positively skewed indicate a distribution with an asymmetric tail extending right side and hence a higher probability of earning positive returns. The value of kurtosis is found to be higher than 3, indicating that the series are leptokurtic indicates that the unconditional return distributions are not normal. Which is further confirmed by the significant Jargue-Bera statistics, which indicates that the series are not normal.

The study uses descriptive statistic test on the individual sample commodities. The summary of the statistics results is reported in the tables 4.2, 4.3,4.4 and 4.5.

Table 4.2: Descriptive Statistics of Daily Returns of Spot and Futures Prices of Agricultural Commodities

MCX- Agricultural Commodities – Near Month Contracts								
Descriptive Statistics	**Cardamom**		**Cotton**		**Crude Palm Oil**		**Mentha Oil**	
	SR	**FR**	**SR**	**FR**	**SR**	**FR**	**SR**	**FR**
Mean	**0.013**	**0.006**	**-0.007**	**-0.008**	**0.033**	**0.033**	**0.019**	**0.021**
Median	**0.000**	**-0.013**	**0.000**	**0.000**	**0.000**	**0.017**	**0.000**	**-0.029**
Maximum	**18.490**	**33.402**	**6.149**	**11.326**	**17.471**	**19.141**	**10.226**	**20.898**
Minimum	**-35.71**	**-39.86**	**-8.787**	**-10.776**	**-5.957**	**-10.284**	**-15.515**	**-21.369**
Std. Dev	**2.082**	**3.202**	**0.798**	**1.298**	**1.000**	**1.193**	**1.646**	**3.734**
Skewness	**-1.766**	**0.325**	**-1.071**	**0.128**	**2.447**	**0.948**	**-0.454**	**0.213**
Kurtosis	**48.970**	**29.946**	**20.883**	**16.485**	**42.101**	**29.353**	**12.270**	**10.610**
Jargue-Bera Statistics	**238791 (0.000*)**	**81614 (0.000*)**	**29316 (0.000*)**	**16439 (0.000*)**	**196818 (0.000*)**	**88539 (0.000*)**	**10826 (0.000*)**	**7253 (0.000*)**
Note: * - Indicates significance at 1% level. Probability values are in Parenthesis SR= Spot Return FR= Future Return; Source: Author's Compilation								

Table 4.2 shows the descriptive statistics of daily returns of spot and futures of four agricultural commodities. It showed positive mean return for commodities Cardamom, CPO and Mentha Oil indicating that these commodities performance is superior. Whereas, negative mean return was observed for spot and futures return price series of Cotton which signifies lower performance. The variability in returns, that is, volatility is greater for the futures markets than compared with spot market, as revealed from standard deviation. The standard deviation is high for Cardamom followed by commodity Mentha oil. Positive skewness is observed in the returns of futures of Cardamom and Mentha Oil and returns of Cotton spot which indicates a distribution with an asymmetric tail extending towards right side and hence a higher probability of earning positive returns. Negative skewness is observed in the returns of spot of cardamom, Cotton and Mentha Oil which indicates a distribution with an asymmetric tail extending towards more negative values. The Kurtosis data points for all data series lies above 3 which indicates leptokurtic behaviour of the data series featuring sharper peaks, longer and fatter tails on both the ends. Besides, the spot and futures return series of these commodity markets are non-normal according to the Jarque-Bera test, which rejects normality at the 1% level.

Table 4.3: Descriptive Statistics of Daily Returns of Non-agricultural Commodities (Base Metal)

MCX- Non- Agricultural Commodities (Base-Metal) – Near Month Contracts								
Descriptive Statistics	Aluminium		Copper		Nickel		Lead	
	SR	FR	SR	FR	SR	FR	SR	FR
Mean	0.024	0.022	0.036	0.036	0.022	0.018	0.040	0.037
Median	0.000	0.000	0.000	0.005	0.000	0.039	0.000	0.045
Maximum	14.761	12.284	20.848	12.272	20.752	20.029	18.913	18.078
Minimum	-10.520	-9.411	-18.03	-9.651	-15.315	-10.825	-20.900	-14.141
Std. Dev	1.344	1.248	1.607	1.347	1.919	1.776	1.922	1.653
Skewness	0.334	0.734	0.456	0.357	0.223	0.321	-0.184	0.158
Kurtosis	12.580	11.384	21.474	9.174	12.647	10.300	21.444	12.468
Jargue-Bera Statistics	11102	8719	43703	4931	12175	7013	42242	11139
P-value	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*

*Note: * - Indicates significance at 1% level. Probability values are in Parenthesis.*
SR= Spot Return FR= Future Return; Source: Author's Compilation

Table 4.3 shows the descriptive statistics of daily returns of spot and futures of four base metal commodities. The mean returns of commodities Aluminium, Copper, Nickel and Lead are positive which implies the price series had increased during the period. The variability in returns, that is, volatility in spot market of all four commodities is relatively greater than the volatility in futures market as revealed from standard deviation.

Positive skewness is observed in the returns of spot and futures market of Aluminium, Copper, Nickel and spot market of Lead which indicates a distribution with an asymmetric tail extending towards right side and hence a higher probability of earning positive returns. Negative skewness is observed in the spot price returns of lead which indicates a distribution with an asymmetric tail extending towards more negative values.

A large Kurtosis figure (>3) is also observed for all four commodities, indicating a leptokurtic distribution, which implies the distribution of returns have fat tails compared to the normal distribution. This means high probability for extreme values. Besides, the spot and futures return series of these commodity markets are non-normal according to the Jarque-Bera test, which rejects normality at the 1% level.

Table 4.4: Descriptive Statistics of Daily Returns of Spot and Futures Prices of Non - Agricultural Commodities (Bullion)

MCX- Non -Agricultural Commodities Bullion – Near Month Contracts				
Descriptive Statistics	**Gold**		**Silver**	
	SR	**FR**	**SR**	**FR**
Mean	**0.038**	**0.043**	**0.042**	**0.043**
Median	**0.000**	**0.042**	**0.000**	**0.047**
Maximum	**12.669**	**9.905**	**27.030**	**29.871**
Minimum	**-12.849**	**-8.560**	**-19.957**	**-17.203**
Std. Dev	**0.916**	**0.977**	**1.686**	**1.790**
Skewness	**-0.030**	**0.190**	**1.675**	**1.384**
Kurtosis	**32.527**	**13.113**	**53.945**	**44.002**
Jargue-Bera Statistics	**104985**	**12332**	**313771**	**203290**
P-value	**0.000***	**0.000***	**0.000***	**0.000***

Note: * - Indicates significance at 1% level. Probability values are in Parenthesis
SR= Spot Return FR= Future Return; Source: Author's Compilation

Table 4.4 shows the descriptive statistics of daily returns of spot and futures of commodities Gold and Silver. It can be seen that the rate of return as given by the mean is positive and almost same for spot and futures return series of Gold and Silver. The volatility as given by the standard deviation is higher for spot and futures markets for commodity Silver (SR=1.68, FR=1.79) as compared to Gold (SR=0.91, FR=0.97) commodity.

Positive skewness is observed in the returns of spot and futures of Silver and Gold spot returns which indicates a distribution with an asymmetric tail extending towards right side and hence a higher probability of earning positive returns. The Kurtosis data points for all data series lies above 3 which indicates leptokurtic behaviour of the data series featuring sharper longer and fatter tails on both the ends. Besides, the spot and futures return series of these commodity markets are non-normal according to the Jarque-Bera test, which rejects normality at the 1% level.

Table 4.5: Descriptive Statistics of Daily Returns of Spot and Futures Prices of Non - Agricultural Commodities (Energy)

MCX- Non -Agricultural Commodities Energy – Near Month Contracts				
Descriptive Statistics	**Crude Oil**		**Natural Gas**	
	SR	**FR**	**SR**	**FR**
Mean	**0.012**	**0.013**	**-0.024**	**-0.023**
Median	**0.000**	**0.063**	**0.000**	**-0.049**
Maximum	**34.705**	**31.894**	**25.108**	**24.473**
Minimum	**-56.843**	**-34.573**	**-26.158**	**-27.221**
Std. Dev	**2.954**	**2.607**	**3.057**	**2.886**
Skewness	**-2.052**	**-0.198**	**0.191**	**0.222**
Kurtosis	**73.938**	**42.667**	**10.581**	**11.124**
Jargue-Bera Statistics	**633025 (0.000*)**	**197291 (0.000*)**	**7299.997 (0.000*)**	**8392.982 (0.000*)**
Note: * - Indicates significance at 1% level. Probability values are in Parenthesis SR= Spot Return FR= Future Return; Source: Author's Compilation				

Table 4.5 shows the descriptive statistic of daily returns of spot and futures of Crude Oil and Natural Gas. The mean returns of spot and future price of Natural Gas is negative which implies that the price series had decreased over the period from January 2009 to December 2020. Whereas, mean return of Crude Oil is positive which implies the price series had increased. During the study period

High standard deviation is observed for spot and futures return of Crude Oil and Natural Gas indicating the most volatile commodities. Negative skewness is observed in the returns of spot and futures of Crude Oil, which indicates a distribution with an asymmetric tail extending towards more negative values. Positive skewness is observed in the returns of spot and futures of Natural Gas, which indicates a distribution with an asymmetric tail extending towards right side and hence a higher probability of earning positive returns.

A Kurtosis figure (>3) is also observed in the returns of spot and futures of Crude Oil and Natural Gas, indicating a leptokurtic distribution, which implies the distribution of returns have fat tails compared to the normal distribution. Besides, the spot and futures return series of these commodity markets are non-normal according to the Jarque-Bera test, which rejects normality at the 1% level.

4.2.3 Augmented Dickey Fuller Test

Before we test for cointegration in market indices and individual commodities, it is necessary to check the order of integration of the variables. Therefore, unit root tests of each variable at their levels, as well as at the first differences were conducted.

Given the time series nature of the data, an initial step in the analysis is to test whether each price series is integrated [I (1)] or stationary [I (0)]. This study uses the standard Augmented Dickey-Fuller Test (ADF) to test whether the assumed time series is I (1) which is a necessary condition for further testing procedure. If not able to reject the null hypothesis about the unit root, run the ADF on the first differences of the original time series. In this step, we can reject the null hypothesis about the unit root in order to be able to conclude that the original time series is I (1).

The hypothesis to test unit root is as follows:

H_0- Has a unit root (i.e., the data is non-stationary)

H_1- Does not have a unit root (i.e., the data is stationary)

If the probability value is more than 5%, it means that the series has unit root and if the probability value is less than 5%, it means that the series has no unit root i.e., stationarity is achieved.

The ADF Test statistic is negative in sign and the more negative it is, the stronger will be the rejection of the null hypothesis that there is a unit root or non-stationarity problem in the data series.

Table 4.6 depicts the Augmented Dickey Fuller (ADF) Test results for spot and future series of commodity market Indices.

Table 4.6: ADF Test Results of Commodity Market Indices

Market Indices	Series	Intercept		Intercept and Trend		No Intercept or Trend	
		t-stat	Prob.	t-stat	Prob.	t-stat	Prob.
A. LEVEL							
MCXCOMDEX	Spot	-3.01431	0.0337	-2.55508	0.3014	0.985257	0.9147
	Future	-5.603	0.095	-5.679	0.672	-5.587	0.987
MCXAGRI	Spot	-4.97671	0.410	-4.99924	0.702	0.44689	0.8106
	Future	-2.64752	0.0836	-2.47229	0.342	1.12461	0.933
MCXMETAL	Spot	-3.38503	0.0116	-2.77776	0.2057	1.551446	0.9708
	Future	-1.465	0.714	-1.99	0.187	-1.586	0.789
MCXENERGY	Spot	-2.20433	0.2049	-2.18653	0.4964	0.260319	0.7616
	Future	-3.20	0.109	-2.96	0.069	-3.1903	0.091
B. FIRST DIFFERENCE							
MCXCOMDEX	Spot	-58.6966	0.0001*	-58.7376	0.000*	-58.686	0.0001*
	Future	-35.60	0.000*	-35.67	0.000*	-35.58	0.0000*
MCXAGRI	Spot	-29.4665	0.000*	-29.4693	0.000*	-29.4648	0.0000*
	Future	-51.2128	0.0001*	-51.2213	0.000*	-51.1975	0.0001*
MCXMETAL	Spot	-59.356	0.0001*	-59.4179	0.000*	-59.3158	0.0001*
	Future	-55.5758	0.0001*	-55.6494	0.000*	-55.5267	0.0001
MCXENERGY	Spot	-35.6427	0.000*	-35.6623	0.000*	-35.6479	0.0000*
	Future	-51.471	0.000*	-51.482	0.000*	-51.46	0.0000*

Source: Author's Compilation; * denotes rejection of null hypothesis at 5% level of significance) *MacKinnon (1996) one -sided p-values.

Tables 4.7 to 4.10 depicts the Augmented Dickey Fuller (ADF) Test results for spot and future prices of the sample commodities.

Table 4.7: ADF Test Results of Agricultural Commodities

Agricultural Commodities	Series	Intercept		Intercept and Trend		No Intercept or Trend	
		t-stat	Prob.	t-stat	Prob.	t-stat	Prob.
B. LEVEL							
Cardamom	Spot	-2.11913	0.2372	-2.14986	0.517	-0.2694	0.5892
	Future	-2.74949	0.066	-2.72754	0.2254	-0.58701	0.4632
Cotton	Spot	-1.55377	0.5061	-1.97009	0.6167	0.137738	0.7258
	Future	-2.04632	0.267	-2.50623	0.3251	0.016015	0.6878
Crude Palm Oil	Spot	-2.7485	0.0661	-2.84193	0.1822	0.097082	0.7134
	Future	-2.60445	0.0921	-2.5048	0.3258	0.25129	0.759
Mentha Oil	Spot	-1.76005	0.4008	-1.96116	0.6216	0.164569	0.7339
	Future	-1.98818	0.2923	-2.23871	0.4672	0.018228	0.6885
B. FIRST DIFFERENCE							
Cardamom	Spot	-17.8272	0.0000 *	-17.8272	0.0000 *	-17.816	0.0000 *
	Future	-48.1735	0.0001*	-48.1795	0.0000 *	-48.1832	0.0001 *
Cotton	Spot	-33.9113	0.0000 *	-33.9091	0.0000 *	-33.918	0.0000 *
	Future	-45.989	0.0001 *	-45.9816	0.0000 *	-46.000	0.0001 *
Crude Palm Oil	Spot	-33.6465	0.0000 *	-33.6555	0.0000 *	-33.6454	0.0000 *
	Future	-32.8539	0.0000 *	-32.871	0.0000*	-32.849	0.0000 *
Mentha Oil	Spot	-51.2527	0.0001 *	-51.2433	0.0000*	-51.2508	0.0001 *
	Future	-46.4922	0.0001 *	-46.4841	0.0000*	-46.4912	0.0001 *

Source: Author's Compilation ;* denotes rejection of null hypothesis at 5% level of significance) *MacKinnon (1996) one -sided p-values.

Table 4.8: ADF Test Results of Non - Agricultural Commodities (Base Metal)

Base Metal	Series	Intercept		Intercept and Trend		No Intercept or Trend	
		t-stat	Prob.	t-stat	Prob.	t-stat	Prob.
A. LEVEL							
Aluminium	Spot	-3.736	0.1822	-5.805	0.506	-0.042	0.668
	Future	-2.469	0.1232	-3.359	0.057	0.398	0.798
Copper	Spot	-4.195	0.0917	-4.320	0.063	-0.086	0.654
	Future	-3.445	0.0896	-3.157	0.093	0.406	0.800
Nickel	Spot	-2.642	0.0845	-2.775	0.206	-0.314	0.572
	Future	-2.504	0.1146	-2.878	0.169	-0.323	0.569
Lead	Spot	-3.337	0.1134	-5.460	0.326	-0.008	0.685
	Future	-3.082	0.0281	-4.275	0.073	-0.318	0.777
B. FIRST DIFFERENCE							
Aluminium	Spot	-23.533	0.0000 *	-23.530	0.0000 *	-23.531	0.0000 *
	Future	-52.837	0.0001 *	-52.830	0.0000 *	-52.835	0.0001 *
Copper	Spot	-23.770	0.0000 *	-23.779	0.0000 *	-23.765	0.0000 *
	Future	-54.156	0.0001 *	-54.184	0.0000 *	-54.146	0.0001 *
Nickel	Spot	-56.969	0.0001 *	-56.973	0.0000 *	-56.978	0.0001 *
	Future	-52.146	0.0001 *	-56.969	0.0001 *	-52.155	0.0001 *
Lead	Spot	-26.705	0.0000 *	-26.707	0.0000 *	-26.699	0.0000 *
	Future	-52.5691	0.0001 *	-52.571	0.0000 *	-52.563	0.0001 *

Source: Author's Compilation
*Note: * denotes rejection of null hypothesis at 5% level of significance) *MacKinnon (1996) one -sided p-values.*

Table 4.9: ADF Test Results of Non - Agricultural Commodities (Energy)

Energy	Series	Intercept		Intercept and Trend		No Intercept or Trend	
		t-stat	Prob.	t-stat	Prob.	t-stat	Prob.
A. LEVEL							
Crude Oil	Spot	-2.022	0.2772	-1.9978	0.6017	-0.2734	0.5877
	Future	-2.052	0.2643	-2.0277	0.5853	-0.2734	0.5877
Natural Gas	Spot	-3.936	0.3018	-3.9691	0.0898	-0.8604	0.3433
	Future	-4.0505	0.2012	-4.0813	0.0567	-0.9135	0.3207
B. FIRST DIFFERENCE							
Crude Oil	Spot	-57.336	0.0000 *	-57.336	0.0000 *	-57.3216	0.0001 *
	Future	-53.381	0.0001 *	-53.406	0.0000 *	-53.3899	0.0001 *
Natural Gas	Spot	-58.09	0.0001 *	-58.091	0.0000 *	-58.1025	0.0001 *
	Future	-55.288	0.0001 *	-55.292	0.0000 *	-55.2983	0.0001 *

Source: Author's Compilation
*Note: * denotes rejection of null hypothesis at 5% level of significance) *MacKinnon (1996) one -sided p-values.*

Table 4.10: ADF Test Results of Non - Agricultural Commodities (Bullion)

Bullion	Series	Intercept		Intercept and Trend		No Intercept or Trend	
		t-stat	Prob.	t-stat	Prob.	t-stat	Prob.
A. LEVEL							
Gold	Spot	-1.9748	0.2982	-1.9817	0.6105	1.17633	0.9389
	Future	-2.0114	0.282	-2.1053	0.5421	1.04608	0.9231
Silver	Spot	-2.1726	0.5042	-2.1726	0.5042	-0.03873	0.6699
	Future	-2.2895	0.1755	-2.1411	0.5219	-0.02038	0.6759
B. FIRST DIFFERENCE							
Gold	Spot	-52.3818	0.0001 *	-52.3911	0.0000 *	-52.3401	0.0001 *
	Future	-54.8603	0.0001 *	-54.8666	0.0000 *	-54.8277	0.0001 *
Silver	Spot	-52.3873	0.0001 *	-52.4107	0.0000 *	-52.3907	0.0001 *
	Future	-56.482	0.0001 *	-56.503	0.0000 *	-56.4861	0.0001 *

Source: Author's Compilation.
Note: * denotes rejection of null hypothesis at 5% level of significance) *MacKinnon (1996) one -sided p-values.)

At level, the calculated t. stat. value of ADF Test is more than the critical value at 0.05 significance level and then p-values are also more than 0.05 respectively. Based on this it can say that commodity market indices and individual commodity spot and futures price series are non-stationary at I (0) series which leads to the acceptance of null hypothesis that series has a unit root problem. But at 1st difference the test statistics value of ADF Test is less than 0.05 and even p-values are less than 0.05 which leads to rejection of null hypothesis and acceptance of alternative hypothesis that series has no unit root problem. Therefore, spot price and futures price series are stationary at I (1) series. This implies that the spot and futures price series of Cardamom, Cotton, Crude Palm Oil, Mentha Oil, aluminium, Copper, Nickel, Lead, Crude Oil, Natural Gas, Gold and Silver traded on MCX is stationary at first difference. This is one of the basic conditions to follow for any financial models in econometrics.

4.3.4 Johansen's Co-integration Test

From the above discussion, it is clear that the price series of individual sample commodities and market indices are non-stationary at their level form, whereas first difference of commodity prices attained stationarity. If each variable of a vector of time series is found to be non-stationary, then there may exist a long run relationship among these variables. This possibility can be investigated with the Johansen's Co-integration Test. Cointegration analysis offers important information about long run relationship between any group of time series data whose degree of integration is the same. Co-integration Tests is used to determine whether there exists a stable long -run relationship between the spot and futures prices of the sample commodities. When both the series are I (1). These two I (1) series may be cointegrated.

The conformation that each level series is I (1) allowed to proceed to Johansen Co-integration Test with respect to each index and individual commodity spot and futures markets. Johansen's Cointegration Test is more sensitive to the lag length employed. Besides, inappropriate lag length may give rise to problems of either over parameterization or under-parametrization. Thus, VAR model is fitted to the time series data in order to estimate an appropriate lag structure. The application of Schwarz Information Criterion (SIC) is used to find the optimal lag (Annexure I). The optimal lag length is 2 days for MCXCOMDEX, 3 days for MCXAGRI, 3 days for MCXMETAL and 2 days for MCXENERGY. The optimal lag length is 2 days for Cardamom, 3 days for Cotton, 3 days for Crude Palm Oil, 3 days for Mentha Oil, 2 days for Aluminium, 3 days for Copper, 4 days for Nickel, 4 days for Lead, 4 days for Gold, 4 days for Silver, 4 days for Crude Oil and 1 day for Natural Gas.

The hypothesis to test long-term relationship among variables applying Johansen's Cointegration Test is as follows:

H_0- There is no co-integration between futures close price and spot close price

H_1- There is co-integration between futures close price and spot close price

Reject H_0 if $P < 0.05$

Table 4.11 to 4.15 presents the Co-integration Test result of spot and futures price series of market Indices MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY and individual commodities namely Cardamom, Cotton, Crude Palm Oil, Mentha Oil, Aluminium, Copper, Nickel, Lead, Crude Oil, Natural Gas, Gold and Silver traded on the exchange MCX.

Table 4.11: Johansen Co-integration Test Result of Commodity Market Indices

Johansen Co-integration Test (Market Indices)							
LSP LFP – MCXCOMDEX – Near Month Contract							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.0472**	**145.714**	**25.872**	**0.000***	**136.351**	**19.387**	**0.0001***
At Most 1	**0.0033**	**9.36250**	**12.517**	**0.159**	**9.362**	**12.517**	**0.159**
LSP LFP – MCXAGRI – Near Month Contract							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.01636**	**52.795**	**25.872**	**0.000***	**46.464**	**19.387**	**0.000***
At Most 1	**0.0022**	**6.331**	**12.517**	**0.4195**	**6.3309**	**12.517**	**0.4195**
LSP LFP – MCXMETAL – Near Month Contract							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.0576**	**179.254**	**25.872**	**0.000***	**167.095**	**19.387**	**0.0001***
At Most 1	**0.0043**	**12.158**	**12.518**	**0.057**	**12.1587**	**12.517**	**0.0574**
LSP LFP – MCXENERGY– Near Month Contract							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.0861**	**259.629**	**25.872**	**0.000***	**253.803**	**19.387**	**0.0001***
At Most 1	**0.0021**	**5.825**	**12.517**	**0.483**	**5.82559**	**12.517**	**0.4828**
Source: Author's Compilation; Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level. *Denotes rejection of the hypothesis at the 0.05 level. ** MacKinnon-Haug-Michelis (1999) p-values							

Table 4.12: Johansen Co-integration Test Result of Agricultural commodities

Johansen Co-integration Test (Agricultural Commodities)							
LSP LFP – Cardamom- Near Month Contracts							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.0424**	**118.647**	**15.4947**	**0.0001***	**116.7228**	**14.2646**	**0.0001***
At Most 1	**0.0007**	**1.924**	**3.8414**	**0.1654**	**1.9241**	**3.8414**	**0.1654**
LSP LFP – Cotton- Near Month Contracts							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.0305**	**71.446**	**25.872**	**0.000***	**67.1177**	**19.387**	**0.0000***
At Most 1	**0.0019**	**4.328**	**12.518**	**0.694**	**4.3284**	**12.517**	**0.6942**
LSP LFP – Crude Palm Oil- Near Month Contracts							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.0879**	**287.905**	**25.872**	**0.000***	**279.567**	**19.3870**	**0.0001***
At Most 1	**0.0027**	**8.337**	**12.517**	**0.225**	**8.337**	**12.517**	**0.225**
LSP LFP – Mentha Oil- Near Month Contracts							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.0527**	**165.53**	**15.49471**	**0.0001***	**161.8953**	**14.2646**	**0.0001***
At Most 1	**0.0012**	**3.642918**	**3.841466**	**0.0563**	**3.642918**	**3.841466**	**0.0563**
Source: Author's Compilation; Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level **** denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values***							

Table 4.13: Johansen Co-integration Test Result of Non- Agricultural Commodities (Base Metal)

Johansen Co-integration Test (Non- Agricultural Commodities: Base Metal)							
LSP LFP – Aluminium- Near Month Contracts							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.013332**	**47.08208**	**25.87211**	**0.000***	**36.84274**	**19.38704**	**0.000***
At Most 1	**0.003723**	**10.23934**	**12.51798**	**0.1167**	**10.23934**	**12.51798**	**0.1167**
LSP LFP – Copper- Near Month Contracts							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.00817**	**31.52875**	**25.87211**	**0.008***	**21.3879**	**19.38704**	**0.002***
At Most 1	**0.003882**	**10.14086**	**12.51798**	**0.1209**	**10.14086**	**12.51798**	**0.1209**
LSP LFP – Nickel- Near Month Contracts							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.079719**	**265.7867**	**25.87211**	**0.000***	**259.6123**	**19.38704**	**0.000***
At Most 1	**0.001974**	**6.174377**	**12.51798**	**0.4385**	**6.174377**	**12.51798**	**0.4385**
LSP LFP – Lead- Near Month Contracts							
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Test**			**Max-Eigen Value Test**		
		Statistic Value	**Critical Values**	**Prob.****	**Statistic Value**	**Critical Values**	**Prob.****
None *	**0.080572**	**250.781**	**12.3209**	**0.000***	**249.9099**	**11.2248**	**0.000***
At Most 1	**0.000293**	**0.8711**	**4.129906**	**0.4052**	**0.8711**	**4.129906**	**0.4052**
Source: Author's Compilation; Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level.							

Table 4.14: Johansen Co-integration Test Result of Non- Agricultural Commodities (Energy)

Johansen Co-integration Test (Non- Agricultural Commodities: Energy)							
LSP LFP – Crude Oil- Near Month Contracts							
Hypothesized No. of CE(s)	Eigenvalue	Trace Test			Max-Eigen Value Test		
		Statistic Value	Critical Values	Prob.**	Statistic Value	Critical Values	Prob.**
None *	0.081505	267.3624	25.87211	0.0001*	255.1409	19.38704	0.0001*
At Most 1	0.004064	12.22147	12.51798	0.056	12.22147	12.51798	0.056
LSP LFP – Natural Gas- Near Month Contracts							
Hypothesized No. of CE(s)	Eigenvalue	Trace Test			Max-Eigen Value Test		
		Statistic Value	Critical Values	Prob.**	Statistic Value	Critical Values	Prob.**
None *	0.369081	1400.15	12.3209	0.0001*	1399.698	11.2248	0.000*
At Most 1	0.000149	0.452415	4.12990	0.5646	0.452415	4.12990	0.5646
Source: Author's Compilation; Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level. ** Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values*							

Table 4.15: Johansen Co-integration Test Result of Non- Agricultural commodities (Bullion)

Johansen Co-integration Test (Non- Agricultural Commodities: Bullion)							
LSP LFP – Gold- Near Month Contracts							
Hypothesized No. of CE(s)	Eigenvalue	Trace Test			Max-Eigen Value Test		
		Statistic Value	Critical Values	Prob.**	Statistic Value	Critical Values	Prob.**
None *	0.0153	46.976	15.4947	0.000*	44.6580	14.2646	0.000*
At Most 1	0.0008	2.3179	3.8414	0.1279	2.3179	3.8414	0.1279
LSP LFP – Silver- Near Month Contracts							
Hypothesized No. of CE(s)	Eigenvalue	Trace Test			Max-Eigen Value Test		
		Statistic Value	Critical Values	Prob.**	Statistic Value	Critical Values	Prob.**
None *	0.036161	112.5977	25.87211	0.000*	106.1845	19.38704	0.000*
At Most 1	0.002222	6.413218	12.51798	0.4097	6.413218	12.51798	0.4097
Source: Author's Compilation; Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level. ** Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values*							

The table 4.11 to 4.15 presents the trace and maximum eigenvalue statistics for the sample period 1st January 2009 31st December 2020. The test statistics are significant at 5% level which is common for every index and sample commodities. The test reveals that spot and futures prices stand in a long-run relationship between them, thus justifying the use of a Vector Error Correction Model (VECM) for showing short run dynamics.

The trace test and Max-Eigen test statistics of Johansen Cointegration Test indicate the presence of one cointegrating vector (p-value < 0.05). The null hypothesis that there is no Cointegration relationship is rejected and the existence of at least one cointegration equation is supported. It is evident from the test results that futures and spot prices of Cardamom, Cotton, Crude Palm Oil, Aluminium, Copper, Nickel, Lead, Crude Oil, Natural Gas, Gold and Silver traded on MCX reveal that there is long run stable relationship between spot and futures prices having very significant consequences on traders who trade in the futures market. The detection of cointegration between the markets implies that even though there is no equilibrium between the two markets in the short term, any deviation that may occur will get corrected in the long term promptly during the process of arbitrage and the underlying market risk may be hedged to the greatest possible degree by hedgers taking up extended period positions. But in the short-run there may be deviations from this equilibrium and to verify whether such disequilibrium converges to the long run equilibrium or not, the Vector Error Correction Model (VECM) can be used to generate this short run dynamics.

4.3.5 Vector Error Correction Model

The presence of non-stationarity in time series suggests a test of co-integration test among variables. Though in the long run series may be integrated, but these series may deviate in the short term which can be interpreted as permanent adjustment process towards an equilibrium. The use of VECM is an important element in this study for at least two reasons. First, the VECM allow analysing how the spot and futures price move over time. Secondly, it allows to determine where the price discovery is occurring in spot or futures market.

The dynamic VECM representation provides us with a framework to test for causal dynamics in the granger sense among the price series through both short-run and error-correction channels/term (ECT) of causation. Short-run market causality test will determine whether spot price in different markets respond instantaneously to changes in futures prices. The Coefficient of the lagged error correction term (ECTs) shows the portion by which the long-run disequilibrium in the dependent variable is being corrected in each short period to have stable long-run relationship.

Table 4.16: Vector Error Correction Estimates of Commodity Market Indices

Error Correction		MCXCOMDEX		MCXAGRI		MCXMETAL		MCXENERGY	
ECT		**D(LSP)**	**D(LFP)**	**D(LSP)**	**D(LFP)**	**D(LSP)**	**D(LFP)**	**D(LSP)**	**D(LFP)**
CointEq1	**Coefficient Standard error t-statistics Prob.**	**-0.13992 -0.01634 [-8.5632] (0.000)**	**-0.0036 -0.01236 [-0.2910] (0.771)**	**-0.0507 -0.00701 [-7.2332] (0.000)**	**-0.00031 -0.00201 [-0.1559] (0.8761)**	**-0.19631 -0.03293 [-5.9617] (0.000)**	**0.00788 -0.02925 [0.26926] (0.7877)**	**-0.21707 -0.08463 [-2.5651] (0.0103)**	**0.06696 -0.08353 [0.80161] (0.4228)**
D (LSP)t-1	**Coefficient Standard error t-statistics Prob.**	**-0.17107 -0.02856 [-5.9893] (0.000)**	**-0.0038 -0.0216 [-0.1757] (0.8605)**	**-0.2654 -0.01923 [-13-807] (0.000)**	**0.00629 -0.0055 [1.14479] (0.2523)**	**-0.27066 -0.04519 [-5.9895] (0.000)**	**-0.05543 -0.04014 [-1.3809] (0.1673)**	**-0.30947 -0.10137 [-3.0529] (0.0023)**	**-0.1236 -0.10006 [-1.2353] (0.21168)**
D (LSP)t-2	**Coefficient Standard error t-statistics Prob.**	____	____	**-0.06616 -0.01895 [-3.4881] (0.0005)**	**-0.00075 -0.0054 [-0.1376] (0.8905)**	**-0.19284 -0.04248 [-4.5396] (0.000)**	**-0.06175 -0.03773 [-1.6367] (0.1017)**	____	____
D (LFP)t-1	**Coefficient Standard error t-statistics Prob.**	**0.189128 -0.03799 [4.97792] (0.000)**	**0.01723 -0.02874 [0.59975] (0.5487)**	**0.114642 -0.06646 [1.72490] (0.0846)**	**0.03427 -0.0190 [1.80271] (0.0715)**	**0.2230 -0.05027 [4.43789] (0.000)**	**0.01044 -0.0446 [0.23376] (0.8152)**	**0.334901 -0.10285 [3.25609] (0.0011)**	**0.15583 -0.10152 [1.53495] (0.1249)**
D (LSP)t-2	**Coefficient Standard error t-statistics Prob.**	____	____	**-0.00049 -0.0663 [-0.0074] (0.994)**	**-0.03317 -0.01898 [-1.7481] (0.0805)**	**0.218143 -0.04794 [4.55061] (0.000)**	**0.08183 -0.04258 [1.92186] (0.0547)**	____	____
Constant	**Coefficient Standard error t-statistics Prob.**	**0.00020 -0.00021 [0.95431] (0.34)**	**0.0002 -0.00016 [1.26808] (0.2048)**	**0.00025 -0.00062 [0.40679] (0.6842)**	**0.0002 -0.00018 [1.16191] (0.2453)**	**0.000289 -0.00019 [1.52379] (0.1276)**	**0.00029 -0.00017 [1.72594] (0.0844)**	**7.91E.05 -0.0003 [0.26008] (0.7948)**	**7.84E-05 -0.0003 [0.26119] (0.794)**
R-Squared Adj. R-Squared F-statistic		**0.051004 0.04999 50.43067**	**0.00024 -0.00083 0.22126**	**0.096943 0.095337 60.3735**	**0.002940 0.000116 1.65678**	**0.051617 0.04993 30.60905**	**0.00382 0.00205 2.1550**	**0.010267 0.009212 9.733431**	**0.00164 0.00057 1.53966**
Source: Author's Compilation; p-values significance at 5% level of significance									

The table 4.16 shows the Vector Error Correction Estimates (ECT) for four Commodity Market Indices (MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY). With spot market as dependent variable and futures market as independent or explanatory variables for different lags and indicate the long-run and short-run speed adjustment (convergence) towards equilibrium or long-run steady state. As can be seen from the table, CointEg1 also known as ECT is the speed of adjustment towards long run equilibrium or Error Correction Term. When the Coefficient of Error Correction Term (ECT) is negative in sign and significant, then it can be said that there is long-run causality running from futures prices to dependent spot prices. Since the Error Correction Term is negative in sign

(MCXCOMDEX: -0.139925, MCXAGRI: -0.0507, MCXMETAL: -0.196318 and MCXENERGY: -0.21707) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 13.99%, 5.07%, 19.63% and 21.70% speed of adjustments in commodities that is MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY, respectively. The speed of correction in the futures market of MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY is 0.36%, 0.031%, 0.78% and 6.69% against spot market, which indicates a highly informative futures market. At the same time, insignificant ECT of Ln futures of market series of MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY indicates futures market efficiency towards maintaining stable long-run equilibrium.

Table 4.17: Vector Error Correction Estimates of Agricultural Commodities

Error Correction		Cardamom		Cotton		Crude Palm oil		Mentha Oil	
ECT		D(LSP)	D(LFP)	D(LSP)	D(LFP)	D(LSP)	D(LFP)	D(LSP)	D(LFP)
Coint Eq1	Coefficient	-0.03948	0.03033	-0.0411	0.01084	-0.0483	0.2288	-0.0282	0.20481
	Standard error	-0.0045	-0.0071	-0.0056	-0.00967	-0.0166	-0.01668	-0.0083	-0.01774
	t-statistics	[-8-706]	[-8.70064]	[-7.348]	[1.1208]	[-2.899]	[12.899]	[-3.364]	[11.543]
	Prob.	(0.000)	(0.000)	(0.000)	(0.2624)	(0.0037)	(0.000)	(0.0008)	(0.0006)
D (LSP)t -1	Coefficient	0.01980	0.03089	-0.0329	0.09862	0.136	0.4561	-0.0258	0.22155
	Standard error	-0.1941	-03071	-0.0225	-0.03905	-0.0390	-0.02537	-0.0197	-0.04417
	t-statistics	[1.0201]	[1.00589]	[-1.460]	[2.5255]	[2.5255]	[17.979]	[-1.307]	[5.3012]
	Prob.	(0.3077)	(0.3145)	(0.1442)	(0.0116)	(0.000)	(0.000)	(0.1909)	(0.000)
D (LSP)t -2	Coefficient	_____	_____	0.09202	-0.0091	0.03344	0.15421	-0.0326	0.1358
	Standard error			-0.0211	-0.0366	-0.023	-0.0247	-0.0182	-0.04179
	t-statistics			[4.342]	[-02495]	[1.476]	[6.2266]	[-1.794]	[3.5267]
	Prob.			(0.000)	(0.8029)	(0.1399)	(0.000)	(0.0728)	(0.0004)
D (LFP)t -1	Coefficient	0.09167	0.03208	0.16129	-0.14813	0.10917	-0.12169	0.10699	-0.31855
	Standard error	-0.0129	-0.0205	-0.0141	-0.0244	-0.0212	-0.0225	-0.0105	-0.02233
	t-statistics	[7.0635]	[1.5625]	[11.416]	[-6.064]	[5.147]	[-5.406]	[10.131]	[14.265]
	Prob.	(0.000)	(0.1182)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
D (LSP)t -2	Coefficient	_____	_____	0.05202	-0.0393	0.0159	-0.0647	0.04087	-0.14199
	Standard error			-0.0141	-0.0245	-0.0184	-0.0195	-0.0095	-0.02027
	t-statistics			[3.6695]	[-1.605]	[0.8652]	[-3.307]	[4.2648]	[-7.006]
	Prob.			(0.0002)	(0.1084)	(0.3869)	(0.0009)	(0.000)	(0.0100)
Constant	Coefficient	0.00012	5.60E.05	-5.89E.0	-8.36E.0	0.00022	0.00017	0.0002	0.00022
	Standard error	-0.00039	-0.00062	-0.0001	-0.00028	-0.0001	-0.00019	-0.0009	-0.00061
	t-statistics	[0.3200]	[0.09105]	[-0.368]	[-0.302]	[1.2721]	[0.8890]	[0.6918]	[0.3506]
	Prob.	(0.7489)	(0.9275)	(0.7123)	(0.7624)	(0.2034)	(0.3754)	(0.4891)	(0.7259)
R-Squared		0.06186	0.0072	0.13265	0.02143	0.06314	0.2565	0.07001	0.19933
Adj. R-Squared		0.0608	0.0061	0.13064	0.0191	0.06160	0.25534	0.06845	0.19799
F-statistic		59.1508	6.5453	66-101	9.4640	40.8742	209.269	44.945	148.627

Source: Author's Compilation; p-values significance at 5% level of significance

The table 4.17 shows the Vector Error Correction Estimates (ECT) for four agricultural commodities (Cardamom, Cotton, Crude Palm Oil and Mentha Oil). With spot market as dependent variable and futures market as independent or explanatory variables for different lags and indicate the long -run and short-run speed adjustment (convergence) towards equilibrium or long-run steady state. When the coefficient of error correction term (coefficient of CointEq1) is negative in sign and significant, then it can be said that there is a long-run causality running from futures prices to dependent spot prices. As can be seen from the table, CointEg1 also known as ECT is the speed of adjustment towards long run equilibrium or Error Correction term. When the Coefficient of Error Correction Term (ECT) is negative in sign and significant, then it can be said that there is long-run causality running from futures prices to dependent spot prices. Since the Error Correction term is negative in sign (Cardamom: -0.039480, Cotton: -0.041118, Crude Palm Oil: -0.04838, Mentha oil -0.0282) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 3.94%, 4.11%, 4.83% and 2.82% speed of adjustments in commodities that is Cardamom, Cotton and Crude Palm Oil and Mentha Oil, respectively. The speed of correction in the futures market of Cardamom, Cotton and Crude Palm Oil and Mentha Oil is 3.30%, 1.08%, 22.8% and 20.48% against spot market, which indicates a highly informative futures market. Insignificant ECT of Ln futures prices of Cardamom, Cotton and Crude Palm Oil and Mentha Oil indicates future market efficiency towards maintaining stable long- run equilibrium.

Table 4.18: Vector Error Correction Estimates of Non- Agricultural Commodities (Base Metal)

Error Correction		Aluminium		Copper		Nickel		Lead	
		D(LSP)	D(LFP)	D(LSP)	D(LFP)	D(LSP)	D(LFP)	D(LSP)	D(LFP)
ECT	Coefficient	-0.0114	0.0156	-0.0037	0.0053	-0.3727	0.0766	-0.40602	0.04372
	Standard error	-0.0033	-0.0029	-0.0011	-0.0016	-0.0254	-0.0292	-0.0226	-0.0286
	t-statistics	[-3.4305]	[5.3822]	[-3.4239]	[-3.2781]	[-14.665]	[2.6234]	[-17.955]	[1.5279]
	Prob.	(0.000)	(0.0721)	(0.0006)	(0.0011)	(0.000)	(0.5986)	(0.000)	(0.1266)
D (LSP) t-1	Coefficient	-0.1298	-0.0206	-0.1376	0.04391	-0.2384	0.07018	-0.2996	-0.0293
	Standard error	-0.0192	-0.0168	-0.0195	-0.0293	-0.0261	-0.03002	-0.0229	-02908
	t-statistics	[-6.7369]	[-1.227]	[-7.049]	[1.4943]	[-91243]	[2.33802]	[-13.041]	[-1.0007]
	Prob.	(0.000)	(0.0721)	(0.000)	(0.1352)	(0.000)	(0.0079)	(0.000)	(0.3136)
D (LSP)t-2	Coefficient	—	—	-0.0354	0.0117	-0.150017	0.03119	-0.16174	-0.01909
	Standard error			-0.0195	-0.0293	-0.02317	-0.0266	-0.01977	-0.02502
	t-statistics			[-1.815]	[0.3999]	[-6.4738]	[1.1719]	[-8.1806]	[-0.762]
	Prob.			(0.0692)	(0.6892)	(0.000)	(0.0202)	(0.000)	(0.4456)
D (LSP)t-3	Coefficient	—	—	—	—	-0.0786	6.27E.05	-0.0385	0.0076
	Standard error					-0.0172	-0.0198	-0.0135	-0.0171
	t-statistics					[-4.5516]	[0.00316]	[-2.840]	[0.4427]
	Prob.					(0.000)	(0.2467)	(0.0045)	(0.658)
D (LFP)t-1	Coefficient	0.0258	-0.0194	0.0341	-0.3042	0.346691	-0.0095	0.3769	0.0443
	Standard error	-0.02182	-0.0190	-0.0127	-0.0192	-0.02767	-0.03178	-0.0256	-0.03244
	t-statistics	[1.1847]	[-1.021]	[2.6680]	[-15.808]	[12.529]	[-0.3012]	[14.705]	[1.36693]
	Prob.	(0.000)	(0.0067)	(0.0078)	(0.000)	(0.000)	(0.9969)	(0.000)	(0.1717)
D (LFP)t-2	Coefficient	-0.01407	0.0468	0.0079	-0.1796	0.2089	-0.0359	0.2953	0.03681
	Standard error	-0.0218	-0.01907	-0.0127	-0.0192	-0.0259	-0.0297	-0.0245	-0.03101
	t-statistics	[-0.6452]	[2.457]	[0.6244]	[-9.3308]	[8.0589]	[-1.2057]	[12.049]	[1.1866]
	Prob.	(0.000)	(0.6023)	(0.5278)	(0.000)	(0.000)	(0.7816)	(0.000)	(0.2354)
D (LFP)t-3	Coefficient	—	—	—	—	0.102309	-0.00898	0.1481	0.01816
	Standard error					-0.02592	-0.0255	-0.0216	-0.0274
	t-statistics					[4.60302]	[-0.3518]	[6.845]	[0.66293]
	Prob.					(0.000)	(0.235)	(0.000)	(0.5074)
Constant	Coefficient	0.00028	0.00024	0.00047	0.00033	0.00014	0.0016	0.00024	0.00032
	Standard error	-0.00027	-0.00024	-0.0003	-0.00045	-0.00027	-0.00032	-0.00024	-0.0003
	t-statistics	[1.03376]	[1.01336]	[1.5632]	[0.7267]	[0.52644]	[0.50894]	[1.04014]	[1.05992]
	Prob.	(0.0843)	(0.0235)	(0.1197)	(0.4674)	(0.5986)	(0.6146)	(0.2983)	(0.2892)
R-Squared		0.025824	0.01335	0.02548	0.10142	0.35412	0.01264	0.5374	0.00109
Adj. R-Squared		0.02404	0.01155	0.023613	0.09969	0.35267	0.010042	0.5363	-0.0012
F-statistic		14.5265	7.41287	13.6095	58.7354	244.30	[5.7033]	492.66	0.4635

Source: Author's Compilation; p-values significance at 5% level of significance

The table 4.18 shows the Vector Error Correction Estimates (ECT) for non- agricultural commodities-Base Metal (Aluminium, Copper, Nickel and Lead) for different lags and indicate the long -run and short-run speed adjustment (convergence) towards equilibrium or long-run steady state. When the coefficient of error correction term (coefficient of CointEq1) is negative in sign and significant, then it can be said that there is a long-run causality running from futures prices to dependent spot prices. With spot market as dependent variable and futures market as independent or explanatory variables. The Error Correction Term

(ECT) is negative in sign (Aluminium – 0.0114, Copper – 0.0037, Nickel -0.3727, Lead – 0.40602) and significant ($p < 0.05$). This implies that there is a long -run causality running from futures prices to dependent spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 1.14%, 0.37%, 37.27% and 40.6% speed of adjustments in sample commodities. The speed of correction in the futures market of Aluminium, Nickel and Lead is 1.56%, 0.53%, 7.66% and 4.37% against spot market, which indicates a highly informative future market. At the same time, insignificant ECT of Ln futures prices of Aluminium, Nickel and Lead indicates futures market efficiency towards maintaining stable long- run equilibrium.

The table 4.19 shows the Vector Error Correction Estimates (ECT) for non- agricultural commodities- Energy (Crude Oil and Natural Gas) and Bullion (Gold and Silver) for different lags and indicate the long -run and short-run speed adjustment (convergence) towards equilibrium or long-run steady state. When the coefficient of error correction term (coefficient of CointEq1) is negative in sign and significant, then it can be said that there is a long-run causality running from futures prices to dependent spot prices. With spot market as dependent variable and futures market as independent or explanatory variables. The Error correction Term (ECT) is negative in sign (Energy: Crude Oil -0.7919, Natural gas – 0.82904, Bullion: Gold- 0.05917, Silver – 0.1828) and significant ($p < 0.05$). This implies that there is a long -run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 79.19%, 82.90% speed of adjustments in commodities Crude Oil and Natural Gas and 5.91% 18.28% speed of adjustments in commodities Gold and Silver. Insignificant ECT of *Ln* futures of Crude Oil, Natural Gas, Gold and Silver indicates futures market efficiency towards maintaining stable long-run equilibrium.

Table 4.19: Vector Error Correction Estimates of Non- Agricultural Commodities (Energy and Bullion)

		Energy				Bullion			
Error Correction		**Crude Oil**		**Natural Gas**		**Gold**		**Silver**	
ECT		**D(LSP)**	**D(LFP)**	**D(LSP)**	**D(LFP)**	**D(LSP)**	**D(LFP)**	**D(LSP)**	**D(LFP)**
CointEq1	Coefficient	-0.7919	0.0026	-0.8290	0.06416	-0.05917	0.02456	-0.1828	0.0392
	Standard error	-0.0393	-0.0449	-0.0221	-0.0337	-0.01038	-0.0136	-0.01654	-0.02166
	t-statistics	[-20.132]	[0.0578]	[-37.47]	[1.903]	[-5.7015]	[1.7989]	[-11.06]	[1.8100]
	Prob.	(0.000)	(0.9539)	(0.000)	(0.058)	(0.000)	(0.0721)	(0.000)	(0.0703)
D(LSP) t-1	Coefficient	-0.10551	-0.0066	-0.0039	0.00325	-0.28864	0.06142	-0.29873	0.02955
	Standard error	-0.0355	-0.0406	-0.0128	-0.0195	-0.02165	-0.0284	-0.02228	-0.02931
	t-statistics	[-2.970]	[-0.164]	[-0.307]	[0.1657]	[13.3293]	[2.1562]	[13.347]	[1.0079]
	Prob.	(0.003)	(0.8696)	(0.7583)	(0.8667)	(0.000)	(0.0311)	(0.000)	(0.3135)
D(LSP) t-2	Coefficient	-0.02967	-0.0455			-0.15073	0.00245	-0.15151	0.01324
	Standard error	-0.02974	-0.034	____	____	-0.02294	-0.0301	-0.0204	-0.0267
	t-statistics	[-09977]	[-1.340]			[-6.5695]	[0.0811]	[-7.421]	[0.4950]
	Prob.	(0.3184)	(0.18)			(0.000)	(0.9353)	(0.000)	(0.6206)
D(LSP) t-3	Coefficient	0.11779	0.0922			-0.10577	0.06187	-0.03855	0.02973
	Standard error	-0.02006	-0.0229	____	____	-0.01734	-0.0228	-0.01647	-0.02157
	t-statistics	[5.8716]	[4.0195]			[-6.0998]	[2.7125]	[-2.340]	[1.3779]
	Prob.	(0.000)	(0.0001)			(0.000)	(0.0067)	(0.0193)	(0.1683)
D(LFP) t-1	Coefficient	0.121426	-0.0208	0.07012	0.00799	0.556179	-0.0401	0.3859	-0.0463
	Standard error	-0.03883	-0.0444	-0.0211	-0.0322	-0.01787	-0.0235	-0.0209	-0.02737
	t-statistics	[3.1267]	[-0.470]	[3.3153]	[0.2478]	[31.1229]	[-1.709]	[18.4706]	[-1.691]
	Prob.	(0.0018)	(0.6382)	(0.0009)	(0.812)	(0.000)	(0.0874)	(0.000)	(0.0908)
D(LFP) t-2	Coefficient	0.026731	-0.0073			0.21247	-0.0146	0.341267	0.0264
	Standard error	-0.03417	-0.0390			-0.0212	-0.0280	-0.0212	-0.0278
	t-statistics	[0.7823]	[-0.189]	____	____	[9.9778]	[-0.521]	[16.054]	[0.9491]
	Prob.	(0.434)	(0.8499)			(0.000)	(0.6023)	(0.000)	(0.3426)
D(LFP) t-3	Coefficient	-0.05383	0.0084			0.090934	-0.0063	0.13421	-0.01785
	Standard error	-0.02669	-0.0305	____	____	-0.02006	-0.0263	-0.01942	-0.02543
	t-statistics	[-2.0174]	[0.2751]			[4.53329]	[-0.239]	[6.9125]	[-0.702]
	Prob.	(0.0437)	(0.7832)			(0.0000)	(0.8104)	(0.000)	(0.4827)
Constant	Coefficient	9.15E.05	8.93E.0	-0.0002	-0.0002	0.000239	0.00041	0.000269	0.00042
	Standard error	-0.00041	-0.0004	-0.0003	-0.0005	-0.00014	-0.0001	-0.00025	-0.00033
	t-statistics	[0.2217]	[0.1893]	[-0.645]	[-0.504]	[1.72673]	[2.2655]	[1.05704]	[1.2597]
	Prob.	(0.8245)	(0.8499)	(0.5184)	(0.6087)	(0.0843)	(0.0235)	(0.2905)	(0.2078)
R-Squared		0.41491	0.0171	0.61788	0.00302	0.34973	0.00861	0.348837	0.00867
Adj. R-Squared		0.41354	0.01481	0.61750	0.00203	0.34815	0.0062	0.347253	0.00626
F-statistic		303.714	7.45297	1635.85	3.05922	221.205	3.56987	220.255	3.59591

Source: Author's Compilation; p-values significance at 5% level of significance

4.3.6 Granger Causality Test

To assess the direction of relationship among spot and futures prices of the sample commodities, Granger Causality Test is applied to analyse whether futures prices influence spot prices or spot prices influence futures prices. The Granger Causality Test is an econometric tool to find out whether one time series is useful in forecasting another. It advocates that while the past can cause/predict the future, the future cannot cause/predict the past. If the spot price is the granger cause of futures price than the spot market leads the futures market and if the futures price is the granger cause of spot price than the futures market leads the spot market.

The null hypothesis to test the granger causality are as follows.

H_{01}- Futures price does not granger cause spot price.

H_{02}- Spot price does not granger cause future price.

Hypothesis is rejected if the probability value is less than alpha (0.05).

Granger Causality Test is always applied on stationary data. So, this test is applied on the spot and futures return series of sample individual commodities and market indices.

Empirical results obtained from Granger Causality Test is given in table 4.20, 4.21, 4.22 and 4.23. Commodities which exhibit unidirectional causality from futures market to spot market are Cardamom, Cotton, Aluminium, Copper, Lead, Crude oil, Silver and for all commodity market indices. The null hypothesis is rejected at 5% level of significance. Here the futures price is the granger cause of the spot price. A bi-directional information flow is observed for commodities CPO, Mentha Oil, Nickel, Natural Gas and Gold. Here the futures price is the granger cause of the spot price and vice versa. Though bi-directional information flow exists for these commodities, but the flow from futures price to spot price is stronger.

Table 4.20: Estimation of Direction of Causality of Agricultural Commodities

Pairwise Granger Causality Tests – Agricultural Commodities

SR FR- Near Month Contracts

		Cardamom				Cotton				Crude Palm Oil				Mentha Oil			
Null Hypothesis	**Lag**	**Obs.**	**F-Stat**	**Prob.**	**Remark**	**Obs.**	**F-Stat**	**Prob.**	**Remark**	**Obs.**	**F-Stat**	**Prob.**	**Remark**	**Obs.**	**F-Stat**	**Prob.**	**Remark**
FR does not granger cause SR	2	3288	42.8583	5.00E-19	→	2359	102.931	2.00E-43	→	3242	27.4628	2.00E-12	↔	3223	102.023	1.00E-43	↔
SR does not granger cause FR			0.54622	0.5792			3.32084	0.0363			403.397	5.00E-156			41.366	2.00E-18	

[SR: Spot Return Series, FR: Future Return Series, ↔ bidirectional, → Unidirectional, * Rejection of Null Hypothesis P-value <0.05] Source: Author's Compilation.

Table 4.21: Estimation of Direction of causality of Non-Agricultural Commodities (Base Metal)

Pairwise Granger Causality Tests – Non-Agricultural Commodities (Base Metal)

SR FR- Near Month Contracts

		Aluminium				Copper					Nickel				Lead			
Null Hypothesis	**Lag**	**Obs.**	**F-Stat**	**Prob.**	**Remark**	**Obs.**	**F-Stat**		**Prob.**	**Remark**	**Obs.**	**F-Stat**	**Prob.**	**Remark**	**Obs.**	**F-Stat**	**Prob.**	**Remark**
FR does not granger cause SR	2	3207	1092.04	0.000	→	3067	1101.02		0.000	→	3290	873.686	1.00E-169	↔	3237	1182.36	0.000	→
SR does not granger cause FR			0.17302	0.8411			2.34951		0.0956			18.9411	1.00E-05			0.01006	0.99	

[SR: Spot Return Series, FR: Future Return Series, ↔ bidirectional, → Unidirectional, * Rejection of Null Hypothesis P-value <0.05] Source: Author's Compilation

Table 4.22: Estimation of Direction of Causality of Non-Agricultural Commodities (Energy and Bullion)

Pairwise Granger Causality Tests – Non-Agricultural Commodities (Energy and Bullion)																	
SR FR- Near Month Contracts	Energy									Bullion							
		Crude Oil				Natural Gas				Gold				Silver			
Null Hypothesis	Lag	Obs.	F-Stat	Prob.	Remark	Obs.	F-Stat	Prob.	Remark	Obs.	F-Stat	Prob.	Remark	Obs.	F-Stat	Prob.	Remark
FR does not granger cause SR	2	3247	655.491	6.00E-237	→	3268	1551.98	0	↔	3206	711.33	8.00E-252	↔	3191	604.539	6.00E-220	→
SR does not granger cause FR			4.58224	0.0103			3.66214	0.0258			4.05121	0.0175			1.59712	0.2027	
[SR: Spot Return series, FR: Future Return series, ↔ bidirectional, → Unidirectional, * Rejection of Null Hypothesis P-value <0.05] Source: Author's Compilation																	

Table 4.23: Estimation of Direction of Causality of Commodity Market Indices

Pairwise Granger Causality Tests – Commodity Market Indices																	
SR FR- Near Month Contracts																	
		MCXCOMDEX				MCXAGRI				MCXMETAL				MCXENERGY			
Null Hypothesis	Lag	Obs.	F-Stat	Prob.	Remark	Obs.	F-Stat	Prob.	Remark	Obs.	F-Stat	Prob.	Remark	Obs.	F-Stat	Prob.	Remark
FR does not granger cause SR	2	2818	32.9021	8.00E-15	→	2818	7.81222	0.0004	→	2818	38.6056	3.00E-17	→	2818	10.1753	4.00E-05	→
SR does not granger cause FR			0.11077	0.8951			0.55234	0.5757			1.82229	0.1618			2.3165	0.0988	
[SR: Spot Return Series, FR: Future Return Series, ↔ bidirectional, → Unidirectional, * Rejection of Null Hypothesis P-value <0.05] Source: Author's Compilation																	

4.3 Findings

The major findings of objective two are stated below:

1. Spot and futures price series of individual commodities and market indices under study are non-stationary at I (0) as per the calculated t. stat. value of ADF test which is more than the critical value at 0.05 level of significance. But at the first difference the test statistics values are less than 0.05. Therefore, the spot price and futures price series are stationary at I (1).

2. The Johansen Test of Cointegration results reveal that there is a long-run relationship between spot and futures prices for all sample commodities and market indices. The trace test and max-eigen value test statistics indicate the existence of one cointegrating vector at 5% level of significance. It means both the market share common long run information.

3. The Vector Error Correction Model results reveal that ECT of *Ln* spot prices of commodities under study is negative in sign (Cardamom: -0.0394480, Cotton: -0.04111, CPO: -0.04838, Aluminium, -0.0114, Copper: -0.0037, Nickel: -0.3727, Lead: - 0.40602, Crude Oil -0.7919, Natural gas – 0.82904, Bullion: Gold- 0.05917, Silver – 0.1828) and significant ($p < 0.05$). This implies that there is a long -run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 79.19%, 82.90% speed of adjustments in commodities Crude Oil and Natural Gas and 3.94%, 3.37%, 4.8%, 1.14%, 0.37%, 37.27%, 40.6%, 5.91% and 18.28% speed of adjustments in commodities in sample commodities that is Cardamom, Cotton, CPO, Mentha Oil, Aluminium, Copper, Nickel, Lead, Gold and Silver.

4. The Granger Causality Test result found that there exists unidirectional causality from futures prices to spot prices for seven commodities namely Cardamom, Cotton, Aluminium, Copper, Lead, Crude Oil and Silver. Bi-directional causality exists between futures and spot prices for five commodities namely CPO, Mentha Oil, Nickel, Natural Gas and Gold. Though bi-directional information flow exists for these commodities but the flow from futures price to spot price is stronger. For all market indices, the futures price is the granger cause of the spot price.

4.4 Conclusion

In a perfectly functioning market, every piece of information should be reflected at the same time in the underlying spot market and its futures market. However, in reality, information can be disseminated in one market first and then transmitted to other markets due to market imperfections. This chapter examines the causal relationship between spot and futures prices in the Indian commodity market by applying econometric tools such as Johansen Co-integration Test, Granger Causality Test and VECM Model. The result from unit root tests indicates that spot and futures prices of sample commodities are not stationary at their levels. But they are stationary at their first difference. The Johansen Cointegration Test results reveal that there is a long run relationship between spot and futures prices. Hence, a Vector Error Correction Model (VECM) is employed to investigate the short-run dynamics and price movements in the two markets. Vector Error Correction Model reveal that the correction is happening from the futures market to the spot market as its co-efficient value is negative and statistically significant and there is no adjustment from spot market to futures market because of positive co-efficient value. Different patterns of causality have been found in the Indian commodity market. For some of the commodities futures market transmits information to the spot market and there are some commodities for which a bi-directional causality exists. Though bi-directional information flow exists for these commodities but the flow from futures price to spot price is stronger. The results of

Cointegration and VECM highlight that futures market contributes largely to the price discovery process. In conclusion, futures market is informationally more efficient than the underlying spot market. The empirical results indicate that futures market leads the spot market and serves as a primary market for price discovery.

CHAPTER V

PRICE VOLATILITY IN INDIAN COMMODITY MARKET

5.1 Introduction

Volatility refers to the measurement of risk involved in any investment. In other words, it is the measurement of variability of prices of an asset over a period of time. A higher value of volatility indicates that the value of the asset has been spread out over a wide range of values. Volatility measures the state of uncertainty in any market. Commodity derivatives market also experiences the volatility. The degree of volatility differs over time and tends to clusters in periods of large volatility and reduces at the periods of tranquillity which is termed as heteroskedasticity in econometric terminology. The volatility is seen to be autocorrelated, which means today's volatility subject to that of the previous period volatility. The possible factors of high volatility may be due to demand and supply conditions, regulatory practices and the government policy changes, speculative trade, weather events, international price pressure. (Chen, Cuny and Haugen, 1995) stated that higher volatility may encourage investors to increase trading in futures because futures contracts constitute a convenient means to adjust their investment positions. It is widely acknowledged that futures markets are more volatile than the spot market, providing additional concern to market regulators for potential transmission of volatility from the futures to spot market. The nature of flow of information to the market also attributes towards the differential degree of market volatility. (Black, 1976) stated that in case of asymmetric volatility the bad information leads to increase in volatility in the market than good information of similar magnitude. Thus, the measurement and forecasting of asymmetric volatility is important to policy makers and investors in their decision-making process.

It is widely recognized that volatilities move together more or less closely over time across the markets or assets. (Banumathy and Azhagaiah, 2014) states that the data in the time series are found to be dependent on its own past value (heteroskedasticity). Before deciding an investment, investors analyse the historical volatility to evaluate the degree of risk involved in the investment. Understanding volatility pattern in any financial instrument is of immense importance in portfolio selection, portfolio diversification, asset pricing, asset allocation and risk management.

There are some of the stylized facts about volatility that should be considered while designing an efficient model (which has minimum error term). Stylized facts are a characterization of some empirical statistical regularities which can be attained by analysing the financial data. The study has analysed the following behaviour of the commodity markets in India.

1. Volatility clustering and persistence in the commodity markets
2. Presence of mean reversion behaviour in the commodity markets
3. Existence of asymmetric behaviour in the commodity markets

1. Volatility clustering and persistence in the commodity markets

Mandelbrot (1963) conveyed that the large changes in the price of an assets are often followed by other large changes and vice versa confirming persistence. This feature is referred as volatility clustering. Taylor (2005) explained persistence as a phenomenon in which market experience periods of high volatility and periods of low volatility, in which, high volatility leads to high dispersion of returns and vice-versa. Persistence is that the innovations today will impact the expectation of volatility many periods in future.

2. Presence of mean reversion behaviour in the commodity markets

The mean reversion is described as a stationary series, where mean and variance are finite and constant over time. Mean reversion in volatility means there is always a normal level of volatility to which the volatility will eventually return which infers that the current information has no long-term impact on volatility. Mean reversion in time series data analyses the nature of impact that shocks might have on volatility. The impact on volatility could be of transitory nature or permanent nature. Transitory effect means that the variations in stock price do not have a permanent impact on the volatility. Transitory effect of shocks on prices is confirmed if the prices are stationary over the time. Thus, the mean reverting behaviour of time series is established. That means when there exists mean reversion, prices will tend to return to its mean value or follow the trend over the long run.

3. Existence of asymmetric behaviour in the commodity market

Black (1976) the author presented the concept of leverage effect in the context of financial time series data. Leverage effect confers a negative correlation between changes in stock price and changes in volatility. Christie A. (1982), Poon S. H., (2005) stated that under leverage effect, volatility tends to be more after a negative shock as compared to the positive shock of similar extent.

In this chapter, the empirical analysis of stylised features of commodity markets is analysed for both selected individual commodities and MCX commodity Indices. Section 5.2 consists of the analysis results for the presence of stylized facts of volatility in individual commodities. To further measure that the results are not limited to some selected individual commodities, the test is repeated with commodity market indices in section 5.3.

5.2 Volatility Persistence in Commodity Spot and Futures Market

Variance or standard deviation is often used by investors to reflect how much the price of the asset has fluctuated from mean price over a period of time. Engle (1982) presented the Auto Regressive Conditional Heteroskedasticity Models to model the time series exhibiting time varying conditional variance. Bollerslev (1986) introduced Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) models to model time series exhibiting stochastic volatility. GARCH models cannot account for modeling leverage effect, and also with the restriction of non-negativity of coefficients. Thus, Nelson (1991) developed Exponential Generalized Auto Regressive Conditional Heteroskedasticity (EGARCH) which captures the asymmetric effects of the time series using logarithmic expression of conditional model and captures the relation between asymmetric volatility and returns. The TGARCH model is also called GJR GARCH model (Glosten, Jagannathan, & Runkle, 1993) is also used to capture asymmetric effect of the time series.

Natural logarithms of price series have been considered as the most consistent measure of variation of price changes in the past.

5.2.1 Volatility Clustering of Individual Commodities

The degree of volatility for the return series is seen to have been changing over the time. The higher is the level of volatility the riskier is the investment in the market. Further, it is stated that volatilities remain high for a certain period of time and then remain low for another period of time, which indicates the volatility clustering behaviour of the data series. The existence of volatility clustering is displayed based on the residuals obtained from the commodity market indices for the futures and spot price series. It is graphically represented as follows:

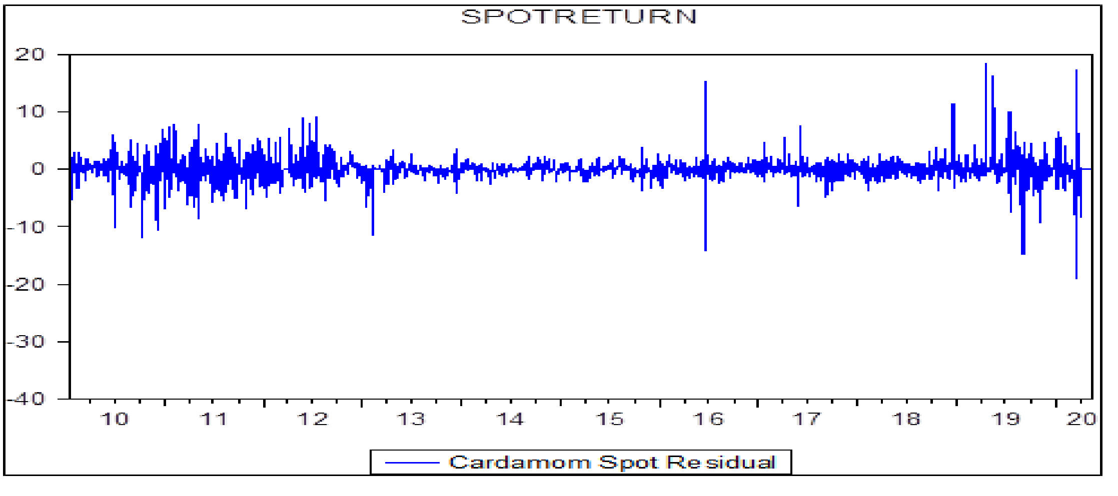


Figure 5.1: Volatility Clustering of Spot Returns of Cardamom

Source: Author's Compilation

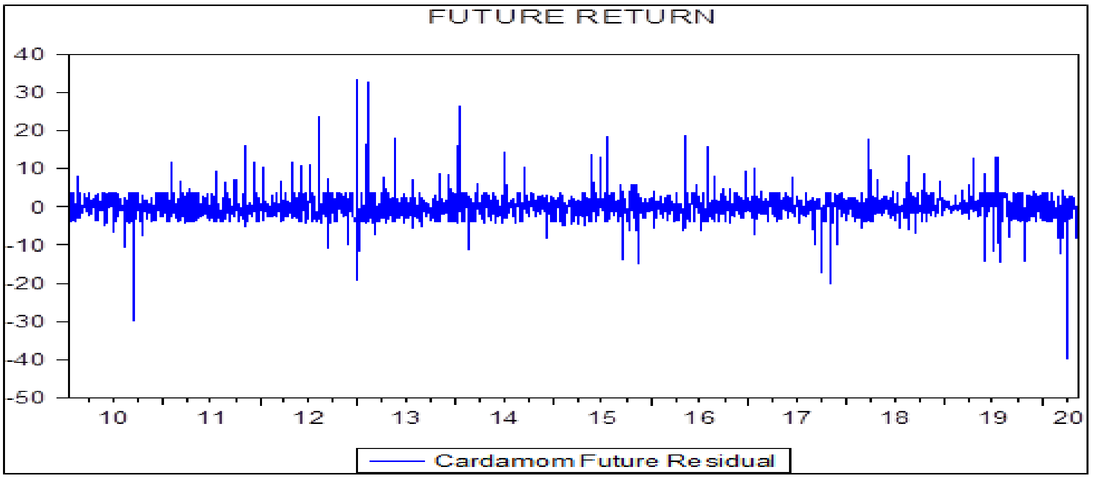


Figure 5.2: Volatility Clustering of Futures Returns of Cardamom

Source: Author's Compilation

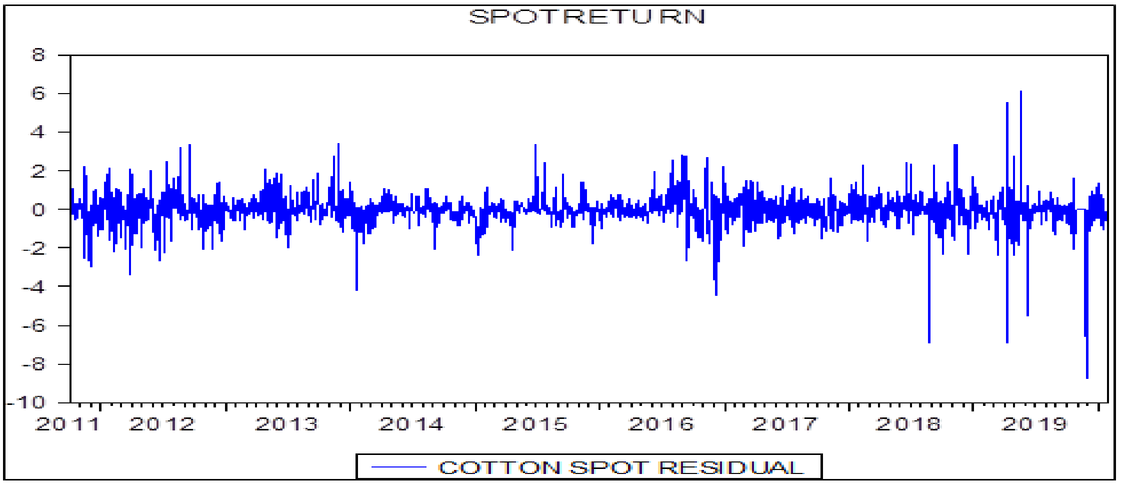


Figure 5.3: Volatility Clustering of Spot Returns of Cotton

Source: Author's Compilation

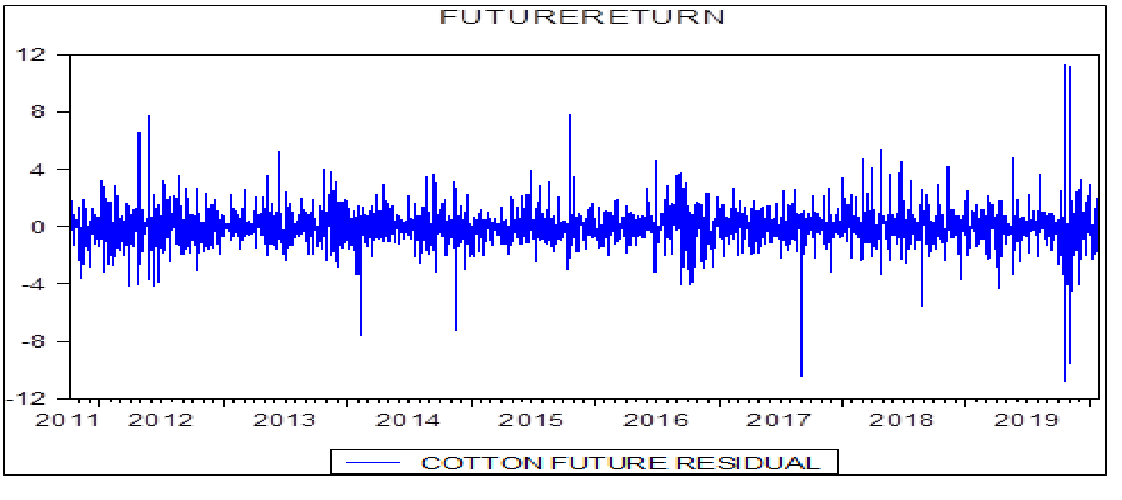


Figure 5.4: Volatility Clustering of Futures Returns of Cotton

Source: Author's Compilation

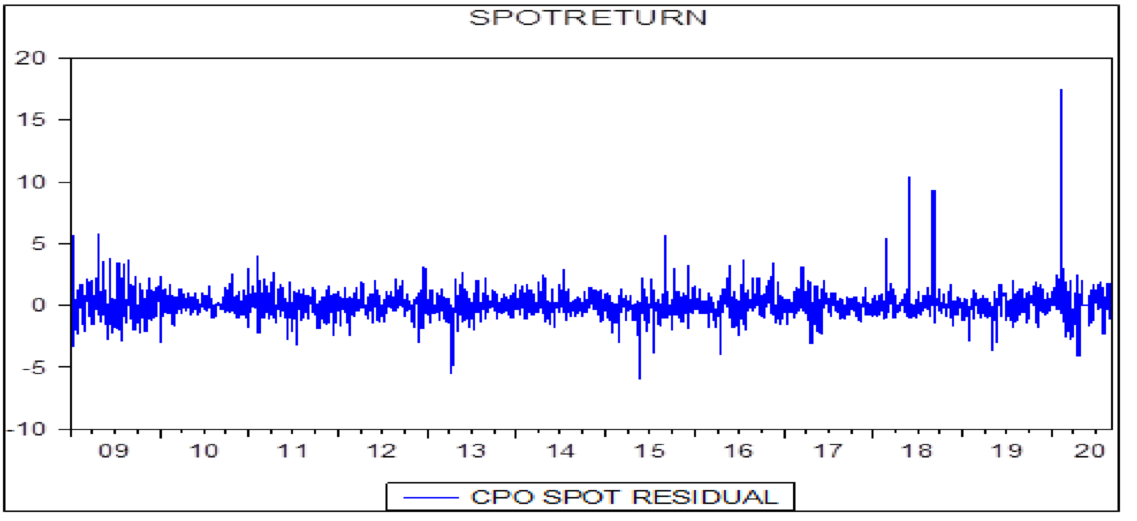


Figure 5.5: Volatility Clustering of Spot Returns of CPO

Source: Author's Compilation

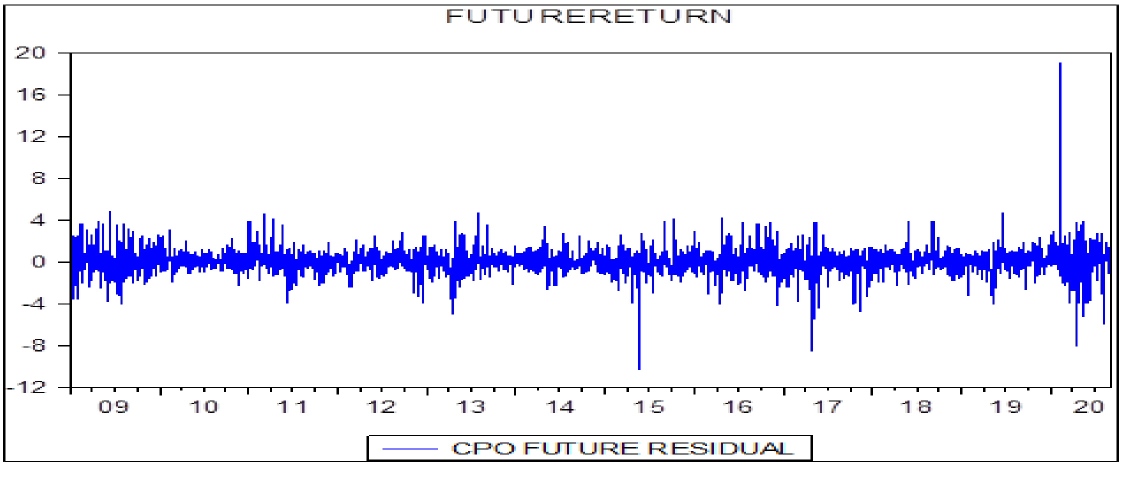


Figure 5.6: Volatility Clustering of Futures Returns of CPO

Source: Author's Compilation

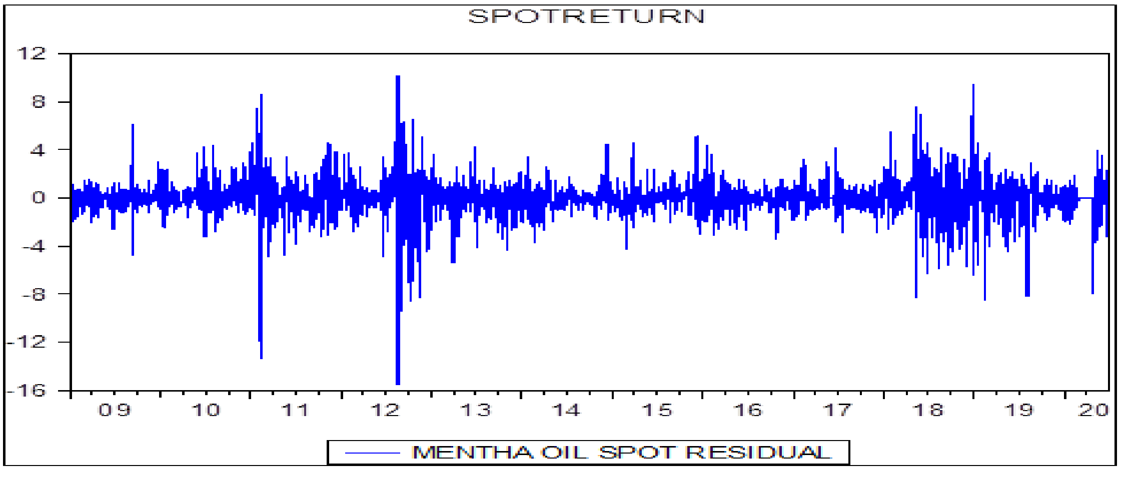


Figure 5.7: Volatility Clustering of Spot Returns of Mentha Oil

Source: Author's Compilation

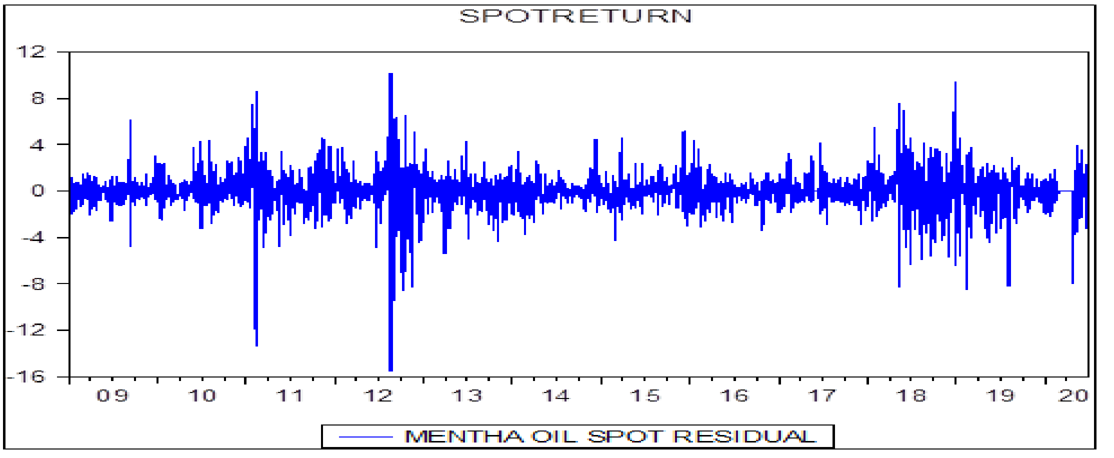


Figure 5.8: Volatility Clustering of Futures Returns of Mentha Oil

Source: Author's Compilation

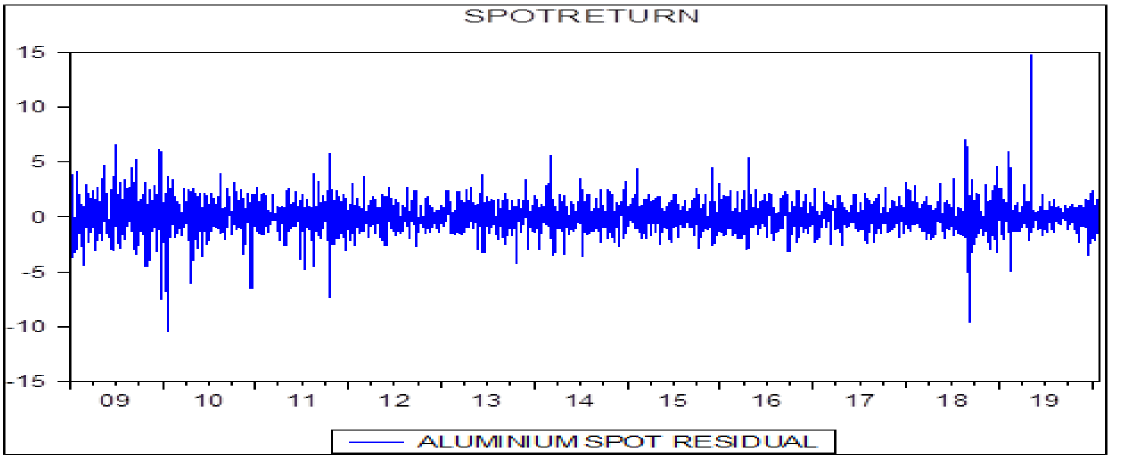


Figure 5.9: Volatility Clustering of Spot Returns of Aluminium

Source: Author's Compilation

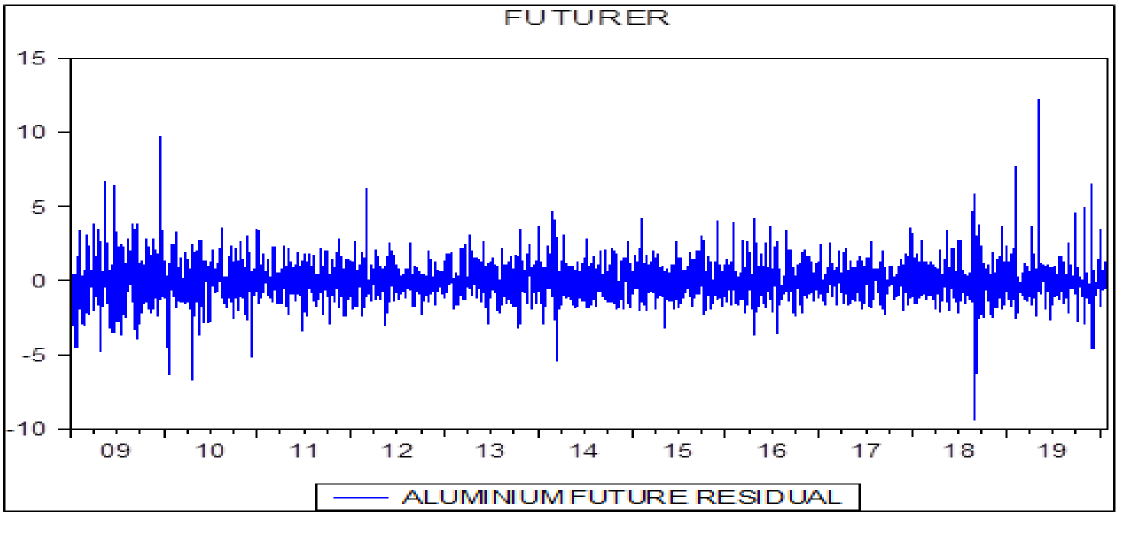


Figure 5.10: Volatility Clustering of Futures Returns of Aluminium

Source: Author's Compilation

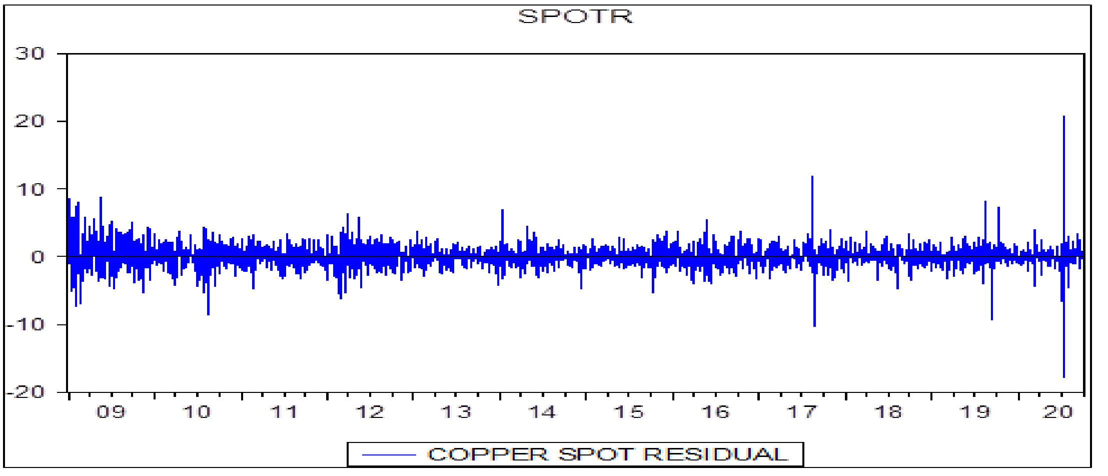


Figure 5.11: Volatility Clustering of Spot Returns of Copper

Source: Author’s Compilation

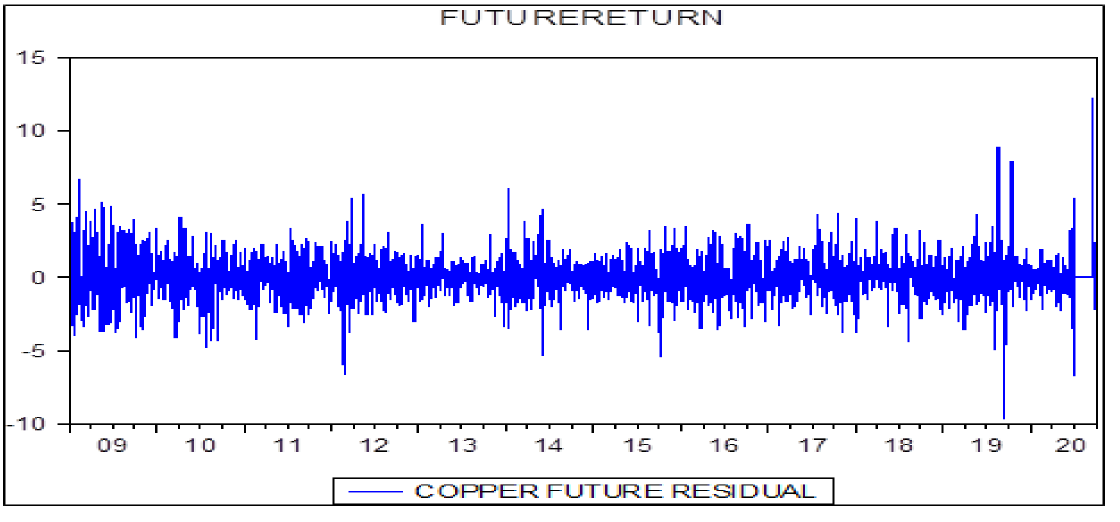


Figure 5.12: Volatility Clustering of Futures Returns of Copper

Source: Author’s Compilation

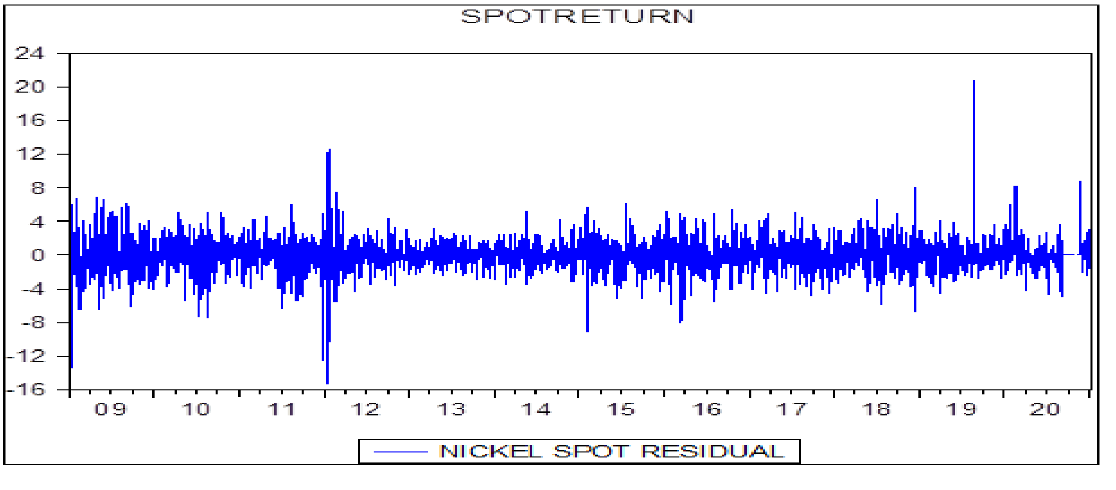


Figure 5.13: Volatility Clustering of Spot Returns of Nickel

Source: Author’s Compilation

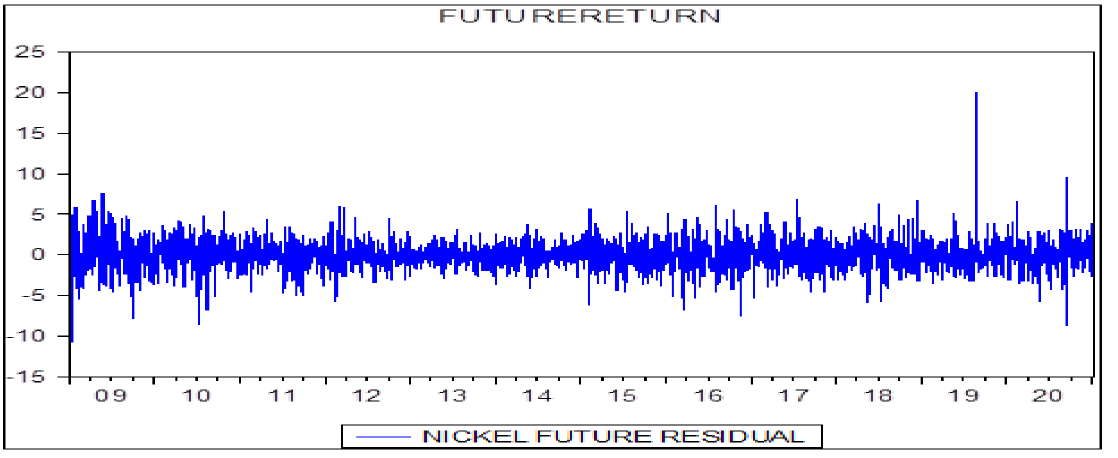


Figure 5.14: Volatility Clustering of Futures Returns of Nickel

Source: Author's Compilation

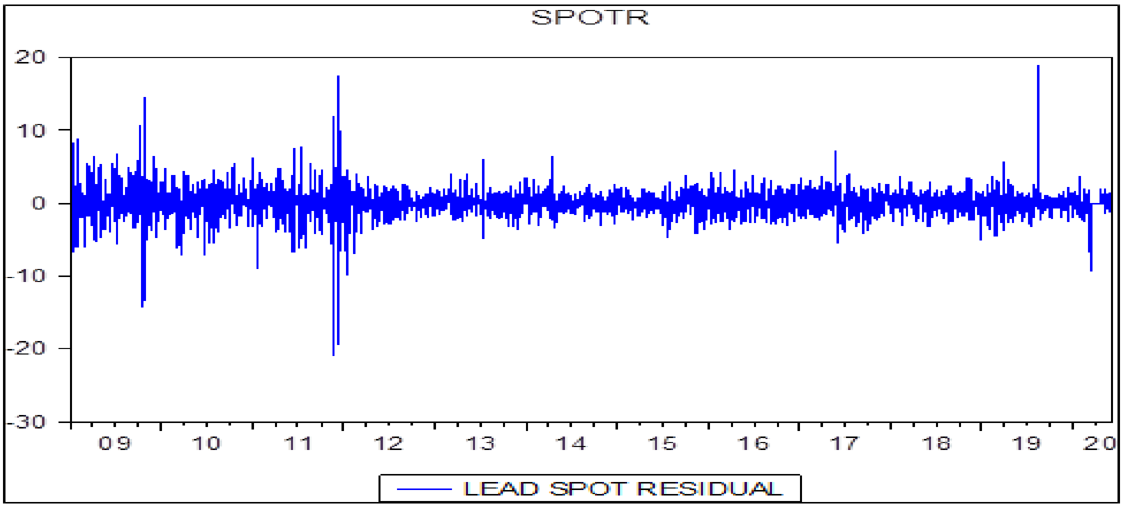


Figure 5.15: Volatility Clustering of Spot Returns of Lead

Source: Author's Compilation

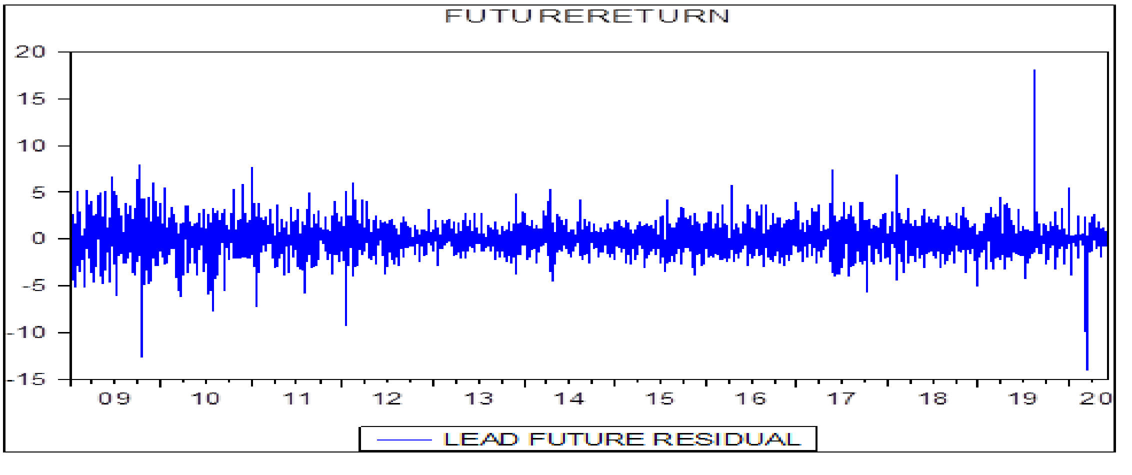


Figure 5.16: Volatility Clustering of Futures Returns of Lead

Source: Author's Compilation

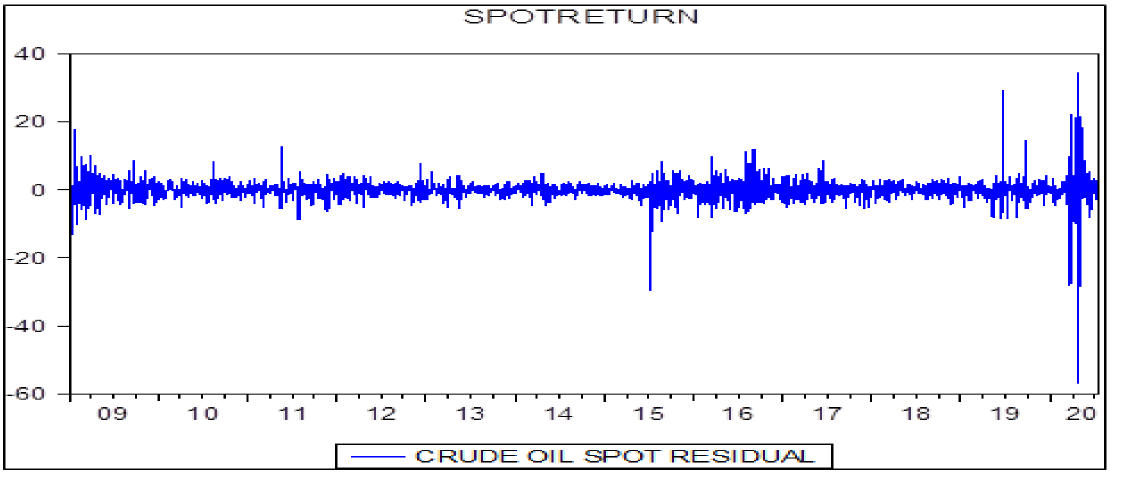


Figure 5.17: Volatility Clustering of Spot Returns of Crude Oil

Source: Author's Compilation

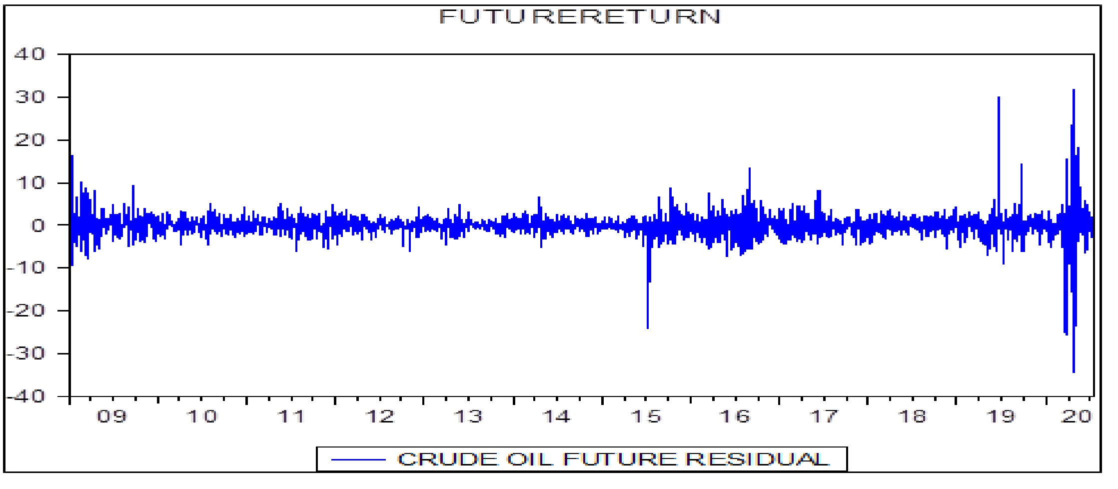


Figure 5.18: Volatility Clustering of Futures Returns of Crude Oil

Source: Author's Compilation

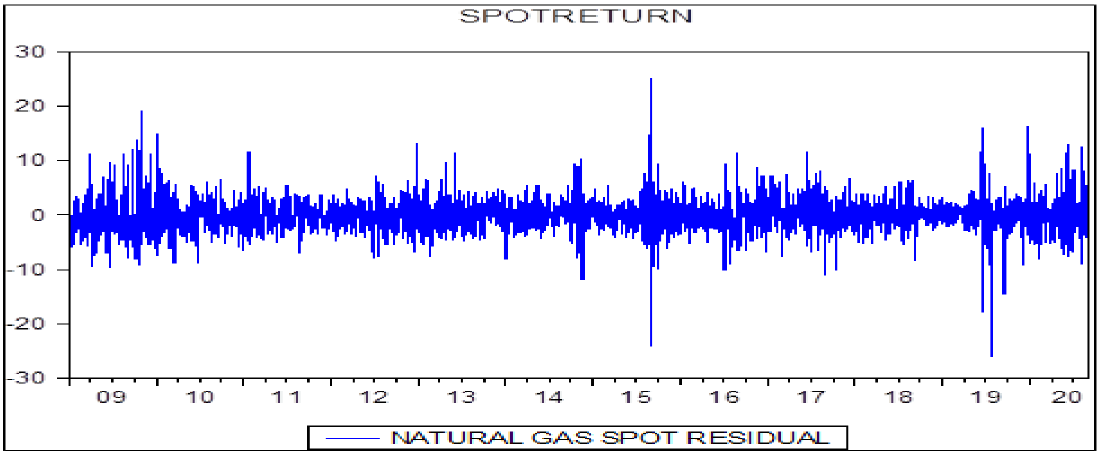


Figure 5.19: Volatility Clustering of Spot Returns of Natural Gas

Source: Author's Compilation

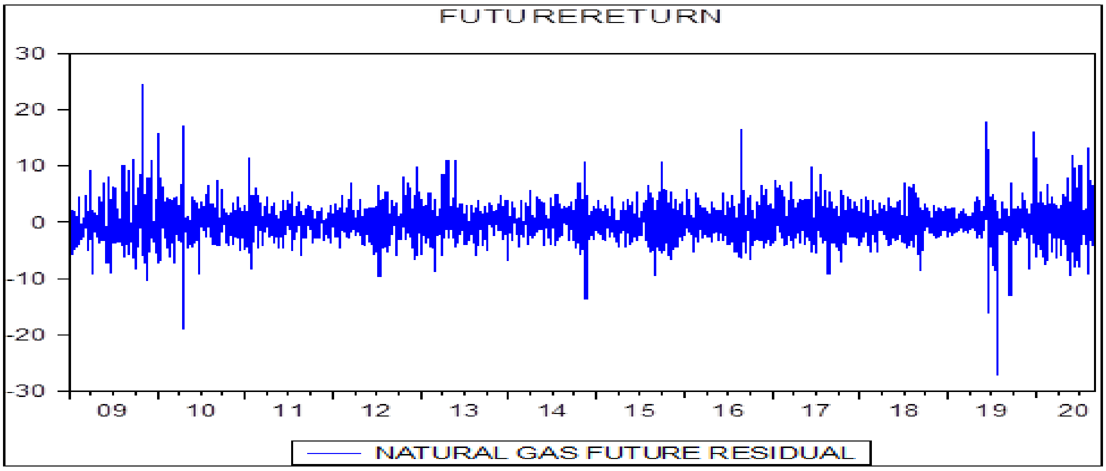


Figure 5.20: Volatility Clustering of Futures Returns of Natural Gas

Source: Author's Compilation

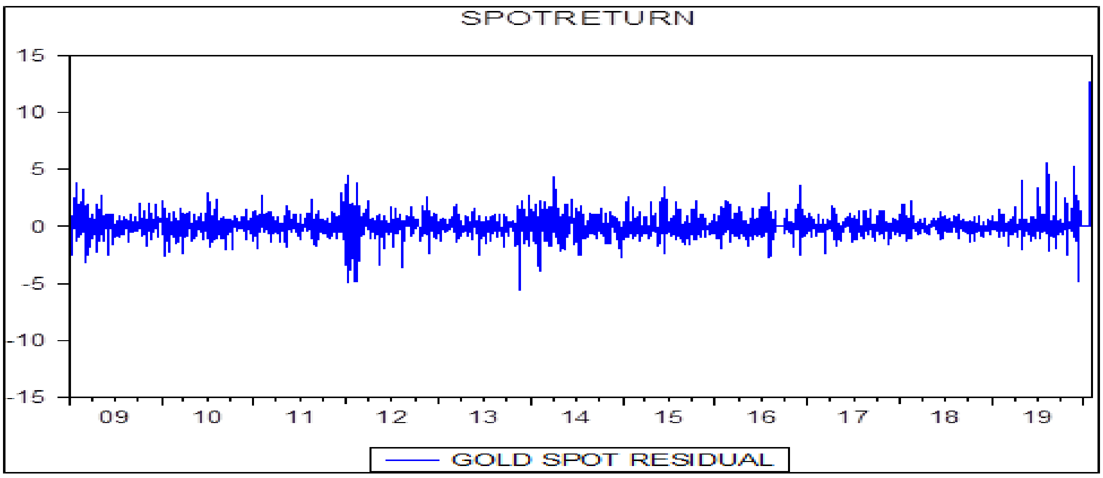


Figure 5.21: Volatility Clustering of Spot Returns of Gold

Source: Author's Compilation

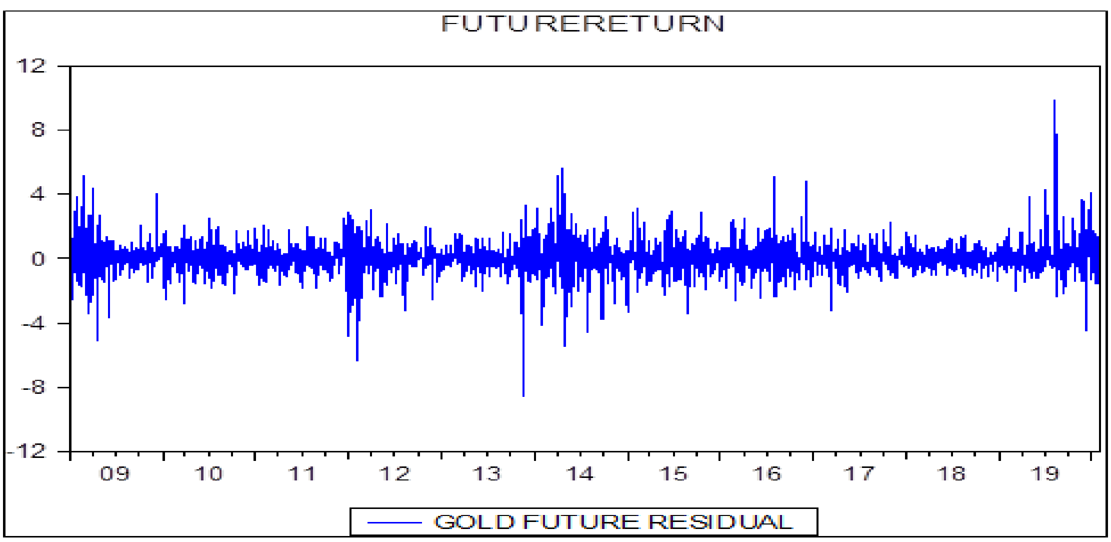


Figure 5.22: Volatility Clustering of Futures Returns of Gold

Source: Author's Compilation

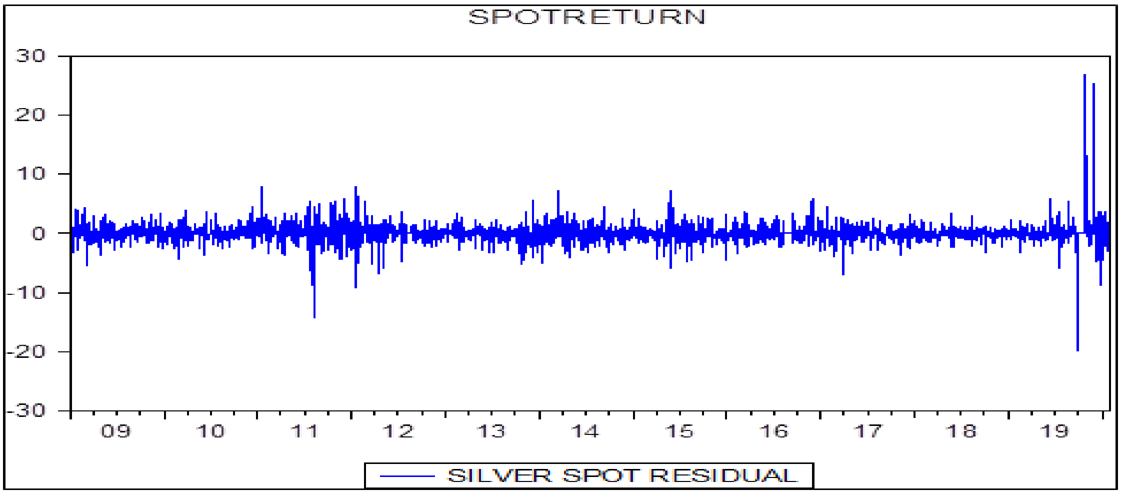


Figure 5.23: Volatility Clustering of Spot Returns of Silver

Source: Author's Compilation

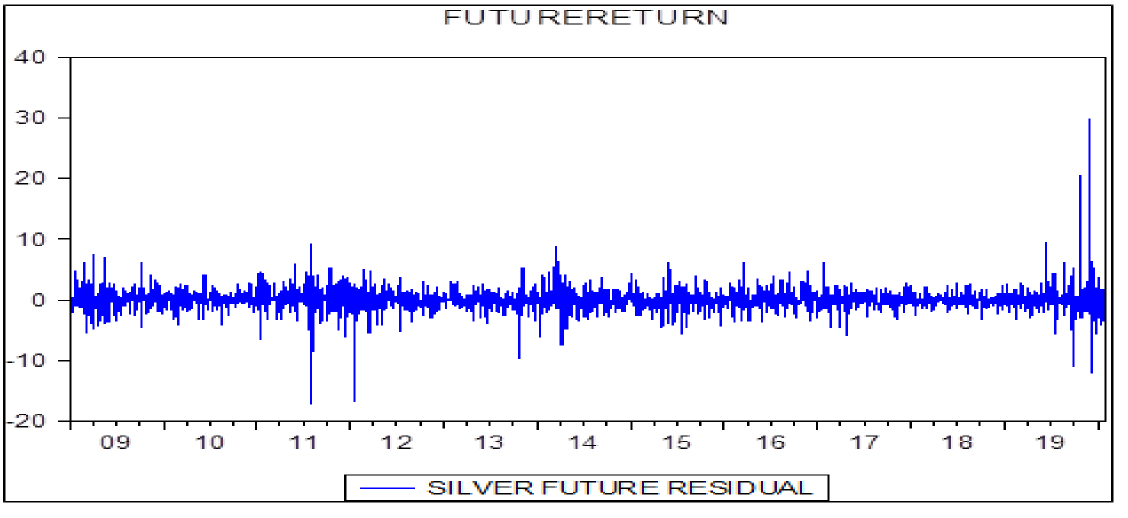


Figure 5.24: Volatility Clustering of Future Returns of Silver

Source: Author's Compilation

Figures 5.1 to 5.24 shows the volatility clustering of spot and futures return series of sample individual commodities for the period ranging from 1st January 2009 to 31st December 2020. The graphical representation of the residuals obtained from the spot and futures commodity market returns of underlying commodities exhibit significant ARCH effects i.e., Volatility Clustering. A visual inspection of this diagram makes it clear that there an intermittent period of high volatility and any reasonable statistical test would infer that those returns are not independently and identically distributed over time.

5.2.2 Descriptive Statistics

The descriptive statistics of daily return series of select individual commodities are summarised in table 4.1 to 4.5 (Chapter III). The average daily returns of all commodities are positive except for commodity Natural Gas. The estimated co-efficient of the Kurtosis of the daily return series are relatively high, suggesting that the underlying distributions are leptokurtic or heavily tailed and peaked towards the mean compared to a normal distribution. The observed skewness and kurtosis indicate that the distribution of daily return series is non-normal. The Jarque -Bera statistics of all the return series are statistically significant at the 1% significance level. However, these descriptive statistics results are not free from limitations. Firstly, volatility is measured through standard deviation over the short period of time. The question remains unclear about the short period, whether two year, ten years or ten days etc. Secondly, it is generally believed that recent past information has greater effect on current prices than the distant past information. Therefore, relative importance should be given more to recent past information than the distant past information which standard deviation does not take into consideration. Therefore, this study uses ARCH and GARCH techniques which overcome the above limitations. Before applying the volatility models, the data series needs to be converted into stationary. To make the series stationary, the series are converted to their return series. The return series are plotted in a graph to understand the volatility clustering.

5.2.3 Augmented Dickey Fuller Test (ADF)

Modelling of non-stationary variables leads to potentially misleading inferences about the degree of association and estimated parameters. Therefore, the order of integration or stationarity of price series must be determined. Spot price and futures price return series are tested for the stationarity by applying the Augmented Dickey-Fuller (ADF) Test.

Table 5.1: Results of Augmented Dickey-Fuller (ADF) Test of Individual Commodities

	ADF TEST			
Commodities	**Spot Return**		**Future Return**	
	t-statistics	**p-value**	**t- statistics**	**p-value**
Cardamom	**-22.1284**	**0.000***	**-51.0099**	**0.0001***
Cotton	**-19.1042**	**0.000***	**-53.0707**	**0.0001***
Crude Palm Oil	**-32.1723**	**0.000***	**-35.7694**	**0.000***
Mentha Oil	**-52.0714**	**0.0001***	**-39.5801**	**0.000***
Aluminum	**-59.6059**	**0.0001***	**-55.6765**	**0.0001***
Copper	**-65.0631**	**0.0001***	**-57.3033**	**0.0001***
Nickel	**-60.5358**	**0.0001***	**-57.174**	**0.000***
Lead	**-61.7492**	**0.0001***	**-54.4955**	**0.0001***
Crude Oil	**-18.8482**	**0.000***	**-16.0902**	**0.000***
Natural Gas	**-58.9552**	**0.0001***	**-57.2709**	**0.0001***
Gold	**-53.173**	**0.0001***	**-55.7483**	**0.0001***
Silver	**-53.7685**	**0.0001***	**-57.1724**	**0.0001***
Note: * Significant at 1 % level; Source: Author's Compilation				

ADF Test statistics reject the hypothesis of a unit root at 1% level of significance in return series, implying the fact that the return series are stationary. Stationarity of the return series also exhibits that these markets do not exhibit characteristics of random walk and as such are not efficient in the weak form.

5.2.4: ARCH LM Test:

The existence of heteroskedasticity in asset returns has been well documented in the existing literature. If the error variance is not constant (heteroskedastic), then the estimates of OLS is inefficient. The tendency of volatility clustering in financial data can be well captured by a Generalized Autoregressive Conditional Heteroskedastic (GARCH) model. Therefore, we modelled the time-varying conditional variance in the study as a GARCH process. To identify the type of GARCH model that is more appropriate for our data, ARCH LM Test (Engle 1982) was performed. This is a Lagrange Multiplier Test for the existence of an ARCH effect in the residuals.

The Engle (1982) ARCH-LM test statistics was conducted in order to test the null hypothesis of no ARCH effects and its results are reported in the table 5.2. The test statistics are highly significant at 1% level, confirming the presence of significant ARCH effects on the spot and futures return series of all selected underlying commodities.

Table 5.2: ARCH LM Test Results of Spot and Futures Return Series of Individual Commodities.

Name of the Commodity	ARCH LM Test Statistics			
	Spot Returns	Prob. Value	Futures Returns	Prob. Value
AGRICULTURE				
Cardamom	41.537	0.000*	8.780	0.003*
Cotton	78.076	0.000*	15.159	0.000*
Crude Palm Oil	3.052	0.023**	0.744	0.000*
Mentha Oil	344.388	0.000*	190.640	0.000*
METAL				
Aluminium	17.634	0.000*	9.964	0.0016*
Copper	492.842	0.000*	30.669	0.000*
Nickel	70.045	0.000*	13.851	0.0002*
Lead	196.060	0.000*	1.920	0.000*
ENERGY				
Crude Oil	128.956	0.000*	256.166	0.000*
Natural Gas	144.196	0.000*	37.258	0.000*
BULLION				
Gold	2.090	0.000*	10.715	0.0011*
Silver	1.168	0.000*	17.199	0.000*

*Note: * Significant at 1 % level ** significant at 5% level.; Source: Author's Compilation*

Before applying ARCH analysis, the study tests for heteroskedasticity effect on the commodities under consideration. This test detects the existence of the ARCH effect in the residuals of the daily return series. The ARCH -LM test statistics are highly significant at 1% level, confirming the presence of significant ARCH effects on the spot and futures return series of sample commodities, namely, Cardamom, Cotton, Crude Palm Oil, Mentha Oil, Aluminium, Copper, Nickel, Lead, Crude Oil, Natural Gas, Gold and Silver.

5.2.5: Estimation of Volatility Persistence using GARCH Family Models

The initial analysis of the commodity spot and futures return series is showing the basic characteristics of financial time series facts like skewness, kurtosis and non-normal distribution and stationarity test is showing the stationarity of return series. Significant heteroscedasticity in return series can be removed by using GARCH model. Thus, the current study uses GARCH framework to examine the presence of stylized facts of volatility in Indian commodity market. The estimates are generated by using GARCH (1,1) which is explained in detail in chapter I (Research Methodology). $\alpha 1$ and β are the ARCH and GARCH terms respectively, which can be defined as the coefficients that measure the impact of recent news and old news on volatility respectively. Sum of $\alpha 1$ and β measures the persistence of volatility. Large value of GARCH coefficient shows the high volatility persistence while the large value of ARCH coefficient signifies less persistence. As GARCH model incorporates squared value of error term, so fails to explain the leverage effect in the model. Thus, for the further examination of the asymmetricity of volatility in individual commodities EGARCH model proposed by Nelson (1991) and TGARCH model developed by Zakoian (1994) are used.

5.2.5.1: GARCH (1,1) Model

The results of GARCH (1,1) Model are presented in table 5.3, 5.4 and 5.5.

Table 5.3: Estimates of GARCH (1,1) Model for Agricultural Commodities

Coefficients	Cardamom		Cotton		Crude Palm Oil		Mentha Oil	
Mean Equation								
	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures
μ (Constant)	0.0061 (0.8826)	0.0010 (0.9798)	-0.0185 (0.2629)	0.0292 (0.1898)	0.0178 (0.2936)	0.0119 (0.5051)	-0.0278 (0.2253)	0.3875 (0.3419)
Variance Equation								
ω (Constant)	1.1157*	8.8184*	0.2288*	1.0432*	0.0718*	0.0202*	0.0848*	8.7645*
α (ARCH Effect)	0.2532*	0.2530*	0.1668*	0.4200*	0.0754*	0.0403*	0.1712*	0.3925*
β (GARCH Effect)	0.5215*	-0.021*	0.4744*	-0.003*	0.8614*	0.9485*	0.8003*	-0.035*
α + β	0.7747	0.2315	0.6412	0.4169	0.9368	0.9888	0.9715	0.3571
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	0.0014	0.3090	0.0176	0.4102	0.089	0.0298	0.007	5.8051
Prob. Chi Square	0.9697	0.5783	0.8942	0.5218	0.766	0.8629	0.935	0.065
Note: Significance at 1% Level.; Source: Author's Compilation								

The above table presents the estimates of the GARCH (1,1) model to determine the volatility persistence effect which takes place in agricultural commodities for the sample period. ARCH (1) variance depends on the squared residuals and GARCH (1,1) variance depend on past variance. GARCH (1,1) refers to the first order ARCH term and first order GARCH term in the conditional variance equation. In the GARCH (1,1) model, α (ARCH 1) is the news coefficient, with a higher value implying that recent news has greater impact on price changes. Similarly, β (GARCH 1) reflects persistence of volatility, it indicates that the level of persistence in information and its effects on volatility. Coefficients values in the mean equation are not statistically significant for spot and futures returns of Cardamom, Cotton, Crude Palm Oil and Mentha Oil. However, coefficient values in variance equation are statistically significant for all agricultural commodities under study. GARCH (1,1) results for CPO futures returns show $\alpha = 0.0403$ and $\beta = 0.9485$ which suggests that past conditional variance has a greater impact on current change in return than recent shocks or news announcements.

The results show the co-efficient value of alpha and beta is 0.77 (Cardamom Spot Market) 0.93 (CPO Spot Market) 0.98 (CPO Futures Market) implying the high volatility and statistically significant at 0.05 significance level. This high volatility indicates inefficiency of the market. There is high volatility persistence in spot market of cardamom and CPO and future market of CPO based on the co-efficient value.

The total of alpha and beta values is 0.23 (Cardamom Futures Market) 0.64 (Cotton Spot Market) 0.4 (Mentha Oil Futures Market) which indicates low volatility and statistically significant at 0.05 significance level. Based on co-efficient value and p-value it can be said that futures market of Cardamom, Cotton and Mentha Oil and Spot Market of Cotton is efficient because of its low volatility.

High β, value shows that persistence of volatility due to old news. If sum of both of the coefficient values is less than unit then the model is stationary and mean reverting. Coefficients values of variance equation results are statistically significant for Cotton, CPO and Mentha oil, which indicate that past conditional variance has greater impact on current change in returns than recent shocks or news announcement and volatility persists over time in the commodities under study. Coefficient values of Cotton, CPO and Mentha oil (Futures) violate the non-negative constraint. A negative value in the conditional variance equation does not make any economic sense. The diagnostic checking of the presence of the ARCH effect has been done using ARCH-LM test. The p- value of the test is found to be higher than 0.05, indicating the absence of ARCH effect in residuals of the model. This confirms that the model is well specified.

Table 5.4: Estimates of GARCH (1,1) Model for Non- Agricultural Commodities (Base Metal)

Coefficients	Aluminum		Copper		Nickel		Lead	
Mean Equation								
	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures
μ (Constant)	0.0392 (0.0784)	0.0241 (0.2739)	0.0305 (0.2052)	0.0307 (0.1827)	0.0344 (0.273)	0.0344 (0.2429)	0.0479 (0.0792)	0.0379 (0.1748)
Variance Equation								
ω (Constant)	0.0918*	0.0048*	0.0589*	0.0231*	0.2578*	0.1039*	0.1024*	0.0928*
α (ARCH Effect)	0.0694*	0.0120*	0.0718*	0.0234*	0.0744*	0.0429*	0.0786*	0.0367*
β (GARCH Effect)	0.8803*	0.9846*	0.9057*	0.9631*	0.8514*	0.9235*	0.8926*	0.9281*
α + β	0.9496	0.9966	0.9775	0.9864	0.9258	0.9664	0.97288	0.964873
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	0.2496	7.1028	0.109	13.9268	6.358	0.8620	1.0009	0.550
Prob. Chi Square	0.6173	0.0077	0.741	0.065	0.071	0.352	0.3171	0.458

Note: * Significance at 1 % level. ; Source: Author's Compilation

From the table 5.4 it can be seen that the Coefficient, ω, α and β are statistically significant for all metal commodities. It suggests that volatility of current day depends on previous days information of volatility and previous days squared residual. Coefficient values in the mean equation are not statistically significant for Aluminium, Copper, Nickel and Lead. The values of β are significantly higher than α, indicating a longer memory and volatility of the Metal commodities under study are sensitive to their own lagged values than new information in the market. The size of α and β indicates the volatility persistence of the commodities.

The result shows the co-efficient value of alpha and beta is 0.94 (Aluminium Spot Market) 0.99 (Aluminium Futures Market) 0.97 (Copper Spot Market) 0.98 (Copper Futures Market) 0.92 (Nickel Spot Market) 0.96 (Nickel Futures Market) 0.97 (Lead Spot Market) 0.96 (Lead

Futures Market) implying high volatility in the markets and statistically significant at 0.05 significance level. This high volatility indicates the inefficiency of the market. The value of all commodities is very close to 1, indicating a high level of volatility persistence. This confirms that volatility takes longer time to reduce. The residual test of ARCH-LM test shows the absence of ARCH effect, indicating that the model is well specified.

Table 5.5: Estimates of GARCH (1,1) Model for Non- Agricultural Commodities (Energy and Bullion)

	Energy				Bullion			
Coefficients	**Crude Oil**		**Natural Gas**		**Gold**		**Silver**	
Mean Equation								
	Spot	**Futures**	**Spot**	**Futures**	**Spot**	**Futures**	**Spot**	**Futures**
μ (Constant)	**0.0754 (0.017)**	**0.0899 (0.002)**	**0.0114 (0.800)**	**0.0245 (0.569)**	**0.0403 (0.016)**	**0.0300 (0.053)**	**0.0171 (0.593)**	**0.0225 (0.382)**
Variance Equation								
ω (Constant)	**0.0966***	**0.0502***	**0.1016***	**0.0745***	**0.1549***	**0.0141***	**1.2676***	**0.0198***
α (ARCH Effect)	**0.1335***	**0.1013***	**0.0613***	**0.0553***	**0.1232***	**0.0581***	**0.2563***	**0.0502***
β (GARCH Effect)	**0.8697***	**0.9011***	**0.9296***	**0.9382***	**0.6846***	**0.9295***	**0.3468**	**0.9477***
α + β	**1.0032**	**1.0025**	**0.9909**	**0.9936**	**0.8079**	**0.9876**	**0.6031**	**0.9980**
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	**0.0247**	**0.0669**	**0.148**	**6.3486**	**0.0157**	**0.1682**	**0.0323**	**0.3655**
Prob. Chi Square	**0.8751**	**0.7959**	**0.712**	**0.0117**	**0.9003**	**0.681**	**0.8573**	**0.5454**
Note: * Significance at 1 % level.; Source: Author's Compilation								

Coefficients values in the mean equation are not statistically significant for Energy and Bullion commodities under study. However, Coefficients values in variance equation are statistically significant. GARCH (1,1) results for Crude Oil futures return show α=0.1013 and β=0.9011 which suggests that past conditional variance has a greater impact on current change in return than recent shocks or news announcements. The values β are significantly higher than α, indicating a longer memory and volatility of commodities under precious metals and Energy segment. The volatility persistence found to be extremely high in spot and futures series of Crude Oil as the total α+ β is found to be greater than unity. High β, value shows that persistence of volatility is due to old news. If sum of both of the coefficient values is less than unit then the model is stationary and mean reverting. Coefficients values of variance equation results are statistically significant which indicate that past conditional variance has greater impact on current change in returns than recent shocks or news announcement and volatility persists over time in the commodity under study.

The results of ARCH -LM test indicate that the fitted GARCH model has no further ARCH effects.

5.2.5.2: Asymmetric Models

E-GARCH and GJR-GARCH (TGARCH) Model

Asymmetric volatility is one of the important features of commodity derivatives market, where bad news generates more volatility than good news of similar magnitude. The study uses two asymmetric models i.e., EGARCH and GJR-GARCH to investigate asymmetric behaviour of the commodity market. EGARCH propounded by Nelson (1991), gives conditional volatility model to address the problem of leverage effect. The result of EGARCH statistics to determine the leverage effect have been depicted in table 5.6.

Table 5.6: Estimates from E-GARCH (1,1) Model for Agricultural Commodities

Coefficients	Cardamom		Cotton		Crude Palm Oil		Mentha Oil	
Mean Equation								
	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures
μ (Constant)	0.1422 (0.000)*	-0.0278 (0.608)	-0.054 (0.000)*	-0.0149 (0.484)	0.03267 (0.059)	0.02582 (0.211)	0.13763 (0.000) *	0.49754 (0.000) *
Variance Equation								
ω (Constant)	0.3028*	-0.0155	-0.555*	-0.146*	-0.348*	-0.0558*	-0.1605*	2.6453*
α (ARCH Effect)	0.3552*	0.1335*	0.3843*	0.5681*	0.4632*	0.0856*	0.3079*	0.5866*
λ (Leverage Effect)	-0.031*	-0.066*	0.1096*	-0.192*	0.0778*	0.0186*	0.0734*	0.1104*
β (GARCH Effect)	0.6079*	0.9675*	0.4353*	0.2204*	0.1573*	0.9881*	0.9060*	-0.2874*
α + β	0.9631	1.1010	0.81969	0.7886	0.6206	1.07379	1.2139	0.29914
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	0.0012	0.6621	3.537	0.1378	1.255	0.0001	0.205	0.0100
Prob. Chi Square	0.972	0.4158	0.060	0.7104	0.262	0.9915	0.650	0.9202
*Note: * Significance at 1% level; Source: Author's Compilation*								

Table 5.6 presents the results of the univariate EGARCH model. The volatility persistence is found to be extremely high in futures series of Cardamom, CPO and spot series of Mentha oil, as the total α + β is found to be greater than unity. GARCH coefficient β is positive and

significant for spot and futures series of Cardamom, Cotton, CPO and spot series of Mentha oil, indicating that the shocks are highly persistent in the long run. The ARCH coefficient α is positive and significant for all series, conveying that the shocks are persistent in the short term. The presence of leverage effect is confirmed in the case of spot and futures series of Cardamom and futures series of Cotton as the λ is negative and significant. Bad news generates more volatility than good news in these markets. However, it is positive and significant for spot series of Cotton, CPO and Mentha oil and futures series of CPO and Mentha Oil, conveying that good news generates more volatility as there is absence of leverage effect in this series. The ARCH-LM test proves the presence of heteroskedasticity in all series. The diagnostic criteria for the residuals reveal that all the models are correctly specified. The results of diagnostic test show that the residuals are free from serial correlation and ARCH effect.

Table 5.7: Estimates from E-GARCH (1,1) Model for Non- Agricultural Commodities (Base Metal)

Coefficients	**Aluminum**		**Copper**		**Nickel**		**Lead**	
Mean Equation								
	Spot	**Futures**	**Spot**	**Futures**	**Spot**	**Futures**	**Spot**	**Future s**
μ(Constant)	**0.0443 (0.057)**	**0.0431 (0.047)**	**0.0131 (0.593)**	**0.0492 (0.032)**	**0.0753 (0.012)**	**0.0368 (0.209)**	**0.0892 (0.000) ***	**0.0202 (0.487)**
Variance Equation								
ω(Constant)	**-0.056***	**-0.024***	**-0.095**	**-0.015**	**-0.0132**	**-0.039***	**-0.093***	**-0.01***
α (ARCH Effect)	**0.0861***	**0.0347***	**0.1593**	**0.0251**	**0.1425**	**0.0774***	**0.1694***	**0.017***
λ (Leverage Effect)	**0.0042***	**0.0038***	**-0.0481***	**-0.029***	**-0.003***	**-0.011***	**0.004***	**-0.010***
β (GARCH Effect)	**0.9869***	**0.9980***	**0.9786***	**0.9938***	**0.9247***	**0.9833***	**0.9738***	**0.996***
α + β	**1.0731**	**1.0327**	**1.1379**	**1.0190**	**1.0673**	**1.0607**	**1.1433**	**1.013**
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	**0.008**	**11.97**	**43.64**	**4.68**	**0.37**	**2.58**	**3.67**	**1.23**
Prob. Chi Square	**0.927**	**0.085**	**0.828**	**0.061**	**0.5382**	**0.108**	**0.0573**	**0.267**
Note: * significance at 1% level; ***Source: Author's Compilation***								

From the table 5.7, it can be seen that the presence of leverage effect is confirmed in the case of spot and futures return series of Copper, Nickel and futures return series of Lead. Bad news generates more volatility than good news in this market. However, it is positive and significant for spot series of Aluminium, Copper, Nickel and Lead and positive and insignificant for futures series of lead, conveying that good news generates more volatility in this market. The volatility persistence is found to be extremely high in all commodities as the total of α + β is found to be greater than unity. ARCH coefficient α is positive and significant for all the series except for spot series of Copper, conveying that the shocks are persistent in the short term. GARCH coefficient β is positive and significant for all series, except in the case spot series of Copper, indicating that the shocks are highly persistent in the long run. Finally, the diagnostic checking of no ARCH effect is confirmed with the insignificant values of test statistic of ARCH-LM test. The results of diagnostic tests show that the residuals are free from serial correlations and arch effect.

Table 5.8: Estimates from E-GARCH (1,1) Model for Non- Agricultural Commodities (Energy and Bullion)

	Energy				Bullion			
Coefficients	**Crude Oil**		**Natural Gas**		**Gold**		**Silver**	
Mean Equation								
	Spot	**Futures**	**Spot**	**Futures**	**Spot**	**Futures**	**Spot**	**Futures**
μ (Constant)	**-0.039 (0.226)**	**0.0123 (0.684)**	**0.0279 (0.553)**	**0.0500 (0.256)**	**0.08516 (0.035)**	**0.0528 (0.000)**	**0.1043 (0.001)**	**0.0398 (0.121)**
Variance Equation								
ω (Constant)	**-0.063***	**-0.066***	**-0.075***	**-0.077***	**-0.275***	**-0.096***	**0.363***	**-0.079***
A (ARCH Effect)	**0.1214***	**0.1143***	**0.1424***	**0.1295***	**0.2828***	**0.1337***	**0.3647***	**0.1269***
λ (Leverage Effect)	**-0.1216***	**-0.102***	**0.0097***	**0.0128***	**0.0139***	**0.0347***	**0.0655***	**0.0222***
β (GARCH Effect)	**0.9860***	**0.9873***	**0.9871***	**0.9912***	**0.7025***	**0.9819***	**0.4034***	**0.9947***
α + β	**1.1074**	**1.1016**	**1.1295**	**1.1207**	**0.9854**	**1.1157**	**0.7618**	**1.1217**
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	**0.5864**	**0.1555**	**0.1139**	**15.739**	**0.0043**	**0.1229**	**0.0081**	**0.0649**
Prob.Chi Square	**0.4438**	**0.6933**	**0.736**	**0.102**	**0.9479**	**0.7259**	**0.9284**	**0.7988**
Note: * Significance at 1% level of significance ***Source: Author's Compilation***								

The table 5.8 presents the results of the univariate EGARCH model for the energy-based and bullion commodities traded on MCX. The volatility persistence is found to be extremely high for all commodities as the total of α + β is found to be greater than unity. GARCH coefficient β is positive and significant for all commodities, indicating that the shocks are highly persistent in the long run. ARCH coefficient α is positive and significant for all series, conveying that the shocks are persistent in the short term. The EGARCH model indicates the leverage effect. It is negative and significant for only one commodity Crude Oil. Bad news generates more volatility than good news in this market. However, there is no leverage effect for commodities Natural Gas, Silver and Gold as λ value is positive and significant.

GJR-GARCH Model (TGARCH)

Table 5.9: Estimates of T-GARCH (1,1) Model for Agricultural Commodities

Coefficients	Cardamom		Cotton		Crude Palm Oil		Mentha Oil	
Mean Equation								
	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures
μ (Constant)	-0.0106 (0.795)	0.05868 (0.290)	-0.0213 (0.194)	-0.02639 (0.2739)	0.0197 (0.269)	0.0230 (0.271)	0.0024 (0.917)	0.4245 (0.000) *
Variance Equation								
ω (Constant)	1.1271*	0.3211*	0.2715*	1.0544*	0.0691*	0.0179*	0.0841*	9.8816*
α (ARCH Effect)	0.2105*	0.0063	0.2816*	0.1186*	0.0914*	0.0514*	0.2215*	0.5839*
λ (Leverage Effect)	0.0945	0.1353*	-0.139*	0.5771*	-0.027*	-0.019*	-0.103*	-0.566*
β (GARCH Effect)	0.5168*	0.9111*	0.3729	-0.0014*	0.8620*	0.9489*	0.8023*	-0.0673*
α + β	0.7273	0.9174	0.65453	0.1172	0.9534	1.0003	1.0238	0.5165
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	0.0021	2.0147	0.0377	0.3965	0.183	0.0295	0.006	0.4247
Prob. Chi Square	0.9633	0.1558	0.8459	0.5289	0.669	0.8636	0.938	0.5701

Note: * Significance at 1% level ***Source: Author's Compilation***

The table 5.9 shows the results of TGARCH (1,1) model for agricultural commodities under study. The analysis shows that the coefficient of leverage effect, λ is positive and significant for spot and futures returns of Cardamom and futures return of Cotton. This confirms the presence of asymmetric effect, which indicate bad news creates more volatility than good news. The size of α and β indicates the volatility persistence of the commodities. The value of all commodities is very close to 1, indicating a high level of volatility persistence. This confirms that volatility takes longer time to reduce. The diagnostic checking of no ARCH effect is confirmed by insignificant p-values.

Table 5.10: Estimates from TGARCH (1,1) Model for Non- Agricultural Commodities (Base Metal)

Coefficients	Aluminum		Copper		Nickel		Lead	
Mean Equation								
	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures
μ (Constant)	0.0443 (0.056)	0.0277 (0.212)	0.0029 (0.908)	0.0307 (0.182)	0.0753 (0.011)	0.0281 (0.355)	0.0545 (0.057)	0.0252 (0.390)
Variance Equation								
ω (Constant)	-0.056*	0.0054*	0.0560*	0.0914*	0.2565*	0.0957*	0.1028*	0.0143*
α (ARCH Effect)	0.0862*	0.0164*	0.0414*	0.0714*	0.0719*	0.0314*	0.0872*	0.0041
λ (Leverage Effect)	0.0042	-0.013*	0.0613*	0.0092*	0.0047	0.0195	-0.0182	0.0082*
β (GARCH Effect)	0.9869*	0.9859*	0.9079*	0.8827*	0.8519*	0.9277*	0.8931*	0.9854*
α + β	1.0731	1.0022	0.9494	0.9541	0.9238	0.9592	0.9802	0.9895
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	0.009	5.7531	13.0494	4.119	1.120	0.0586	0.9822	0.567
Prob. Chi Square	0.926	0.0165	0.1039	0.052	0.289	0.8087	0.3217	0.451
Note: * significance at 1 % level			*Source: Author's Compilation.*					

The table 5.10 shows the results of TGARCH (1,1) model for metal commodity under study. The analysis shows presence of asymmetric effect for Aluminium futures, Copper spot, Nickel spot and futures and Lead futures as λ is positive and significant. Other commodities do not exhibit leverage effect. GARCH Coefficient β is positive and significant for all commodities, indicating that the shocks are highly persistent in the long run. The diagnostic checking of no ARCH effect is confirmed by insignificant p-values.

Table 5.11: Estimates of TGARCH (1,1) Model for Non- Agricultural Commodities (Energy and Bullion)

	Energy				Bullion			
Coefficients	Crude Oil		Natural Gas		Gold		Silver	
Mean Equation								
	Spot	Futures	Spot	Futures	Spot	Futures	Spot	Futures
μ (Constant)	-0.0054 (0.8648)	0.01572 (0.6835)	0.0244 (0.6075)	0.0407 (0.3718)	0.0423 (0.0128)	0.0428 (0.0065)	0.0444 (0.1931)	0.0355 (0.1747)
Variance Equation								
ω (Constant)	0.0647*	0.0464*	0.1019*	0.0679*	0.1526*	0.0133*	1.3049*	0.0217*
α (ARCH Effect)	0.0061	0.0097	0.0672*	0.0618*	0.1285*	0.0766*	0.3547*	0.0610*
λ (Leverage Effect)	0.1599*	0.1365*	-0.017*	-0.024*	-0.014*	-0.048*	-0.177*	-0.023*
β (GARCH Effect)	0.9122*	0.9199*	0.9317*	0.9439*	0.6892*	0.9354*	0.32761*	0.94761*
α + β	0.9183	0.9295	0.9989	1.0057	0.8176	1.0119	0.6823	1.0086
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	0.0807	0.0034	0.346	5.0474	0.0139	0.1574	0.0444	0.0355
Prob. Chi Square	0.7763	0.9534	0.556	0.0247	0.906	0.6915	0.1931	0.1747
Note: * Significant at 1% level			*Source: Author's Compilation*					

TGARCH results are reported in the table 5.11 for energy and bullion commodities to analyse asymmetric behavior of the commodities. The analysis shows that the coefficient of leverage effect, λ is positive and significant for Crude Oil spot and futures and Gold spot. This confirms the presence of asymmetric effect, which indicate bad news creates more volatility than good news. Natural gas and Silver do not exhibit leverage effect. The diagnostic checking of no ARCH effect is confirmed by insignificant p-values.

5.3 Volatility Persistence in Commodity Market Indices

The MCX indices namely MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY are used to study the defined objectives as they are representative of the commodities derivatives market.

5.3.1 Descriptive Statistics

The descriptive statistics results for commodity indices are summarized in the table 4.1 (Chapter III). The results show that the daily mean return for all indices are positive and minimum during the sample period. We generally measure volatility trough standard deviation as it catches dispersion of the data. Standard deviation results for MCXENERGY is comparatively more than other indices.

5.3.3: Augmented Dickey Fuller Test and ARCH-LM Test

Table 5.12 presents the ADF and ARCH-LM Test. It is necessary to check the suitability of the series to develop GARCH models. The unit root tests have been carried out to analyse the stationarity properties of the series. The Augmented Dickey Fuller Test have been used to perform the unit root analysis. The test of heteroskedasticity, ARCH-LM test was conducted on the series, and the results are presented in the table 5.12.

Table 5.12: Results of ADF and ARCH-LM tests for Commodity Market Indices

Indices		**ADF**		**ARCH-LM Test for Residuals**	
		t- statistics	**p-value**	**ARCH- LM Statistics**	**p-value**
MCX COMDEX	**Spot**	**-58.737**	**0.000***	**45.416**	**0.000***
	Future	**-35.686**	**0.000***	**51.513**	**0.000***
MCX AGRI	**Spot**	**-29.4693**	**0.000***	**8.029**	**0.000***
	Future	**-51.230**	**0.000***	**38.705**	**0.000***
MCX METAL	**Spot**	**-59.4179**	**0.000***	**98.560**	**0.000***
	Future	**-55.649**	**0.000***	**40.187**	**0.000***
MCX ENERGY	**Spot**	**-35.6623**	**0.000***	**151.777**	**0.000***
	Future	**-51.396**	**0.000***	**142.162**	**0.000***
Note: * Significant at 1% level; ***Source: Author's Compilation***					

From the table 5.12, it can be seen that the p-values of all the variables are less than 0.01, which confirms that the return series are stationary. The ARCH-LM test statistics are highly significant at 1% level, confirming the presence of significant ARCH effects on return series of commodity market indices namely MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY.

After verifying volatility clustering on the return series, stationarity test using ADF tests and heteroskedasticity using ARCH-LM tests, we begin to determine volatility pattern in commodity markets. Based on the above two results, both the conditions were satisfied and the commodity market indices are suitable to fit in GARCH models. The estimates of GARCH (1,1) model are presented in the table 5.13.

5.3.3 Estimation of Volatility Persistence using GARCH Family Models

5.3.3.1 Symmetric Model (GARCH 1.1 Model)

Table 5.13: Estimates of GARCH (1,1) Model for Commodity Market Indices

Coefficients	MCX COMDEX		MCX AGRI		MCX METAL		MCX ENERGY	
	Future	Spot	Future	Spot	Future	Spot	Future	Spot
Mean Equation								
μ (Constant)	0.019	0.0196	0.086	0.0944	0.017	0.0204	0.022	0.0246
Variance Equation								
ω (Constant)	0.019*	0.0209*	0.042*	0.131*	0.021*	0.0452*	0.021*	0.0238*
α (ARCH Effect)	0.062*	0.0657*	0.093*	0.298*	0.057*	0.0862*	0.054*	0.0593*
β (GARCH Effect)	0.909*	0.9208*	0.680*	0.491*	0.915*	0.8698*	0.937*	0.9322*
α + β	0.971	0.9865	0.773	0.789	0.972	0.9660	0.991	0.9560
Log Likelihood	-3375	-4144	-3715	-4103	-3527	-3823	-5057	-5098
AIC	2.396	2.9422	2.637	2.9150	2.504	2.7145	3.588	3.6187
SIC	2.404	2.9507	2.645	2.9234	2.512	2.7229	3.596	3.6271
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	0.259	0.8680	0.014	0.0100	2.667	1.6847	0.909	2.1840
Prob. Chi Square	0.610	0.3516	0.904	0.92	0.102	0.1944	0.340	0.1396

*Note: * Significance at 1% level* *Source: Author's Compilation*

From the table 5.13, it can be seen that the coefficient, ω, α and β are statistically significant. The values of β are significantly higher than α, indicating a longer memory and volatility of the index is sensitive to their own lagged values than new information in the market. Coefficient values in the mean equation are not statistically significant for spot and futures returns of MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY. The size of α + β indicates the volatility persistent of the commodity indices. The value of spot and future series of all indices is close to 1, except in case of MCXAGRI, indicating a high level of volatility persistence. This confirms that the volatility takes a longer time to reduce. The diagnostic checking of the presence of the ARCH effect has been done using ARCH-LM test. The p-value of the test is found to be higher than 0.05, indicating the absence of ARCH effect in residuals of the model. This confirms that the model is well specified.

5.3.3.2 Asymmetric Model (EGARCH and TGARCH Model)

The **Asymmetric models** of GARCH help to capture the leverage effect, if any in the time series. Result obtained from EGARCH (1,1) model results is presented in the table 5.14.

Table 5.14: Estimates of EGARCH (1,1) Model for Commodity Market Indices

Coefficients	MCX COMDEX		MCX AGRI		MCX METAL		MCX ENERGY	
	Futures	Spot	Futures	Spot	Futures	Spot	Futures	Spot
Mean Equation								
μ (Constant)	0.023	0.0253	0.063*	0.0528*	0.020	0.0200	0.004	0.0078
Variance Equation								
ω (Constant)	-0.118*	-0.108*	-0.137*	-0.162*	-0.11*	-0.145*	-0.074*	-0.085*
α (ARCH Effect)	0.140*	0.1652*	0.185*	0.2530*	0.131*	0.199*	0.112*	0.1312*
λ (Leverage Effect)	-0.004*	0.0181*	-0.071*	-0.069*	0.008	0.0084	-0.033*	-0.031*
β (GARCH Effect)	0.970*	0.9804*	0.758*	0.7722*	0.977*	0.962*	0.987*	0.984*
α + β	1.11	1.14	0.933	0.9252	1.108	1.15	1.099	1.11
Log Likelihood	-3376.	-4171	-3620	-4034	-3530	-3832	-5052	-5097
AIC	2.397	2.962	2.570	2.866	2.506	2.721	3.585	3.619
SIC	2.408	2.972	2.580	2.877	2.517	2.732	3.595	3.629
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	0.167	1.5146	0.032	0.0180	1.603	1.9620	1.163	2.8010
Prob. Chi Square	0.682	0.2185	0.856	0.8931	0.205	0.1614	0.280	0.0943
Note: * Significance at 1% level				*Source: Author's Compilation.*				

From the table 5.14, it can be seen that the presence of leverage effect is confirmed in the case of futures market of MCXAGRI and MCXENERGY and not in other indices. The volatility persistence is found to be extremely high in all the indices as the total α + β is found to be greater than unity. The good news and bad news have equal impact on spot and futures market of MCXCOMDEX and MCXMETAL and spot market of MCXAGRI and MCXENERGY as there is absence of leverage effect in this series. Finally, the diagnostic checking of no ARCH effect is confirmed with the insignificant values of test statistic of ARCH - LM test.

Another asymmetric model for modelling the volatility is TGARCH model, which has been developed by Zakaian (1994). The results of TGARCH (1,1) model have been presented in the table 5.15.

Table 5.15: Estimates of TGARCH (1,1) Model for Commodity Market Indices

Coefficients	MCX COMDEX		MCX AGRI		MCX METAL		MCX ENERGY	
	Future	Spot	Future	Spot	Future	Spot	Future	Spot
Mean Equation								
μ (Constant)	0.020	0.0305	0.068*	0.0505*	0.020	0.0232	0.011	0.0136
Variance Equation								
ω (Constant)	0.019*	0.0201*	0.078*	0.1267*	0.021	0.0455*	0.020*	0.0227*
α (ARCH Effect)	0.066*	0.0833*	0.037*	0.1276*	0.064	0.0936*	0.034*	0.0400*
λ (Leverage Effect)	-0.008	-0.033*	0.182*	0.3337*	-0.012	-0.0147	0.032*	0.0311*
β (GARCH Effect)	0.909	0.9208*	0.810*	0.6974*	0.915	0.8694*	0.940*	0.9360*
α + β	0.975	1.00	0.847	0.824	0.979	0.952	0.974	0.976
Log Likelihood	-3375	-4141	-3682	-4065	-3527	-3823	-5052	-5094
AIC	2.396	2.9407	2.614	2.8891	2.504	2.7149	3.585	3.6164
SIC	2.407	2.9512	2.624	2.8996	2.514	2.7255	3.595	3.627
ARCH LM Test for Heteroskedasticity								
ARCH LM Test Statistics	0.304	1.1459	0.021	0.0004	3.019	1.8597	1.011	2.1054
Prob. Chi Square	0.580	0.2845	0.884	0.984	0.082	0.1728	0.314	0.1469

*Note: * Significance at 1% level* *Source: Author's Compilation.*

The table 5.15 shows the result of TGARCH (1,1) model for commodity market indices. The analysis shows that the coefficient of leverage effect, λ is positive and significant in spot and futures market of MCXAGRI and MCXENERGY. This confirms the existence of asymmetric effect in MCXAGRI and MCXENERGY indices. Bad news generates more volatility than good news in this market. However, there is no leverage effect for markets MCXCOMDEX and MCXMETAL as λ value is positive and significant. The diagnostic checking of no ARCH effect if confirmed by insignificant p- values.

5.4 Conclusion

In this study, volatility of four commodity indices and twelve individual commodities traded on MCX is analysed applying various family of GARCH models. Analysis of dynamic behavior of commodity futures market has focused on issues around volatility clustering, mean reversion and volatility asymmetry effect relating to the sample commodities. The daily return price series of four commodity market indices namely MCXAGRI, MCXMETAL, MCXENERGY, and MCXCOMDEX and twelve individual commodities traded on MCX were examined using various symmetric and asymmetric GARCH family models. The symmetric volatility model GARCH (1,1) have been applied, which reveals that there is high volatility persistent found for all commodity market indices and individual commodities except for MCXAGRI and futures market of agricultural commodities namely Cardamom, Cotton and Mentha Oil. Low level of volatility persistence is observed for agricultural commodity futures market since agriculture is a government regulated market, any innovation entering the market has short-lived impact due to government intervention. Commodities from metal and energy sector are found to be most volatile markets as these markets are mostly dependent on the foreign markets.

Volatility is persistent in spot and futures market for all the commodities but the level of persistence differs across the commodities. All the return series of MCX indices and twelve commodities show sign of the mean reversion except for commodity Crude Oil. Total value of ARCH and GARCH is less than 1 as per GARCH (1.1) model which specifies that return volatility will not move indefinitely downward or upwards. In due course, the return volatility will come down to a mean level.

The asymmetric volatility models like EGARCH (1,1) model and TGARCH (1,1) model have been employed to analyse the leverage effect in the commodity market. The Models reveals that there is existence of leverage effect in the case of MCXAGRI, MCXENERGY, spot and futures market of Cardamom, Nickel and Crude Oil, spot market of Copper and Gold, futures market of cotton and Aluminium as the λ is negative and significant. Bad news generates more volatility in the above-mentioned commodities than the good news of the similar magnitude. Whereas, series that does not exhibit leverage effect are MCXCOMDEX, MCXMETAL, Spot and futures market of Mentha Oil, CPO, Lead and Silver, spot market of Cotton and Aluminium, futures market of Copper and Gold as λ value is positive and significant. Here positive news has a greater influence on volatility than negative news of same magnitude.

The empirical result suggests that derivative market in India is having a high volatility persistence except for agricultural commodities. Availability of high inventory and strict delivery rules may be one of the causes for such a high volatility persistence in the Indian commodity market. The existence of mean reversion also confirms that volatility eventually comes back to its mean level because of presence of arbitrage. Existence of high persistence and leverage effect for MCXENERGY index may be due to presence of illegal traders and hoarders and speculation. It is recommended to strengthen the institutional mechanism in India that would bring the commodity under government scanner to gather the evidence of speculation and spot out the illegal traders and hoarders rather than imposing a ban on specific commodity futures trading. The findings obtained for individual commodities and overall market represented by MCX Indices are by and large similar.

CHAPTER VI

HEDGE EFFECTIVENESS OF FUTURES CONTRACTS IN INDIAN COMMODITY DERIVATIVES MARKET

6.1 Introduction

Risk management is one of the vital economic functions of the commodity derivatives market and also the motive for the existence of derivatives market. Derivatives markets carry out risk allocation function and can be used to hedge the prices of the underlying asset. The practice of offsetting the transaction in the spot market with another transaction in the futures market is known as hedging. The requirement for price risk management emerges because of variation in prices of most commodities. The larger and the more unexpected the price variability in a commodity, the greater is the price risk involved in it.

Hedging comprises of buying or selling of a standardised futures contract against the corresponding sale or purchase of the corresponding physical commodity. Hedging performs the economic function to minimise significantly if not eliminate in total, the losses originating from the price risks in commodities. The volatile financial market today has occupied financial risk as centre point in every sphere of economic activity. Thus, hedging of risk has become a very significant concern worldwide.

Hedging effectiveness assess how much reduction in variance of the commodity prices takes place when it is held simultaneously with a futures contract. Johnson (1960) was the first to derive the number of futures contracts necessary to hedge a certain spot position based on reducing the variance of the hedged portfolio. Johnson (1960) and Stein (1961) presented the concept of portfolio theory through hedging spot positions with derivative futures. According to the portfolio theory, hedging with derivative futures can be considered as a portfolio selection problem in which futures can be used as one of the instruments in the portfolio to reduce the overall risk or to maximize utility function. Ederington (1979) employed this concept to determine a risk minimising hedge ratio and derived a measure of hedging effectiveness. The hedge ratio that creates the least portfolio variance should be the optimal hedge ratio, which is also known as the Minimum Variance Hedge Ratio (MVHR). One of the vital theoretical matters in hedging is the determination of the optimal hedge ratio and hedging effectiveness. The optimal hedge ratio for any unbiased futures market can be given by ratio of covariance of (spot prices, futures prices) and variance of (futures prices).

Hedging effectiveness takes a value between zero and one. It is zero when there is no hedging benefit at all and one when the derivative futures contract is a perfect hedge. Here there is 100% risk reduction. Indian commodity derivatives market has gone through many ups and down after establishment of national exchanges. In spite of phenomenal growth for past decade, futures contracts trading has been banned and revived many times specially in agricultural commodities. High growth in commodity derivatives market in India has been accompanied by higher volatility in prices which requires a systematic examination of hedging effectiveness provided by these markets. Such an examination will help in designing superior hedging strategy and diversified portfolio. The fourth objective of the study is to estimate the hedge ratio and hedging effectiveness of Indian commodity derivatives market. For the analysis twelve commodities from different sectors are considered namely four agricultural commodities, four commodities from base metal, two commodities from bullion and two commodities from energy sector for a study period of twelve years (1st January 2009 to 31st December 2020). The data is also divided into two non-overlapping sub-periods of six year each. The first period from 1st January 2009 to 31st December 2014 represents growth phase of the national commodity exchanges and is characterized by high futures trading volume and market depts and the second sub-period from 1st January 2015 to 31st December 2020 is a period when futures trading volume and depth were relatively low.

The purpose of this chapter is to analyse the effectiveness of commodity futures market in hedging price risk. The chapter estimates the price risk and basis risk, optimal hedge ratio, hedging effectiveness through construction of hedged portfolio and un-hedged portfolio and finally how it results into the process of risk management. The study employed OLS, VECM and VECM-GARCH model to estimate hedge ratios and hedging effectiveness for all commodity market indices and individual commodities.

6.2 Empirical Results and Discussion

In order to examine the hedging performance of twelve commodities two constant hedge model techniques such as Ordinary Least Square (OLS) and VECM and one dynamic hedge model such as VECM-GARCH technique were used. Details of these techniques are given in Chapter II (Research Methodology). Natural logarithm of price series has been considered as the most reliable measure of variation of price changes. Thus, for current analysis the price series has been converted in the return series as shown in the chapter II.

6.2.1 Result of ADF and Co-integration Test

Stationarity of the prices series and their first difference is tested using Augmented Dickey Fuller Test (ADF) statistics and co-integration among spot and futures prices is tested employing Johansen Co-integration Tests. The results of table 4.6 to 4.10 (shown in chapter III) indicate that all the commodities are stationary at one percent cent level of significance at first difference. The results of Johansen Co-integration Test (presented in table no 4.11 to 4.15,) confirm that there is long- run relationship between spot and futures prices for all sample commodities and market indices.

6.2.2: Basis Risk and Price Risk Analysis

Basis is computed for near month futures contracts for all twelve commodities under study. Difference between the spot and futures price is termed as basis. Hedging does not eradicate the risk completely but replaces with the price risk. There are usually two reasons for emerging basis risk. First, the asset to be hedged is not exactly the same as the underlying asset of the futures contract. Second, basis risk depends on the closed-out date of the futures contract, if it is near the expiration day, the basis risk is going to be lower. The best way to know if futures contracts have been involved in reducing spot price risk is to compare the variance of basis with variance of spot price. A futures contract is suitable for hedging only if basis risk is lower than spot price risk.

Table 6.1: Estimates of Price Risk and Basis Risk of Commodities

Category	Commodity	Based on Daily Returns	
		Price Risk (%)	Basis Risk (%)
Agricultural Commodities	Cardamom	1.70	2.15
	Cotton	0.73	1.19
	Crude Palm Oil	1.09	2.26
	Mentha Oil	1.67	2.77
Metals	Aluminium	1.58	1.97
	Copper	2.14	2.68
	Lead	2.03	1.95
	Nickel	1.93	1.91
Energy	Crude Oil	2.24	2.80
	Natural Gas	2.96	3.86
Bullion	Gold	1.90	1.65
	Silver	1.46	1.39

Source: Author's Compilation

The table 6.1 shows the estimates of price risk and basis risk of near month contracts of sample commodities over the study period. The outcome suggest that the basis risk is lower than the price risk only for four commodities namely Lead, Nickel, Gold and Silver. Thus, out of twelve sample commodities only four commodities are suitable for hedging, i.e., where there will be a reduction in the variance of spot prices by using futures contracts.

6.2.3: Estimates of Hedge Ratio and Hedging Effectiveness

6.2.3.1 OLS Regression Model

This is the conventional model of the Ordinary Least Square Regression (OLS) which is a linear regression of change in spot price on the change in futures prices. In case of the OLS method, the slope of the regression model is an estimate of the hedge ratio while R-square value gives the hedge effectiveness. The estimates of minimum variance hedge ratio obtained from OLS method is static. In other words, it means that once estimated, the hedger uses this ratio of futures to spot during the entire hedging period.

Table 6.2: Estimates of Hedge Ratio and Hedging Effectiveness by OLS Model

Category	Commodity	Hedge Ratio (H*)	R-Square (HE)
Agricultural Commodities	**Cardamom**	**0.127 ***	**0.052**
	Cotton	**0.198***	**0.109**
	Crude Palm Oil	**0.057 ***	**0.029**
	Mentha Oil	**0.096 ***	**0.047**
Metals	**Aluminium**	**0.346 ***	**0.0045**
	Copper	**0.004***	**0.0001**
	Lead	**0.142 ***	**0.002**
	Nickel	**0.375 ***	**0.114**
Energy	**Crude Oil**	**0.143 ***	**0.016**
	Natural Gas	**0.103 ***	**0.009**
Bullion	**Gold**	**0.271 ***	**0.095**
	Silver	**0.205 ***	**0.049**
*Note: * Significant at 5% level.*	*Source: Author's Compilation*		

The amount of variance reduction by holding the derivative futures contract is a function of beta. In case of the OLS model, the slope of regression model is an estimate of the hedge ratio, while R-Square value gives the hedge effectiveness. The higher the beta value, higher will be the amount of variance reduction. The low level of estimated beta designates that derivative futures contract is not a good choice for risk management in the spot market.

The hedge ratio of agricultural commodities is Cardamom 0.127, Cotton 0.198, Crude Palm Oil 0.057, Mentha Oil 0.096. It means the sample agricultural commodity futures provide 12.7%, 19.8%, 5.7% and 9.6% variance reduction in their spot markets, respectively. The estimates of hedge effectiveness of commodities namely Cardamom, Cotton, Crude Palm

Oil and Mentha Oil are 0.051, 0.108, 0.029 and 0.047 respectively. It reveals that a farmer who is trying to minimize price risk by hedging in futures markets is able to reduce the risk by 5.1%, 10.8%, 2.9% and 4.7% by selling 12.6%, 19.8%, 5.7% and 9.6% of produce in near month contracts of Cardamom, Cotton, Crude Palm Oil and Mentha Oil respectively. Here the hedge ratios estimated for agricultural commodities are comparatively low (Less than 20%). The cotton attains a hedge ratio of 19.8% only followed by cardamom 12.6%, mentha oil 9.6% and CPO 5.7%. This result indicate that the hedge ratio provided by Cardamom, Cotton, CPO and Mentha Oil is ineffective in Indian Commodity Market. The farmer with the Mentha Oil has to face the risk of 94.3% since the mentha oil futures reduces the variance of spot price by 5.7% only.

The hedge ratio of commodities under metal is Aluminium 0.346, Copper 0.0043, Lead 0.141 and Nickel 0.374 respectively. It means, that the sample commodity futures provide for 34.6%, 0.43%, 14.1% and 37.4% variance reduction in their spot markets respectively. The hedge ratio is maximum in case of Aluminium and Nickel. The estimates of hedge effectiveness of Aluminium, Copper, Lead and Nickel are 0.004, 0.00, 0.002 and 0.114, respectively. It reveals that a trader who is trying to minimize price risk by hedging in metal futures markets is able to reduce the risk by 0.4%, 0%, 0.2% and 11.4% by selling 34.6%, 0.43%, 14.1% and 37.4% of the underlying commodity.

The hedge ratio of commodities under category Energy is 0.143 for Crude Oil, 0.102 for Natural Gas, respectively. It means Crude Oil and Natural Gas provide 14.3% and 10.2% variance reduction in spot markets, respectively. The estimates of hedge effectiveness of Crude Oil and Natural Gas is 0.16 and 0.009 respectively. It reveals that a trader who is trying to minimize price risk by hedging in energy futures markets is able to reduce the risk by 1.6% and 0.9% by selling 14.3% and 10.2% of underlying commodity in near month contracts of Crude Oil and Natural Gas respectively.

The hedge ratio of commodities under category Bullion is 0.271 for Gold and 0.204 for Silver respectively. Hedge ratio is maximum in case of Gold. It means Gold and Silver provide 27.1% and 20.4% variance reduction in their spot markets respectively. The estimates of hedge effectiveness are 0.094 for commodity Gold and 0.049 for commodity Silver. It reveals trader who is trying to minimize price risk by hedging in futures market is able to reduce the risk by 9.4% and 4.9% of the underlying commodity in near month contracts of Gold and Silver respectively.

The usage of OLS Regression for calculating the hedge ratio and regression coefficient R^2 have been criticised in two ways. Firstly, the hedge ratio obtained from OLS regression method becomes a biased one, if there is a cointegration relationship between the spot and futures prices of commodities. In this study there is cointegration between the spot and futures prices for all commodities under study. Usage of Vector Error Correction Model is appropriate, if the spot and futures prices of two series are cointegrated. Secondly, the constant hedge model does not consider the time varying nature of the spot and futures series thus it becomes time invariant.

6.2.3.2 Estimates of Hedge Ratio and Hedging Effectiveness of Vector Error Correction Model.

Hedge ratio and hedging effectiveness of twelve commodities are estimated based on the Vector Error Correction Model parameters. The ratio of the variance of the un-hedged position less variance of hedged position over the variance of un-hedged position is known as hedging effectiveness. Though, the time varying conditional covariance structure of futures and spot prices is not measured under VECM model, yet it is considered as the best model to capture the constant hedge ratio and hedging effectiveness as it takes into account the long-term co-integration among the spot and futures prices. The parameters of VECM model are estimated and residuals from this model is used to calculate hedge ratio and hedging effectiveness.

The optimal hedge ratio and hedge effectiveness for the entire study period (1st January 2009-31st December 2020), First sub-period (1st January 2009-31st December 2014) and Second Sub-period (1st January 2014-31st December 2020) is presented in table 6.3, 6.4 and 6.5 respectively.

Hedge Ratio and Hedging Effectiveness of Commodity Futures Contracts for Entire Study Period

Table 6.3: Estimates of Hedge Ratio and Hedging Effectiveness by VECM Model [Entire Period: 1st January 2009 to 31st December 2020]

Commodity	Variance (Spot)	Variance (Future)	Covariance (Spot:Future)	Hedge Ratio	Variance (Unhedged)	Variance (Hedged)	Hedge Effectiveness
Agricultural Commodities							
Cardamom	**0.00026**	**0.00093**	**0.00013**	**0.13439**	**0.00026**	**0.00025**	**0.06387**
Cotton	**0.00004**	**0.00015**	**0.00003**	**0.21759**	**0.00004**	**0.00004**	**0.15973**
Crude Palm Oil	**0.00008**	**0.00008**	**0.00003**	**0.44600**	**0.00008**	**0.00007**	**0.18800**
Mentha Oil	**0.00026**	**0.00113**	**0.00021**	**0.18723**	**0.00026**	**0.00022**	**0.15501**
Non- Agricultural Commodities (Metal)							
Aluminium	**0.00012**	**0.00014**	**0.00006**	**0.40548**	**0.00012**	**0.00010**	**0.18690**
Copper	**0.00009**	**0.00001**	**0.00000**	**0.12242**	**0.00009**	**0.00009**	**0.00086**
Lead	**0.00014**	**0.00027**	**0.00004**	**0.14848**	**0.00027**	**0.00013**	**0.50774**
Nickel	**0.00021**	**0.00030**	**0.00013**	**0.44346**	**0.00021**	**0.00015**	**0.28153**
Non- Agricultural Commodities (Energy)							
Crude Oil	**0.00016**	**0.00040**	**0.00007**	**0.17479**	**0.00016**	**0.00014**	**0.07844**
Natural Gas	**0.00035**	33.97514	**0.02533**	**0.00075**	**0.00035**	**0.00033**	**0.05357**
Non- Agricultural Commodities (Bullion)							
Gold	**0.00004**	**0.00009**	**0.000028**	**0.3260**	**0.00004**	**0.00003**	**0.24960**
Silver	**0.00004**	**0.00009**	**0.00003**	**0.32595**	**0.00004**	**0.00003**	**0.25072**
Source: Author's Compilation							

The table 6.3 shows the results of the hedge ratio and hedge effectiveness of commodity futures using VECM model for the entire study period. It reveals that the hedge ratios of agricultural commodities viz Cardamom, Cotton, Crude Palm Oil and Mentha Oil are 0.14, 0.22, 0.45 and 0.19 respectively. It means that the sample commodity futures provide 14%, 22%. 45% and 19% variance reduction in their spot markets respectively. The estimates of hedge effectiveness are 0.063, 0.159, 0.188 and 0.155 respectively. It reveals that a farmer who is trying to minimize price risk by hedging in futures markets is able to reduce the risk by 6.3%, 1.5% and 1.8% by selling 14%, 22%, 45% and 19% of produce in near month contracts of Cardamom, Cotton, Crude Palm Oil and Mentha Oil, respectively. The result show that hedge ratio provided by agricultural commodities is ineffective in Indian Commodity Market.

The hedge ratio of non-agricultural commodity under metal segment namely Aluminium, Copper, Lead and Nickel are 0.40, 0.12, 0.15 and 0.44 respectively. It means that the sample commodity futures provide 40%, 12%, 15% and 44% variance reduction in their spot markets respectively. The estimates of hedge effectiveness are 0.186, 0.0008,0.507 and 0.281 respectively. It reveals that a trader who is trying to minimise price risk by 18.6%, 0.08%, 50.7% and 28% by selling 40%, 12%, 15% and 44% of the underlying commodity in near month contracts of Aluminium, Copper, Lead and Nickel respectively. In the case of industrial metal, hedging effectiveness is low for copper with 0.08% variance reduction as compared to Aluminium with 18.6% variance reduction. Hedging effectiveness is highest for Lead (50%). The hedge ratio of non-agricultural commodities under Energy category namely Crude Oil and Natural Gas are 0.174, 0.0007 respectively. It means that the sample commodity futures provide 17.4% and 0.07% variance reduction in their spot markets respectively. The estimates of hedge effectiveness are 0.078 and 0.053 respectively. It reveals that a trader who is trying to minimize price risk by hedging in futures markets is able to reduce risk by 7.8% and 5.3% by selling 17.4% and 0.07% of the underlying commodity in near month contracts of Crude Oil and Natural Gas respectively.

The hedge ratio of non-agricultural commodities under Bullion category viz Gold and Silver are 0.326 and 0.325 respectively. It means that the sample commodity futures provide 32.6% and 32.5% variance reduction in their spot market respectively. The estimates of hedge effectiveness are 0.249 and 0.250 respectively. It reveals that a trader who is trying to minimize price risk by hedging in futures markets is able to reduce risk by 24.9% and 25% by selling 32.6% and 32.5% of the underlying commodity in near month contracts of Gold and Silver respectively. By purchasing precious metal futures, trader can reduce its risk by 32.6% and 32.5% for commodity Gold and Silver. Copper has the lowest amount of variance reduction followed by Natural Gas, Crude Oil and in agricultural commodities Cardamom has the lowest variance reduction of 6.3%. Highest hedging effectiveness is observed for commodities Lead, Gold and Silver which place them in most effective futures segment.

Hedge Ratio and Hedging Effectiveness of Commodity Futures Contracts for First Sub-Period

Table 6.4: Estimates Hedge Ratio and Hedging Effectiveness by VECM Model (First Sub Period: 1st January 2009-31st December 2014)

Commodity	Variance (Spot)	Variance (Futures)	Covariance (Spot:Futures)	Hedge Ratio	Variance (Unhedged)	Variance (Hedged)	Hedge Effectiveness
Agricultural Commodities							
Cardamom	**0.00037**	**0.00118**	**0.00018**	**0.15456**	**0.00037**	**0.00034**	**0.07639**
Cotton	**0.00005**	**0.00016**	**0.00005**	**0.28941**	**0.00005**	**0.00004**	**0.25543**
CPO	**0.00008**	**0.00008**	**0.00005**	**0.55474**	**0.00008**	**0.00005**	**0.32130**
Mentha Oil	**0.00028**	**0.00096**	**0.00023**	**0.23401**	**0.00028**	**0.00023**	**0.18939**
Non- Agricultural Commodities (Metal)							
Aluminium	**0.00009**	**0.00016**	**0.00004**	**0.21516**	**0.00009**	**0.00008**	**0.08872**
Copper	**0.00006**	**0.00020**	**0.00001**	**0.03062**	**0.00006**	**0.00006**	**0.00317**
Lead	**0.00019**	**0.00032**	**0.00004**	**0.13573**	**0.00019**	**0.00018**	**0.03087**
Nickel	**0.00013**	**0.00029**	**0.00004**	**0.13074**	**0.00013**	**0.00012**	**0.03913**
Non- Agricultural Commodities (Energy)							
Crude Oil	**0.00014**	**0.00031**	**0.00005**	**0.16653**	**0.00014**	**0.00014**	**-0.93984**
Natural Gas	**0.00023**	**0.00077**	**0.00014**	**0.17866**	**0.00023**	**0.00020**	**-0.89131**
Non- Agricultural Commodities (Bullion)							
Gold	**0.00004**	**0.00011**	**0.00003**	**0.32766**	**0.00004**	**0.00001**	**0.786**
Silver	**0.00014**	**0.00033**	**0.00011**	**0.33645**	**0.00014**	**0.00010**	**0.26788**
Source: Author's Compilation							

The table 6.4 shows the results of the hedge ratio and hedge effectiveness of commodity futures Contracts using VECM model for the First Sub-Period (1st January 2009 – 31st

December 2014). The hedge ratio of Cardamom, Cotton, CPO and Mentha Oil are 0.15,0.28.0.55 and 0.23, respectively. It means, that the sample commodity futures provide 15%, 28%, 55% and 23% variance reduction in their spot markets, respectively. The estimates of hedge effectiveness are 0.07,0.25, 0.32 and 0.18, respectively. It reveals that a farmer who is trying to minimize price risk by hedging in futures market is able to reduce the risk by 7%, 25% and 32% by selling 15%, 28%, 55% and 23% of produce in near month contracts of Cardamom, Cotton, CPO and Mentha oil.

The hedge ratio for industrial metals and precious metals namely Aluminium, Copper, Lead, Nickel, Gold and Silver is 0.21, 0.03, 0.135, 0.13, 0.32 and 0.33, respectively. It means, that sample commodity futures provide 21%, 3%, 13.5 %, 13%, 32% and 33% variance reduction in their spot markets, respectively. The estimates of hedge effectiveness are 0.088,0.003, 0.03, 0.78 and 0.26 respectively. It reveals that a manufacturer who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 8.8%, 0.03%, 3.9%, 78% and 26% by 21%, 3%, 13.5%, 13%, 32% and 33% of the underlying commodity of near month futures contracts.

It reveals that hedge ratio and hedge effectiveness if high for precious metals as compared to industrial metals during the First Sub-Period. Gold futures contracts has the highest hedging effectiveness of 78.6% during the First Sub-Period.

The hedge ratio of commodity futures under energy segment is 0.16 and 0.17 for Crude Oil and Natural Gas, respectively. The estimates of hedge effectiveness are -0.93 and -.0.89 for Crude Oil and Natural Gas, respectively. This indicates the near month futures contracts provide negative hedge effectiveness of 93% and 89%. It reveals that the variance of hedged portfolio is increasing as compared to the variance of unhedged portfolio.

Hedge Ratio and Hedging Effectiveness of Commodity Futures Contracts for Second Sub-Period

Table 6.5: Estimates of Hedge Ratio and Hedging Effectiveness by VECM model (Second Sub-Period: 1st January 2015-31st December 2020)

Commodity	Variance (Spot)	Variance (Futures)	Covariance (Spot:Futures)	Hedge Ratio	Variance (Unhedged	Variance (Hedged)	Hedge Effectiveness
Agricultural Commodities							
Cardamom	0.00015	0.00069	0.00007	0.10652	0.00015	0.00015	0.05133
Cotton	0.00004	0.00014	0.00002	0.17566	0.00004	0.00003	0.11214
CPO	0.00008	0.00007	0.00002	0.31212	0.00008	0.00008	0.07970
Mentha Oil	0.00022	0.00130	0.00020	0.15002	0.00022	0.00019	0.13413
Non- Agricultural Commodities (Metal)							
Aluminium	0.00433	0.00014	0.00006	0.43560	0.00433	0.00433	0.00000
Copper	0.00373	0.00014	0.00001	0.09545	0.00373	0.00373	0.00070
Lead	0.00227	0.00021	0.00004	0.19010	0.00227	0.00227	0.00327
Nickel	0.00029	0.00029	0.00023	0.79287	0.00029	0.00011	-0.37214
Non- Agricultural Commodities (Energy)							
Crude Oil	0.00016	0.00049	0.00009	0.18201	0.00016	0.00015	0.10132
Natural Gas	0.00026	0.00076	0.00008	0.10984	0.00026	0.00025	0.03562
Non- Agricultural Commodities (Bullion)							
Gold	0.00003	0.00006	0.00002	0.31896	0.00003	0.00002	0.23290
Silver	0.00007	0.00016	0.00002	0.09612	0.00007	0.00007	0.02037
Source: Author's Compilation							

The table 6.5 reveals the results of hedge ratio and hedge effectiveness of commodity futures returns of sample commodities on their spot returns using VECM model for the Second Sub-Period (1st January 2015-31st December 2020).

The hedge ratio of agricultural commodity futures namely Cardamom, Cotton, CPO and Mentha Oil are 0.10,0.17, 0.31 and 0.15, respectively. It means, that the sample commodity futures provide 10%, 17%, 13% and 15% variance reduction in their spot markets, respectively. The estimates of hedge effectiveness are 0.05, 0.11, 0.079 and 0.13, respectively. It reveals that a farmer who is trying to minimize price risk by hedging in futures markets is able to reduce the risk by 5%, 11%, 7.9% and 13% by selling 10 %, 17%, 31% and 15% of produce in near month contracts of agriculture futures. The hedge ratio for industrial metals and precious metals are Aluminium, 0.43, Copper 0.095, Lead 0.19, Nickel 0.79, Gold 0.31 and Silver 0.096. the estimates of hedge effectiveness are Aluminium 0.00, Copper 0.0007, Lead 0.003, Nickel -0.372, Gold 0.23 and Silver 0.02. This indicates that the hedge effectiveness for industrial metals and precious metal is very low except for commodity gold. It also reveals that the hedge effectiveness of Nickel is negative which means that the variance of hedged portfolio is increasing as compared to the variance of unhedged portfolio of near month contracts of Nickel.

The hedge ratio of Crude Oil is 0.18 and Natural Gas is 0.10. it means Crude oil and Natural Gas futures provides 18% and 10% variance reduction in their spot markets, respectively. The estimates of hedge effectiveness are 0.10 and 0.035 respectively. It reveals that a oil refinery company who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 10% and 3% by selling 18% and 10% of the underlying commodity.

6.2.3.3 Estimates of Hedge Ratio and Hedging Effectiveness of VECM-GARCH (1,1) Model

The existence of ARCH effect in the residual series derived from VECM model confirms the necessity of estimating conditional variance, covariance and time series hedge ratio by using GARCH model. VECM-GARCH (1,1) model is used to estimate conditional covariance and variance of the spot and futures residuals obtained from VECM model.

Table 6.6: Estimates of Hedge Ratio and Hedging Effectiveness by VECM- GARCH (1,1) Model (Entire Period 1st January 2009-31st December 2020)

Commodity	Variance (Spot)	Variance (Futures)	Covariance (Spot:Futures)	Hedge Ratio	Variance (Unhedged)	Variance (Hedged)	Hedge Effectiveness
Agricultural Commodities							
Cardamom	**0.00025**	**0.00094**	**0.00012**	**0.12237**	**0.00025**	**0.00023**	**0.07178**
Cotton	**0.00004**	**0.00015**	**0.00003**	**0.20125**	**0.38157**	**0.00004**	**0.14425**
Crude Palm Oil	**0.00008**	**0.00007**	**0.00003**	**0.44489**	**0.00008**	**0.00006**	**0.19027**
Mentha Oil	**0.00025**	**0.00113**	**0.00012**	**0.18680**	**0.00025**	**0.00021**	**0.15471**
Non- Agricultural Commodities (Metal)							
Aluminium	**0.00012**	**0.00014**	**0.00005**	**0.39445**	**0.00012**	**0.00010**	**0.17390**
Copper	**0.00008**	**0.000006**	**0.0000006**	**0.10261**	**0.00008**	**0.80367**	**0.00080**
Lead	**0.00013**	**0.000247**	**0.00003**	**0.16113**	**0.00013**	**0.00013**	**0.04594**
Nickel	**0.00021**	**0.00028**	**0.00013**	**0.46408**	**0.000212**	**0.00015**	**0.29136**
Non- Agricultural Commodities (Energy)							
Crude Oil	**0.00016**	**0.00040**	**0.0007**	**0.17150**	**0.00015**	**0.00014**	**0.07012**
Natural Gas	**0.00035**	**33.012**	**0.02533**	**0.00075**	**0.00035**	**0.00033**	**0.05020**
Non- Agricultural Commodities (Bullion)							
Gold	**0.00003**	**0.00008**	**0.00002**	**0.32607**	**0.00003**	**0.00002**	**0.23799**
Silver	**0.00003**	**0.00008**	**0.00002**	**0.33763**	**0.00003**	**0.00002**	**0.29968**
Source: Author's Compilation							

Table 6.7: Estimates of Hedge Ratio and Hedging Effectiveness by VECM-GARCH (1,1) Model (First Sub-Period 1st January 2009 to 31st December 2014)

Commodity	Variance (Spot)	Variance (Futures)	Covariance (Spot:Futures)	Hedge Ratio	Variance (Unhedged)	Variance (Hedged)	Hedge Effectiveness
Agricultural Commodities							
Cardamom	**0.00035**	**0.00118**	**0.00018**	**0.15442**	**0.00035**	**0.00033**	**0.10609**
Cotton	**0.00005**	**0.00016**	**0.00005**	**0.28753**	**0.37241**	**0.37242**	**0.26211**
Crude Palm Oil	**0.00007**	**0.82334**	**0.00004**	**0.55486**	**0.00007**	**0.54511**	**0.31741**
Mentha Oil	**0.00026**	**0.00096**	**0.00022**	**0.23401**	**0.00026**	**0.00021**	**0.19093**
Non- Agricultural Commodities (Metal)							
Aluminium	**0.86584**	**0.00015**	**0.00003**	**0.22913**	**0.86584**	**0.78498**	**0.09339**
Copper	**0.00005**	**0.00018**	**0.00005**	**0.03221**	**0.00005**	**0.59489**	**0.00324**
Lead	**0.00017**	**0.00031**	**0.00005**	**0.13888**	**0.00017**	**0.00017**	**0.03412**
Nickel	**0.00013**	**0.00029**	**0.00003**	**0.13074**	**0.00013**	**0.00013**	**0.03622**
Non- Agricultural Commodities (Energy)							
Crude Oil	**0.00014**	**0.00032**	**0.00005**	**0.16773**	**0.00014**	**0.00013**	**-0.93007**
Natural Gas	**0.00022**	**0.00077**	**0.00012**	**0.16569**	**0.000225**	**0.00020**	**-0.90622**
Non- Agricultural Commodities (Bullion)							
Gold	**0.00004**	**0.00011**	**0.00003**	**0.29934**	**0.00004**	**0.00001**	**0.7360**
Silver	**0.00013**	**0.00032**	**0.00011**	**0.33339**	**0.00013**	**0.00009**	**0.27752**
Source: Author's Compilation							

Table 6.8: Estimates of Hedge Ratio and Hedging Effectiveness by VECM- GARCH (1,1) (Second Sub-Period: 1st January 2015 to 31st December 2020)

Commodity	Variance (Spot)	Variance (Futures)	Covariance (Spot:Futures)	Hedge Ratio	Variance (Unhedged	Variance (Hedged)	Hedge Effectiveness
Agricultural Commodities							
Cardamom	**0.00015**	**0.00069**	**0.00007**	**0.10219**	**0.00015**	**0.00014**	**0.04603**
Cotton	**0.00003**	**0.00013**	**0.00002**	**0.17438**	**0.00003**	**0.00003**	**0.11435**
Crude Palm Oil	**0.00008**	**0.00006**	**0.00002**	**0.31165**	**0.00008**	**0.00007**	**0.08056**
Mentha Oil	**0.00020**	**0.00130**	**0.00018**	**0.14017**	**0.00020**	**0.00017**	**0.20830**
Non- Agricultural Commodities (Metal)							
Aluminium	**0.00433**	**0.00011**	**0.00006**	**0.519186**	**0.00433**	**0.00433**	**-0.0000007**
Copper	**0.00352**	**0.00014**	**0.00001**	**0.09336**	**0.00352**	**0.00352**	**0.000712**
Lead	**0.00229**	**0.00020**	**0.00004**	**0.24393**	**0.00227**	**0.00228**	**-0.00345**
Nickel	**0.00028**	**0.00029**	**0.00023**	**0.79980**	**0.00028**	**0.98046**	**-0.33934**
Non- Agricultural Commodities (Energy)							
Crude Oil	**0.00017**	**0.00049**	**0.00009**	**0.18200**	**0.00016**	**0.00015**	**0.05997**
Natural Gas	**0.00025**	**0.00075**	**0.00008**	**0.11642**	**0.00025**	**0.00024**	**0.03956**
Non- Agricultural Commodities (Bullion)							
Gold	**0.00002**	**0.00006**	**0.00002**	**0.30483**	**0.00002**	**0.00002**	**0.21498**
Silver	**0.00007**	**0.00015**	**0.00001**	**0.10579**	**0.00007**	**0.000007**	**0.02325**
Source: Author's Compilation							

Estimation of average hedge ratio and hedging effectiveness from VECM- GARCH (1,1) model is presented in tables 6.6, 6.7 and 6.8 for the Entire Study Period, First Sub-Period and Second Sub-Period. The average hedge ratio and hedging effectiveness estimated from VECM-GARCH (1,1) model are slightly more effective than the constant hedge ratio calculated from VECM model because it incorporates the autoregressive nature of time series. VECM-GARCH result also indicates that hedging effectiveness of commodities Copper, Natural Gas and Crude Oil is very low.

6.2.4: Comparative Analysis of Hedge Ratio and Hedging Effectiveness of Constant Hedge Model and Dynamic Hedge Model.

Table 6.9: Comparative Analysis of Hedging Effectiveness by Constant Hedge Model and Dynamic Hedge Model

Commodity	Hedge Ratio			Hedging Effectiveness		
	OLS	VECM	VECM-GARCH	OLS	VECM	VECM-GARCH
Agricultural Commodities						
Cardamom	12.67	13.43	12.23	5.19	6.38	7.71
Cotton	19.84	21.75	20.12	10.89	15.97	14.42
Crude Palm Oil	5.71	44.60	44.48	2.90	18.80	19.03
Mentha Oil	9.62	18.72	18.68	4.72	15.50	15.47
	Non- Agricultural Commodities (Metal)					
Aluminium	34.66	40.50	39.44	0.44	18.69	17.39
Copper	0.43	12.24	10.26	0.0001	0.08	0.08
Lead	14.19	14.84	16.11	0.23	50.77	45.59
Nickel	37.49	44.34	46.40	11.42	28.15	29.13
	Non- Agricultural Commodities (Energy)					
Crude Oil	14.33	17.47	17.15	1.63	07.84	07.01
Natural Gas	10.26	0.074	0.075	0.91	05.35	05.02
	Non- Agricultural Commodities (Bullion)					
Gold	27.14	32.56	23.79	9.49	24.96	23.79
Silver	20.46	32.59	29.96	4.93	25.07	29.96
Source: Author's Compilation						

The optimal hedge ratios derived from three different models are reported in table 6.9. The results show that the hedge ratios from OLS, VECM and VECM-GARCH model is significant at 5% level, which specifies that the commodity futures can be used to hedge against the underlying spot prices. It is mere not only vital to compute the hedge ratio, it is further required to test whether the hedge ratios obtained from the different models provide the greatest variance reduction and better hedging performance. The hedge ratios obtained from three models were further used in estimating the hedging effectiveness and discover which model provide the greatest variance reduction. OLS R^2 indicates the hedge ratio of the sample commodities. Here the hedge ratios estimated are comparatively low. The CPO attains a hedge ratio of 5.71% only followed by Natural Gas 10.26%.

The usage of OLS Regression for calculating the hedge ratio and regression coefficient R^2 have been criticised in two ways. Firstly, the hedge ratio obtained from OLS regression method becomes a biased one if there is a cointegration relationship between the spot and futures prices of commodities. Secondly, the constant hedge model does not consider the time varying nature of the spot and futures series thus it becomes time invariant. The result show that hedge effectiveness calculated from VECM-GARCH is similar to VECM model. In the case of constant hedge ratio estimation, VECM gives higher hedge ratio and provides greater variance reduction than OLS model.

Hedge ratio of CPO, Aluminium and Nickel is 44.60%, 40.50% and 44.34% respectively. Hedge effectiveness is low for CPO 18.80%, Aluminium 18.69% and Nickel 28.15%. It indicates that though hedge ratios are moderate, investors are unable to reduce risk. It is observed that commodity Lead futures are most effective in hedging followed by Nickel 29%, Silver 25% and Gold 24%. Hedging performance of Commodity Cardamom is very poor because of low volume of trade. The result indicate that hedge provided by the sample commodities is ineffective in the Indian Commodity Market.

6.2.5: Comparative Analysis of Hedge Ratio and Hedging Effectiveness for Different Time Periods

Table 6.10: In-Sample Comparison of Hedge Ratio and Hedging Effectiveness for Entire Period, First Sub-Period and Second Sub-Period

Commodity	Entire Period (Jan. 2009-Dec. 2020)		First Sub- Period (Jan. 2009-Dec. 2014)		Second Sub- Period (Jan. 2015-Dec.2020)	
	Hedge Ratio	Hedging Effectiveness	Hedge Ratio	Hedging Effectiveness	Hedge Ratio	Hedging Effectiveness
Agricultural Commodities						
Cardamom	0.13439	0.06387	0.15456	0.07639	0.10652	0.05133
Cotton	0.21759	0.15973	0.28941	0.25543	0.17566	0.11214
CPO	0.44600	0.18800	0.55474	0.32130	0.31212	0.07970
Mentha Oil	0.18723	0.15501	0.23401	0.18939	0.15002	0.13413
Non- Agricultural (Metal)						
Aluminium	0.40548	0.18690	0.21516	0.08872	0.43560	0.00000
Copper	0.12242	0.00086	0.03062	0.00317	0.09545	0.00070
Lead	0.14848	0.50774	0.13573	0.03087	0.19010	0.00327
Nickel	0.44346	0.28153	0.13074	0.03913	0.79287	-0.37214
Non- Agricultural (Energy)						
Crude Oil	0.17479	0.07844	0.16653	-0.93984	0.18201	0.10132
Natural Gas	0.00075	0.05357	0.17866	-0.89131	0.10984	0.03562
Non- Agricultural (Bullion)						
Gold	0.3260	0.24960	0.32766	0.786	0.31896	0.23290
Silver	0.32595	0.25072	0.33645	0.26788	0.09612	0.02037
Source: Author's Compilation						

Table 6.10 shows the In-Sample comparison of hedge ratio and hedging effectiveness for different time periods. In the case of Entire study period (January 2009- December 2020) the hedge ratio is in the range of 15% to 40% with lowest hedge ratio of 0.075% for Natural Gas. Commodity Futures CPO, Aluminium and Nickel recorded highest hedge ratio of 40%.

In the case of First Sub-Period, the optimal hedge ratio is in the range of 15% to 55% with lowest hedge ratio of 3% for Copper futures. CPO recorded highest hedge ratio of 55% with 32% hedging effectiveness. All other futures contracts provide less than 26% hedge effectiveness, except for Gold futures which recorded highest hedging effectiveness of 78%. It is observed that the commodity futures are more effective in hedging in the case of Gold futures as compared to all other commodities during First Sub-Period.

In the case of Second Sub-Period, optimal hedge ratio is in the range of 10% to 40% except Nickel futures with highest hedge ratio of 79%. Low hedging effectiveness is observed for all commodities during Second Sub-Period (less than 20%).

The near month futures of metals and energy commodities provide similar hedging effectiveness in both the sub-periods. Overall, hedging effectiveness has decreased in the second sub-period for all sample commodity futures (less than 10%) except 23% for Gold futures.

6.2.6: Hedge Ratio and Hedging Effectiveness of Commodity Market Indices

As commodity Indices are considered to be the representative of the individual commodities. Constant and Dynamic hedge ratios are also calculated for MCX Indices (MCXCOMDEX, MCXAGRI, MCXMETAL, and MCXENERGY) to test the applicability of the results with all the commodity futures. Hedging effectiveness of these Indices is shown in table 6.11.

Table 6.11: In-sample Comparison of Hedging Effectiveness Estimates by Different Models for MCX Indices

Commodity Market Indices	OLS	VECM	VECM-GARCH Model
MCX COMDEX	**55.07**	**57.61**	**61.05**
MCX AGRI	**42.24**	**14.58**	**13.99**
MCX METAL	**77.66**	**65.85**	**79.86**
MCX ENERGY	**14.94**	**31.13**	**36.01**
Source: Author's Compilation			

The results for MCX Indices are similar as have been witnessed in the case of individual commodities. The result suggests that VECM and VECM-GARCH model provide comparatively better hedging strategy in reducing the conditional variance of the hedged position. MCXAGRI reduces risk most by 14.58%, MCXMETAL by 65.85%, MCXENERGY by 31.13% and MCXCOMDEX by 57.61% as per VECM model, which is the best model to reduce the maximum risk.

6.2.7: Speculation Ratio

A speculative and inefficient futures market provides the low hedging effectiveness as both the spot and futures market drift apart because of the inefficient futures market. Sometimes the high friction in the spot market i.e., high transportation cost or brokerage makes it difficult to perform arbitrage and co-movement between spot and futures price become restricted.

A further analysis reveals that more speculation activities for Crude Oil and Natural Gas commodity futures, may be reason for less hedging effectiveness. Figure 6.1 shows the speculation ratio (volume to open interest ratio) for the sample commodities.

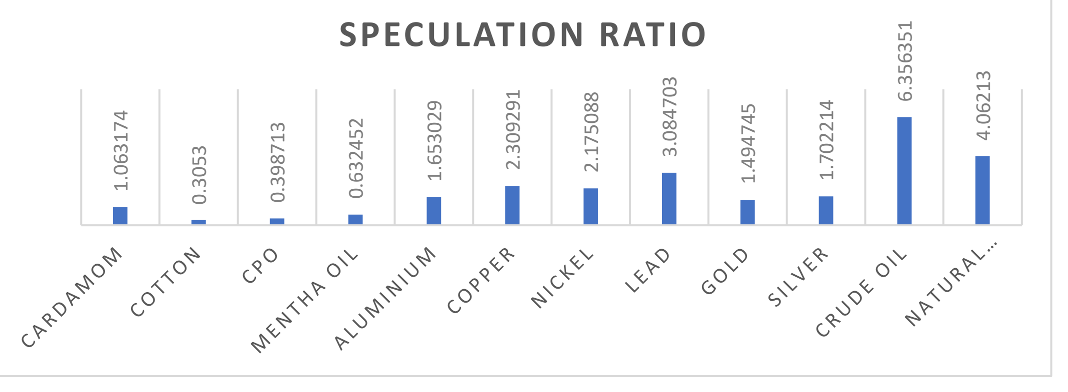


Fig 6.1: Speculation Ratio

Source: Author's Compilation

6.3 Conclusion

The study examines risk minimizing hedge ratio and hedging effectiveness of Indian commodity futures contracts for twelve commodities namely Cardamom, Cotton, CPO, Mentha oil, Aluminium, Copper, Lead, Nickel, Crude Oil, Natural Gas, Gold and Silver. The fourth objective of the study was to estimate the optimal hedge ratio and hedging effectiveness of commodity futures contracts in India by employing three different models namely OLS, VECM and VECM-GARCH model. The empirical analysis was conducted for the daily data series for the period of twelve years from January, 2009 to December 2020. It was observed that the VECM model and VECM-GARCH Model is the superior model since the hedge ratio obtained is high and provided highest variance reduction as compared to the OLS model. Hence, we can conclude from the empirical analysis that the VECM model can be used to estimate the hedge ratio, which will help the hedgers to compare and take advantage for a given position from the different futures position.

The empirical results suggests that reduction in variance that is attained by holding the derivatives futures contract is low and on an average range between 15% to 40% in most of the sample commodities. Thus, it can be concluded that the price risk reduction with commodity derivatives futures markets is only 15% to 40% in India. Hedge ratio for commodities Cardamom, Aluminium and Nickel is moderate i.e., 44%, 39% and 46% respectively and hedge effectiveness is 19%, 17% and 29% respectively which is low. This indicates that though hedge ratios are moderate for these commodities, still investors are unable to reduce risk. The findings point out the great difference between agricultural and non -agricultural commodities with regard to the hedging performance of futures contracts traded in India. In case of agricultural commodities, Indian commodity futures markets provide lower hedging effectiveness (less than 20%) as compared to non-agricultural commodities. The results confirm that variance reduction by holding agricultural commodity futures is low. Reason for such a low hedging effectiveness in agricultural futures contracts are as follows. First, constrained imposed by the Indian government on agricultural commodities. Second, Minimum support price. Third, ban on futures trading. These are some of the steps taken by Indian government which may have hampered the effectiveness of futures commodities and did not allow the futures contracts to function according to market forces resulting in low hedging efficiency. The variance reduction for some of the non-agricultural commodities is even smaller. It has been observed that commodities such as Natural Gas, Crude Oil and Copper has the lowest hedging effectiveness under non-agricultural commodities. Copper futures has the lowest amount of variance reduction (0.086%) followed by Natural Gas (5.02%) and Crude Oil (7.01%).

The hedging role of Commodity Futures market in India has declined in the Second Sub-Period with reduced trading activity in the market. Commodity Gold has the highest hedging effectiveness of 78.6% during the First Sub-Period which decreased to 23.9% in Second Sub-Period. The estimates of hedge effectiveness are negative -93% and -89% for commodities Crude Oil and Natural Gas during the First Sub-Period. It reveals that variance of hedged portfolio is increasing as compared to the variance of unhedged portfolio. Hedge effectiveness increased to 10% and 3% for Crude Oil and Natural Gas during the Second Sub-Period. Hedge effectiveness of commodity Nickel was positive 3.9% during the First Sub-Period. Whereas, hedge effectiveness of Nickel was negative -37% during the Second Sub-Period.

The empirical analysis suggests that Indian futures contracts are not effective for hedging exposures and overall hedge effectiveness has declined in recent years. The reason for low hedging effectiveness may be due to low awareness of futures markets among participants, low participation by hedgers, high transaction costs in the futures markets, policy restrictions, lower number of delivery centres, inadequate contract design or high transaction costs in the spot market. Traders of futures markets are using these futures for more speculation purpose than hedging as evidenced by the speculation ratio (table 6.1). The hedging role of Indian commodity futures markets has declined in the Second Sub-Period (1st January 2015 to 31st December 2020) with reduced trading activity in the market. Some of the main reasons are NSEL scam and introduction of Commodity Transaction Tax (CTT) in the year 2013. Suspension of trading in agricultural commodities at regular intervals Measures taken by SEBI in the year 2016 to increase the initial margin and reduction in the maximum position affected the market. In the same year demonetisation of rupee reduced the cash holdings of investors, hence affecting the commodity market.

CHAPTER VII

FINDINGS AND CONCLUSION

The chapter attempts to document the summary of key findings during the course of this research work. The important inferences and findings obtained from the analysis of secondary data are presented here in accordance with the objectives of the study.

7.1 Findings

7.1.1 Growth in Commodity Derivatives Market in India

1. Remarkable growth is witnessed in the initial years of establishment of national exchanges up to the year 2005-06. Thereafter, a stable growth is recorded averaging to 40% per annum up to the year 2011-12. Total turnover in commodity futures decreased by 40.5% for the year 2013-2014. Following sudden decline in volume and trade transactions is witnessed since the year 2014-2015 to 2019-2020. In the year 2019-20 the aggregate turnover at all the exchanges in commodity derivatives segment increased by 25% to Rs. 92.25 lakh crores from Rs. 73.78 lakh crores.
2. MCX dominated the value traded in commodity derivative trading with 94.2% share in the overall turnover, up from the 91.2% share recorded in 2018-19. The turnover at MCX was Rs. 86,89,517 crores in 2019-20 as compared to Rs. 67,72,373 crores, a rise of 28.3% share. On the other hand, NCDEX's share decreased to Rs. 4,42,009 crore (4.8% share) from Rs. 5,31,588 crore (7.2% share) recorded during the last year. The combined contribution of BSE, NSE and ICEX to the aggregate turnover of all exchanges is one per cent for the financial year 2019-20.
3. There is gradual decline in trade in commodity derivatives futures market in agricultural commodities. The share of agricultural commodities which was recorded the highest with 68.3% in the year 2004-05, has gradually decreased to 29% for the year 2018-19. whereas, the share of non- agricultural commodities gradually increased from 30% to

70% over the years with a dominating role of commodities from energy segment (35%) and metal (23%). In the year 2019-2020, non-agricultural commodities accounted for 93.7% of the aggregate commodity futures turnover of all the exchanges, while the balance 6.3% was contributed by agricultural commodities.

4. Majority of the turnover in commodity derivatives was reported by client trades in agriculture as well as non- agricultural segment followed by proprietary trades at the exchanges MCX, NMCE and ICEX. At NCDEX, higher turnover in agriculture segment was recorded by client trades. Whereas, proprietary trade contributed higher turnover in non-agriculture segment. At BSE and NSE, majority of the turnover was accounted for the proprietary trade (93% BSE, 82% NSE).

7.1.2 Effectiveness of Commodity Derivatives Market in Price Discovery

This section deals with second objective of the study i.e., to study the effectiveness of commodity derivatives in price discovery by analysing the long-run equilibrium between spot and futures markets, long-run and short-run causality between the futures and spot markets, what directional causality between the two market and how it results in to the process of price discovery.

Market Indices

MCXCOMDEX

i. The stationarity result of MCXCOMDEX spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen test of Cointegration result reveal that existence of long run relationship between spot and futures series of index as its value is 0.000, which is less than 0.05.

iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.139925) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices, which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 13.99% speed of adjustments in sample commodities. The speed of correction in the futures market of MCXCOMDEX is 0.36% against spot market, which indicates a highly informative futures market. At the same time, insignificant ECT of Ln futures market series of MCXCOMDEX indicates futures market efficiency towards maintaining stable long-run equilibrium. VECM model shows that price correction happens from futures prices to the dependent spot prices and not vice versa. It means futures market is efficient in terms of price discovery.

iv. The Granger Causality Test results disclose that there is unidirectional causality from futures returns to spot returns for the market Index MCXCOMDEX ($p < 0.05$).

MCXAGRI

i. The stationarity result of MCXAGRI spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen Test of Cointegration result reveal that existence of long run relationship between spot and futures series of index as its value is 0.000, which is less than 0.05.

iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.0507) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 5.07% speed of adjustments in sample commodities. The speed of correction in the futures market of MCXAGRI is 0.031% against spot market, which indicates a highly informative futures market. VECM model shows that price correction happens from futures prices to the dependent spot prices and not vice versa. It means futures market is efficient in terms of price discovery.

iv. The Granger Causality Test results disclose that there is unidirectional causality from futures returns to spot returns for the market Index MCXAGRI ($p < 0.05$).

MCXENERGY

i. The stationarity result of MCXENERGY spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.
ii. The Johansen test of Cointegration result reveal that existence of long run relationship between spot and futures series of index as its value is 0.000, which is less than 0.05.
iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (0.21707) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices, which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 21.70% speed of adjustments in sample commodities. The speed of correction in the futures market of MCXENERGY is 6.69% against spot market, which indicates a highly informative futures market. VECM model shows that price correction happens from futures prices to the dependent spot prices and not vice versa. It means futures market is efficient in terms of price discovery.
iv. The Granger Causality Test results disclose that there is unidirectional causality from futures returns to spot returns for the market Index MCXENERGY ($p < 0.05$)

MCXMETAL

i. The stationarity result of MCXMETAL spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.
ii. The Johansen Test of Cointegration result reveal that existence of long run relationship between spot and futures series of index as its value is 0.000, which is less than 0.05.
iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.196318) and significant ($p < 0.05$). This implies that there is a long-run

causality running from futures prices to spot prices, which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 19.63% speed of adjustments in sample commodities. The speed of correction in the futures market of MCXMETAL is 0.78% against the spot market, which indicates a highly informative futures market. VECM model shows that price correction happens from futures prices to dependent spot prices and not vice versa. It means futures market is efficient in terms of price discovery.

iv. The Granger Causality Test results disclose that there is unidirectional causality from future returns to spot returns for the market Index MCXMETAL ($p < 0.05$).

Agricultural Commodities

Cardamom

i. The stationarity result of Cardamom spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen test of Cointegration result reveal that existence of long run relationship between commodity spot and future price series as its value is 0.000 which is less than 0.05.

iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.03948) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices, which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 3.94% speed of adjustments in sample commodities. The speed of correction in the futures market of Cardamom is 3.03% against spot market, which indicates a highly informative futures market. VECM model shows that price correction happens from futures prices to dependent spot prices and not vice versa. It means futures market is efficient in terms of price discovery.

iv. The Granger Causality Test results disclose that there is unidirectional causality from futures returns to spot returns for commodity Cardamom ($p < 0.05$).

Cotton

i. The stationarity result of Cotton spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen Test of Cointegration result reveal that, there is existence of long run relationship between commodity spot and futures price series as its value is 0.000, which is less than 0.05.

iii. The VECM result reveal that the coefficient of ECT of log spot prices is negative in sign (-0.0411) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices, which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 4.11% speed of adjustments in sample commodities. The speed of correction in the futures market of Cotton is 1.08% against spot market, which indicates a highly informative futures market. At the same time, insignificant ECT of Ln futures prices of Cotton indicates futures market efficiency towards maintaining stable long-run equilibrium. VECM model shows that price correction happens from futures prices to dependent spot prices and not vice versa.

iv. The Granger Causality Test results disclose that there is unidirectional causality from futures returns to spot returns for commodity Cardamom ($p < 0.05$).

Crude Palm Oil

i. The stationarity result of Crude Palm Oil spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen Test of Cointegration result reveal that, there is existence of long run relationship between commodity spot and futures price series as its value is 0.000, which is less than 0.05.

iii. The VECM result reveal that the coefficient of ECT of log spot prices is negative in sign (-0.0483) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 4.83% speed of adjustments in sample commodities. The speed of correction in the futures market of Crude Palm Oil is 22.88% against spot market, which indicates a highly informative futures market. VECM model shows that price correction happens from futures prices to the dependent spot prices and not vice versa. It means futures market is efficient in terms of price discovery.

iv. The Granger Causality Test result disclose that there is bidirectional causality from future returns to spot returns and vice-versa for commodity Crude Palm Oil ($p < 0.05$).

Mentha Oil

i. The stationarity result of Mentha Oil spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen Test of Cointegration result reveal that, there is existence of long run relationship between commodity spot and futures price series as its value is 0.000, which is less than 0.05.

iii. The VECM result reveal that the coefficient of ECT of log spot prices is negative in sign (-0.0282) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 2.82% speed of adjustments in sample commodities. The speed of correction in the futures market of

Mentha Oil is 20.48% against spot market, which indicates a highly informative futures market. VECM model shows that price correction happens from futures prices to the dependent spot prices and not vice versa. It means futures market is efficient in terms of price discovery.

iv. The Granger Causality Test result disclose that there is bidirectional causality from future returns to spot returns and vice-versa for commodity Mentha Oil ($p < 0.05$).

Precious Metal Commodities

Gold

i. The stationarity result of Gold spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen test of Cointegration result reveal that, there is existence of long run relationship between commodity spot and futures price series as its value is 0.000, which is less than 0.05.

iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.05917) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 5.91% speed of adjustments in sample commodities. The speed of correction in the futures market of Gold is 2.45% against spot market, which indicates a highly informative futures market. At the same time, insignificant ECT of Ln futures prices of Gold indicates futures market efficiency towards maintaining stable long-run equilibrium. VECM result indicates that there is long -run causality running from futures prices to the dependent spot prices and not vice versa.

iv. The Granger Causality Test result disclose that there is bidirectional causality from future returns to spot returns and vice-versa for commodity Gold ($p < 0.05$).

Silver

i. The stationarity result of Silver spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.
ii. The Johansen test of Cointegration result reveal that there is existence of long run relationship between commodity spot and futures price series as its value is 0.000, which is less than 0.05.
iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.1828) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 18.28% speed of adjustments in sample commodities. The speed of correction in the futures market of Silver is 3.9% against spot market, which indicates a highly informative futures market. At the same time, insignificant ECT of Ln futures prices of Silver indicates futures market efficiency towards maintaining stable long-run equilibrium. VECM model shows that price correction happens from futures prices to dependent spot prices and not vice versa.
iv. The Granger Causality Test results disclose that, there is unidirectional causality from future returns to spot returns for commodity Silver ($p < 0.05$).

Industrial Metal Commodities

Aluminium

i. The stationarity result of Aluminium spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.
ii. The Johansen Test of Cointegration result reveal that, there is existence of long run relationship between commodity spot and futures price series as its value is 0.000, which is less than 0.05.

iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.0114) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 1.14% speed of adjustments in sample commodities. The speed of correction in the futures market of Aluminium is 1.56% against spot market, which indicates a highly informative futures market. At the same time, insignificant ECT of Ln futures prices of Aluminium indicates futures market efficiency towards maintaining stable long-run equilibrium. VECM model shows that price correction happens from futures prices to the dependent spot prices and not vice versa.

iv. The Granger Causality Test result disclose that, there is unidirectional causality from futures returns to spot returns for commodity Aluminium ($p < 0.05$).

Copper

i. The stationarity result of Copper spot sand future market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen test of Cointegration result reveal that, there is existence of long run relationship between commodity spot and futures price series as its value is 0.000, which is less than 0.05.

iii. The VECM result reveal that the coefficient of ECT of log spot prices is negative in sign (-0.0037) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 0.37% speed of adjustments in sample commodities. The speed of correction in the futures market of Copper is 0.53% against spot market, which indicates a highly informative futures market. VECM results show that error correction happens from futures to spot market.

It means both the markets are efficient in terms or price discovery as their co-efficient values are negative.

iv. The Granger Causality Test results disclose that, there is unidirectional causality from futures returns to spot returns for commodity Copper ($p < 0.05$)

Nickel

i. The stationarity result of Nickel spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen test of Cointegration result reveal that, there is existence of long run relationship between commodity spot and future price series as its value is 0.000 which is less than 0.05.

iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.3727) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 37.27% speed of adjustments in sample commodities. The speed of correction in the futures market of Nickel is 7.66% against spot market, which indicates a highly informative futures market. At the same time, insignificant ECT of Ln futures prices of Nickel indicates futures market efficiency towards maintaining stable long-run equilibrium. VECM model shows that price correction happens from futures prices to the dependent spot prices and not vice versa.

iv. The Granger Causality Test results disclose that there is bidirectional causality from future returns to spot returns and vice-versa for commodity Nickel ($p < 0.05$).

Lead

i. The stationarity result of Lead spot and futures market show that there is a stationarity in the series at I (1) as their p-value are is than 0.05.

ii. The Johansen test of Cointegration result reveal that existence of long run relationship between commodity spot and future price series as its value is 0.000 which is less than 0.05.

iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.40602) and significant ($p < 0.05$). this implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 40.60% speed of adjustments in sample commodities. The speed of correction in the futures market of Lead is 4.37% against spot market, which indicates a highly informative futures market. At the same time, insignificant ECT of Ln futures prices of Lead indicates futures market efficiency towards maintaining stable long-run equilibrium. VECM model shows that price correction happens from futures prices to the dependent spot prices and not vice-versa.

iv. The Granger Causality Test results disclose that, there is unidirectional causality from futures returns to spot returns for commodity Lead ($p < 0.05$).

Energy Commodities

Crude Oil

i. The stationarity result of Crude Oil spot and futures market show that, there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen test of Cointegration result reveal that, there is existence of long run relationship between commodity spot and futures price series as its value is 0.000, which is less than 0.05.

iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.7919) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 79.19% speed of adjustments in sample commodities. The speed of correction in the futures market of Crude oil 0.26% against spot market, which indicates a highly informative futures market. At the same time, insignificant ECT of Ln futures prices of Crude Oil indicates futures market efficiency towards maintaining stable long-run equilibrium. VECM model shows that price correction happens from futures prices to the dependent spot prices and not vice-versa.

iv. The Granger Causality Test results disclose that, there is unidirectional causality from futures returns to spot returns for commodity Crude Oil ($p < 0.05$).

Natural Gas

i. The stationarity result of Crude Oil spot and futures market show that there is a stationarity in the series at I (1) as their p-value is less than 0.05.

ii. The Johansen Test of Cointegration result reveal that, there is existence of long run relationship between commodity spot and future price series as its value is 0.000, which is less than 0.05.

iii. The VECM results reveal that the coefficient of ECT of log spot prices is negative in sign (-0.8290) and significant ($p < 0.05$). This implies that there is a long-run causality running from futures prices to spot prices which enable the spot market to adjust to the short-run deviation from long-run equilibrium path with nearly 82.90% speed of adjustments in sample commodities. The speed of correction in the futures market of Natural Gas is 0.64% against spot market, which indicates a highly informative futures market. At the same time, insignificant ECT of Ln futures prices of Natural Gas indicates futures market efficiency towards maintaining stable long-run equilibrium. VECM model shows that price correction happens from futures prices to the dependent spot prices and not vice-versa.

iv. The Granger Causality Test result disclose that, there is bidirectional causality from futures returns to spot returns and vice-versa for commodity Natural Gas ($p < 0.05$).

Summary

Spot and futures price series of commodities and market indices under study are non-stationary at I (0) as per the calculated t. stat. value of ADF Test which is more than the critical value at 0.05 level of significance. But at the first difference the test statistics values are less than 0.05. Therefore, the spot price and futures price series are stationary at I (1). As per Johansen Cointegration Test, to identify the long run relationship between spot and futures price series, the trace test and maximum-Eigen value test statistics indicate the presence of one co-integrating vector for commodity spot and futures prices at 5% level of significance. Therefore, based on the result the null hypothesis is rejected which indicates there is a long run relationship between commodity spot and futures price series for all sample commodities and market indices under study. The VECM result reveal that the co-efficient of ECT of *Ln* spot prices of commodities are negative and statistically significant at 0.05. Therefore, the null hypothesis is rejected, which means commodity futures market prices do influence commodity spot market prices. It means there is adjustment happening from futures to spot market prices. Granger Causality Test disclose that there is unidirectional causality from commodity futures prices to spot prices for all market indices and for seven individual commodities namely Cardamom, Cotton, Aluminium, Copper, Lead, Crude Oil and Silver. Therefore, Null hypothesis is rejected for these commodities. Which indicates that there is granger causality from commodity futures market price to spot market price. Null hypothesis is accepted for commodities CPO, Mentha Oil, Nickel, Natural Gas and Gold, as there is bidirectional causality running from spot market price to futures market price and vice-versa.

7.1.3 Analysis of Volatility Persistent of Indian Commodity Markets

The immense importance of understanding the volatility and its patterns in the financial asset is evident from the fact that they have been used as critical input in portfolio selection, asset allocation, asset pricing, portfolio diversification and risk management.

Commodity Market Indices

MCXCOMDEX

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of index MCXCOMDEX.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot market of MCXCOMDEX is 0.98, implying high volatility and statistically significant at 0.05 significance level. Here spot market is inefficient based on the Co-efficient value.

iii. As per GARCH (1,1) model, the co-efficient value of alpha & beta of Futures market of MCXCOMDEX is 0.971, implying high volatility and statistically significant at 0.05 significance level. Here futures market is inefficient based on the co-efficient value.

iv. EGARCH (1,1) confirms the presence of no leverage effect in case of futures market of MCXCOMDEX as λ is negative and not significant (-0.004) at 0.05 level. There is also no leverage effect in the case of spot market (0.0181) as λ is positive and significant at 0.05 significance level. Here positive shock effects create much greater levels of volatility, when compared to negative shock effects.

v. TGARCH also confirms the presence of no leverage effect in case of spot and futures market of MCXCOMDEX, as λ is negative and significant at -0.008 and -0.0331 respectively and significant at 0.05 significance level.

vi. The result of ARCH-LM test indicates that the fitted GARCH model has no further ARCH effects.

MCXAGRI

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of index MCXAGRI.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot market of MCXAGRI is 0.789, implying high volatility and statistically significant at 0.05 significance level. Here spot market is inefficient based on the co-efficient value.

iii. As per GARCH (1,1) model the co-efficient value of alpha & beta of futures market of MCXAGRI is 0.773, implying high volatility and statistically significant at 0.05 significance level. Here futures market is inefficient based on the co-efficient value.

iv. EGARCH (1,1) confirms the presence of leverage effect in case of spot market as λ is negative and significant (-0.071) and futures market (-0.0691) for index MCXAGRI and significant at 0.05 significance level. Here negative shock effects create much greater levels of volatility when compared to positive shock effects.

v. TGARCH also confirms the presence of leverage effect in case of spot and futures market of MCXAGRI as λ is positive and significant at 0.182 and 0.3337 respectively and significant at 0.05 significance level.

vi. The result of ARCH-LM test indicates that the fitted GARCH model has no further ARCH effects.

MCXMETAL

i. ARCH-LM test confirm presence of significant ARCH effect on the spot and futures return series of index MCXMETAL.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot market of MCXMETAL is 0.966 implying high volatility and statistically significant at 0.05 significance level. Here spot market is inefficient based on the co-efficient value.

iii. As per GARCH (1,1) model the co-efficient value of alpha & beta of Futures market of MCXMETAL is 0.972, implying high volatility and statistically significant at 0.05 significance level. Here futures market is efficient based on the co-efficient value.

iv. EGARCH (1,1) confirms the presence of no leverage effect in case of spot market as λ is positive and significant (0.0084) and futures market (0.008) for index MCXMETAL and significant at 0.05 significance level. Here positive shock effects create much greater levels of volatility when compared to negative shock effects.

v. TGARCH also confirms the presence of no leverage effect in case of spot and futures market of MCXMETAL as λ is negative and significant at (-0.012) and (-0.0147) respectively and significant at 0.05 significance level.

vi. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

MCXENERGY

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of index MCXENERGY.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot market of MCXENERGY is 0.956, implying high volatility and statistically significant at 0.05 significance level. Here spot market is inefficient based on the co-efficient value.

iii. As per GARCH (1,1) model the co-efficient value of alpha & beta of futures market of MCXENERGY is 0.991, implying high volatility and statistically significant at 0.05 significance level. Here futures market is inefficient based on the co-efficient value.

iv. EGARCH (1,1) confirms the presence of leverage effect in case of spot market as λ is negative and significant (-0.0314) and futures market (-0.033) for index MCXENERGY and significant at 0.05 significance level. Here negative shock effects create much greater levels of volatility when compared to positive shock effects.

v. TGARCH also confirms the presence of leverage effect in case of spot and futures market of MCXENERGY as λ is positive and significant at 0.0311 and 0.032 respectively and significant at 0.05 significance level.

vi. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Agricultural Commodities

Cardamom

i. ARCH-LM test confirm presence of significant ARCH effect on the spot and futures return series of commodity Cardamom.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot market of Cardamom is 0.77, implying high volatility and statistically significant at 0.05 significance level. Here spot market is inefficient based on the co-efficient value.

iii. As per GARCH (1,1) model, the co-efficient value of alpha & beta of futures market of Cardamom is 0.23, implying low volatility and statistically significant at 0.05 significance level. Here futures market is efficient based on the co-efficient value.

iv. EGARCH (1,1) confirms the presence of leverage effect in case of spot market as λ is negative and significant (-0.031) and futures market (-0.066) for commodity Cardamom and significant at 0.05 significance level. Here negative shock effects create much greater levels of volatility when compared to positive shock effects.

v. TGARCH also confirms the presence of leverage effect in case of spot and futures market of Cardamom as λ is positive and significant at 0.944 and 0.135 respectively and significant at 0.05 significance level.

vi. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Cotton

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of commodity Cotton.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot and futures market of Cotton is 0.64 and 0.41 respectively, implying low volatility and statistically significant at 0.05 significance level. Here spot and futures market of Cotton is efficient based on the co-efficient value.

iii. EGARCH (1,1) confirms the presence of leverage effect in case of futures market of Cotton as λ is negative (-0.109) and significant at 0.05 significance level. Here bad news generates more volatility than good news in this market. However, λ is positive in case of spot market (0.1096) and significant at 0.05 significance level indicating no leverage effect. Here good news generates more volatility than bad news in this market.

iv. TGARCH (1,1) confirms the presence of leverage effect in case of future market of Cotton as λ is positive (0.577) and significant at 0.05 significance level. Here bad news generates more volatility than good news in this market. However, λ is negative in case of spot market (-0.139) and significant at 0.05 significance level indicating no leverage effect. Here good news generates more volatility than bad news in this market.

v. The results of diagnostic test show that the residuals are free from serial correlation and ARCH effect.

Crude Palm Oil

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of commodity Crude Palm Oil.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot and futures market of Crude Palm is Oil 0.936 and 0.988 respectively, implying high volatility and statistically significant at 0.05 significance level. Here spot and futures market of Crude Palm Oil is inefficient based on the co-efficient value.

iii. EGARCH (1,1) confirms the presence of no leverage effect in case of spot market as λ is positive and significant (0.077) and futures market (0.0186) for commodity Crude Palm Oil and significant at 0.05 significance level. Here positive shock effects of conditional volatility impact much more significantly as compared to positive shock effects

iv. TGARCH also confirms the presence of no leverage effect in case of spot and futures market of Crude Palm Oil as λ is negative and significant at -0.027 and -0.019 respectively and significant at 0.05 significance level. Here positive shock effects create much greater levels of volatility when compared to negative shocks of identical magnitude.

v. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Mentha Oil

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of commodity Mentha Oil.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot market of Mentha Oil is 0.97 implying high volatility and statistically significant at 0.05 significance level. Here spot market is inefficient based on the co-efficient value.

iii. As per GARCH (1,1) model the co-efficient value of alpha & beta of futures market of Mentha Oil is 0.035, implying low volatility and statistically significant at 0.05 significance level. Here futures market is efficient based on the co-efficient value.

iv. EGARCH (1,1) confirms the presence of no leverage effect in case of spot market as λ is positive and significant (-0.0734) and futures market (-0.1104) for commodity Mentha Oil and significant at 0.05 significance level. Here positive shock effects of conditional volatility impact much more significantly as compared to negative shock effects

v. TGARCH also confirms the presence of no leverage effect in case of spot and futures market of Mentha Oil as λ is negative and significant at (-0.103) and (-0.566) respectively and significant at 0.05 significance level. Here positive shock effects create much greater levels of volatility when compared to negative shocks of identical magnitude.

vi. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Industrial Metals

Aluminium

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of commodity Aluminium.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot and futures market of Aluminium is 0.949 and 0.996 respectively, implying high volatility and statistically significant at 0.05 significance level. Here spot and futures market of Aluminium is inefficient based on the co-efficient value.

iii. EGARCH (1,1) confirms the presence of no leverage effect in case of spot market as λ is positive and significant (0.004) and futures market (0.003) for commodity

Aluminium and significant at 0.05 significance level. Here positive shock effects of conditional volatility impact much more significantly as compared to negative shock effects

iv. TGARCH also confirms the presence of no leverage effect in case of futures market of Aluminium as λ is negative and significant at -0.013. λ is positive and insignificant at 0.0041 for spot market. Here positive shock effects create much greater levels of volatility when compared to negative shocks of identical magnitude.

v. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Copper

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of commodity Copper.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot and futures market of copper is 0.977 and 0.986 respectively, implying high volatility and statistically significant at 0.05 significance level. Here spot and futures market of copper is inefficient based on the co-efficient value.

iii. EGARCH (1,1) confirms the presence of leverage effect in case of spot market as λ is negative and significant (-0.048) and futures market -(0.028) for commodity Copper and significant at 0.05 significance level. Here bad news generates more volatility than good news in this market.

iv. TGARCH also confirms the presence of leverage effect in case of spot and future market of Copper as λ is positive and significant at 0.061 and 0.009 respectively and significant at 0.05 significance level. Here negative shock effects create much greater levels of volatility when compared to positive shocks of identical magnitude.

v. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Nickel

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of commodity Nickel.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot and future market of Nickel is 0.925 and 0.966 respectively, implying high volatility and statistically significant at 0.05 significance level. Here spot and futures market of Nickel is inefficient based on the co-efficient value.

iii. EGARCH (1,1) confirms the presence of leverage effect in case of spot market as λ is negative and significant (-0.003) and futures market (-0.010) for commodity Nickel and significant at 0.05 significance level. Here bad news generates more volatility than good news in this market.

iv. TGARCH also confirms the presence of leverage effect in case of spot and future market of Nickel as λ is positive and significant at 0.004 and 0.019 respectively and significant at 0.05 significance level. Here negative shock effects create much greater levels of volatility when compared to positive shocks of identical magnitude.

v. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Lead

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of commodity Lead.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot and futures market of Lead is 0.972 and 0.964 respectively, implying high volatility and statistically significant at 0.05 significance level. Here spot and futures market of Lead is inefficient based on the co-efficient value.

iii. EGARCH (1,1) confirms the presence of leverage effect in case of futures market of Lead as λ is negative (-0.010) and significant at 0.05 significance level. Here bad news generates more volatility than good news in this market. However, λ is positive in case of spot market (0.003) and significant at 0.05 significance level indicating no leverage effect. Here good news generates more volatility than bad news in this market.

iv. TGARCH (1,1) confirms the presence of leverage effect in case of futures market of Lead as λ is positive (0.008) and significant at 0.05 significance level. Here bad news generates more volatility than good news in this market. However, λ is negative (-0.018) in case of spot market and significant at 0.05 significance level indicating no leverage effect. Here good news generates more volatility than bad news in this market.

v. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Energy Commodities

Crude Oil

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of commodity Crude Oil.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot and futures market of Crude Oil is 1.003 and 1.002 respectively, implying high volatility and statistically significant at 0.05 significance level. Here spot and futures market of Crude Oil is inefficient based on the co-efficient value. Volatility persistence found to be extremely high in the spot and future market of Crude Oil as the total of alpha & beta is found to be greater than unity. Coefficient values of variance equation results are statistically significant which indicate that past conditional variance has greater impact on current change in returns that recent shocks or news announcement and volatility persists over time in the commodity under study.

iii. EGARCH (1,1) confirms the presence of leverage effect in case of spot market as λ is negative and significant (-0.121) and futures market (-0.101) for commodity Crude Oil and significant at 0.05 significance level. Here bad news generates more volatility than good news in this market.

iv. TGARCH also confirms the presence of leverage effect in case of spot and futures market of Crude Oil as λ is positive and significant at 0.159 and 0.136 respectively and significant at 0.05 significance level. Here negative shock effects create much greater levels of volatility when compared to positive shocks of identical magnitude.

v. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Natural Gas

i. ARCH-LM test the presence of significant ARCH effect on the spot and futures return series of commodity Natural Gas.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot and futures market of Natural Gas is 0.990 and 0.993 respectively, implying high volatility and statistically significant at 0.05 significance level. Here spot and futures market of Natural Gas is inefficient based on the co-efficient value.

iii. EGARCH (1,1) confirms the presence of no leverage effect in case of spot market as λ is positive and significant (0.009) and futures market (0.012) for commodity Natural Gas and significant at 0.05 significance level. Here good news generates more volatility than bad news in this market.

iv. TGARCH also confirms the presence of no leverage effect in case of spot and futures market of Natural Gas as λ is negative and significant at (-0.0167) and (-0.023) respectively and significant at 0.05 significance level. Here positive shock effects create much greater levels of volatility when compared to negative shocks of identical magnitude.

v. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Precious Metal

Gold

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of commodity Gold.
ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot and futures market of Gold is 0.807 and 0.987 respectively, implying high volatility and statistically significant at 0.05 significance level. Here spot and futures market of Gold is inefficient based on the co-efficient value.
iii. EGARCH (1,1) confirms the presence of no leverage effect in case of spot market as λ is positive and significant (0.013) and futures market (0.034) for commodity Gold and significant at 0.05 significance level. Good news generates more volatility than bad news in this market.
iv. TGARCH also confirms the presence of no leverage effect in case of spot and futures market of Gold as λ is negative and significant at (-0.014) and (-0.048) respectively and significant at 0.05 significance level. Here positive shock effects create much greater levels of volatility when compared to negative shocks of identical magnitude.
v. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Silver

i. ARCH-LM test confirm the presence of significant ARCH effect on the spot and futures return series of commodity Silver.

ii. Estimates of GARCH (1,1) model shows the co-efficient value of alpha & beta of spot market of Silver is 0.603 implying low volatility and statistically significant at 0.05 significance level. Here spot market is efficient based on the co-efficient value.

iii. As per GARCH (1,1) model the co-efficient value of alpha & beta of Futures market of Silver is 0.998, implying high volatility and statistically significant at 0.05 significance level. Here futures market is inefficient based on the co-efficient value.

iv. EGARCH (1,1) confirms the presence of no leverage effect in case of spot market as λ is positive and significant (0.065) and futures market (0.022) for commodity Silver and significant at 0.05 significance level. Here good news generates more volatility than bad news in this market.

v. TGARCH also confirms the presence of no leverage effect in case of spot and future market of Silver as λ is negative and significant at (-0.177) and (-0.022) respectively and significant at 0.05 significance level. Here positive shock effects create much greater levels of volatility, when compared to negative shocks of identical magnitude.

vi. The results of ARCH-LM test indicate that the fitted GARCH model has no further ARCH effects.

Summary

The results show that co-efficient value of alpha and beta is high for spot and futures market of MCXCOMDEX, MCXAGRI, MCXMETAL and MCXENERGY, CPO, Aluminium, Copper, Nickel, Lead, Crude Oil, Natural Gas, Gold and Silver and Spot market of Cardamom and Mentha Oil. Implying persistent high volatility existed and statistically significant at 0.05 significance level. This high volatility indicates the inefficiency of this markets. Therefore, null hypothesis is rejected as there is significant volatility persistence for above mentioned commodities. Result shows that futures market of Cardamom, Cotton and Mentha oil is efficient as its volatility is low (Cardamom 23%, Cotton 41%, Mentha oil 3.5%) and statistically significant, as compared to spot market of respective commodities. Null hypothesis is accepted as there is low volatility persistence for the above-mentioned commodities.

Past conditional variance has a greater impact on current change in return, than recent shocks or news announcements for all commodities under study. The values of β are significantly higher than α, indicating a longer memory and volatility for all commodities under study. Prices are sensitive to their own lagged values than new information in the market.

The presence of leverage effect is confirmed in the case of spot and futures market of MCXAGRI, MCXENERGY, Cardamom, Copper, Nickel and Crude Oil and futures market of Cotton and Lead. Therefore, null hypothesis is rejected for this market which indicates asymmetric impact of news on current volatility. Market indices and commodities which does not exhibit leverage effect are spot and futures market of MCXCOMDEX, MCXMETAL, CPO, Mentha Oil, Aluminium, Natural Gas and Silver and spot market of Cotton and Lead. Here null hypothesis is accepted for this market which indicates asymmetric impact of news on current volatility.

7.1.4 Effectiveness of Commodity Futures Contracts in Hedging Effectiveness

The fourth objectives of the study i.e., to examine the effectiveness of commodity derivatives in hedging by using futures contracts to manage the price risk in spot markets of underlying assets with Optimal Hedge Ratio (OHR), Hedge Effectiveness (HE). Through construction of hedged portfolios and un-hedged portfolios and finally how it results in to the process of risk management.

Agricultural Commodities

Cardamom

i. It is observed that the basis risk is higher than the price risk for commodity Cardamom. It reveals that contracts will not be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 12.67% variance reduction in near month contracts of Cardamom. It further reveals that, a hedger who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 5.19% by selling 12.67% of the underlying commodity in near month contract of Cardamom.

iii. According to VECM results, it is found that the commodity futures provide 13.43% variance reduction in the spot prices of Cardamom. It further found that, a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 6.38% by selling 13.43% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 12.23% variance reduction in near month contracts of Cardamom. It further reveals that, a Hedger who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 7.71% by selling 12.23% of the underlying commodity in near month contract of Cardamom.

v. The hedging effectiveness decreased to 5.13% from 7.63% in the Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method. The overall hedging effectiveness is very low in Cardamom futures market.

vii. It is found that performance of Cardamom futures is not effective in minimising the spot price risk as the hedge ratio and hedging effectiveness is very low.

viii. It reveals that Cardamom futures contracts are not suitable for hedging i.e., there will not be a reduction in the variance of spot market by using commodity futures contracts.

Cotton

i. It is observed that the basis risk is higher than the price risk for commodity Cotton. It reveals that contracts will not be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 19.84% variance reduction in near month contracts of Cotton. It further reveals that, a hedger who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 10.89% by selling 19.84% of the underlying commodity in near month contract of Cotton.

iii. According to VECM results, it is found that the Commodity futures provide 21.75% variance reduction in the spot prices of Cotton. It further found that, a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 15.97% by selling 21.75% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 20.12% variance reduction in near month contracts of Cotton. It further reveals that, a hedger who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 14.42% by selling 20.12% of underlying commodity in near month contract of Cotton.

v. The hedging effectiveness decreased to 11.21% from 25.5% in Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method. The overall hedging effectiveness is low in Cotton futures market.

vii. It is found that performance of Cotton future is not effective in minimising the spot price risk as the hedge ratio and hedging effectiveness is low.

viii. It reveals that Cotton futures contracts are not suitable for hedging i.e., there will not be a reduction in the variance of spot market by using commodity futures contracts.

Mentha Oil

i. It is observed that the basis risk is higher than the price risk for commodity Mentha Oil. It reveals that contracts will not be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 9.62% variance reduction in near month contracts of Mentha Oil. It further reveals, that a hedger who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 4.72% by selling 9.62% of the underlying commodity in near month contract of Mentha Oil.

iii. According to VECM results, it is found that the Commodity futures provide 18.72% variance reduction in the spot prices of Mentha Oil. It further found that, a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 15.50% by selling 18.72% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 18.68% variance reduction in near month contracts of Mentha Oil. It further reveals that a hedger who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 15.47% by selling 18.86% of the underlying commodity in near month contract of Mentha Oil.

v. The hedging effectiveness decreased to 13.41% from 18.93% in Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method. The overall hedging effectiveness is low in Mentha Oil futures market.

vii. It is found that performance of Mentha Oil future is not effective in minimising the spot price risk as the hedge ratio and hedging effectiveness is low.

viii. It reveals that Mentha Oil futures contracts are not suitable for hedging i.e., there will not be a reduction in the variance of spot market by using commodity futures contracts.

CPO

i. It is observed that the basis risk is higher than the price risk for commodity CPO. It reveals that contracts will not be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 5.71% variance reduction in near month contracts of CPO. It further reveals that a hedger who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 2.90% by selling 5.71% of the underlying commodity in near month contract of CPO.

iii. According to VECM results, it is found that the commodity futures provide 44.60% variance reduction in the spot prices of CPO. It further found that, a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 15.50% by selling 44.60% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 44.48% variance reduction in near month contracts of CPO. It further reveals that, a hedger who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 19.03% by selling 44.48% of the underlying commodity in near month contract of CPO.

v. The hedging effectiveness decreased to 7.97% from 32.13% in Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method. The overall hedging effectiveness is low in CPO futures market.

vii. It is found that performance of CPO future is not effective in minimising the spot price risk as the hedge ratio and hedging effectiveness is low.

viii. It reveals that CPO futures contracts are not suitable for hedging i.e., there will not be a reduction in the variance of spot market by using commodity futures contracts.

Precious Metal Commodities

Gold

i. It is observed that the basis risk is lower than the price risk for commodity Gold. It reveals that future contract will be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 27.14% variance reduction in near month contracts of Gold. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 9.49% by selling 27% of the underlying commodity in near month contract of Gold.

iii. According to VECM results, it is found that the commodity futures provide 32.60% variance reduction in the spot prices of Gold. It further found that a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 24.96% by selling 32.56% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 32.26% variance reduction in near month contracts of Gold. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 23.79% by selling 32.26% of the underlying commodity in near month contract of Gold.

v. The hedging effectiveness decreased to 23.29% from 78.6% in Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method. The overall hedging effectiveness is average in Gold futures market.

vii. It reveals that Gold futures contracts are suitable for hedging i.e., there will be a reduction in the variance of spot market by using commodity futures contracts.

Silver

i. It is observed that the basis risk is lower than the price risk for commodity Silver. It reveals that futures contract will be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 20.46% variance reduction in near month contracts of Silver. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 4.93% by selling 20.46% of the underlying commodity in near month contract of Silver.

iii. According to VECM results, it is found that the commodity futures provide 32.59% variance reduction in the spot prices of Silver. It further found that, a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 25.07% by selling 32.59% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 33.76% variance reduction in near month contracts of Silver. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 29.96% by selling 33.76% of the underlying commodity in near month contract of Silver.

v. The hedging effectiveness decreased to 2.03% from 26.78% in Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method. The overall hedging effectiveness is average in Silver futures market.

vii. It reveals that silver futures contracts are suitable for hedging i.e., there will be a reduction in the variance of spot market by using commodity futures contracts.

Industrial Metal

Aluminium

i. It is observed that the basis risk is higher than the price risk for commodity Aluminium. It reveals that contracts will not be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 34.66% variance reduction in near month contracts of Aluminium. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 0.44% by selling 34.66% of the underlying commodity in near month contract of Aluminium.

iii. According to VECM results, it is found that the commodity futures provide 40.50% variance reduction in the spot prices of Aluminium. It further found that a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 18.69% by selling 40.50% of underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 39.44% variance reduction in near month contracts of Aluminium. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 17.39% by selling 39.44% of underlying commodity in near month contract of Aluminium.

v. The hedging effectiveness decreased to 0.00% from 8.87% in Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method. The overall hedging effectiveness is low in Aluminium futures market.

vii. It reveals that Aluminium future contracts are suitable for hedging i.e., there will not be a reduction in the variance of spot market by using commodity futures contracts.

Copper

i. It is observed that the basis risk is higher than the price risk for commodity Copper. It reveals that contracts will not be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides -0.43% variance reduction in near month contracts of copper. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 0.001% by selling -0.43% of underlying commodity in near month contract of copper.

iii. According to VECM results, it is found that the commodity futures provide 12.24% variance reduction in the spot prices of copper. It further found that, a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 0.08% by selling 12.24% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 10.26% variance reduction in near month contracts of copper. It further reveals that a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 0.08% by selling 10.26% of underlying commodity in near month contract of copper.

v. The hedging effectiveness decreased to 0.07% from 0.31% in Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method.

vii. Hedge Ratio and Hedge Effectiveness is low as per all models under study. Therefore, the performance of Copper futures is not effective in minimising the spot price risk as the hedge ratio and hedging effectiveness is very low.

viii. It reveals that Copper futures contracts are not suitable for hedging i.e., there will not be a reduction in the variance of spot market by using commodity futures contracts.

Nickel

i. It is observed that the basis risk is higher than the price risk for commodity Nickel. It reveals that contracts will be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 37.5% variance reduction in near month contracts of Nickel. It further reveals that a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 11.42% by selling 37.5% of the underlying commodity in near month contract of Nickel.

iii. According to VECM results, it is found that the commodity futures provide 44.34% variance reduction in the spot prices of Nickel. It further found that, a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 28.15% by selling 44.34% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 46.40% variance reduction in near month contracts of Nickel. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 29.13% by selling 16.11% of the underlying commodity in near month contract of Nickel.

v. The hedging effectiveness decreased to -37.21% from 3.91% in Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method.

ix. It is found that hedging effectiveness of Nickel futures is moderate in minimising the spot price risk as the hedge ratio and hedging effectiveness is average.

x. It reveals that Nickel futures contracts are suitable for hedging i.e., there will be a reduction in the variance of spot market by using commodity futures contracts.

Lead

i. It is observed that the basis risk is higher than the price risk for commodity Lead. It reveals that contracts will be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 14.2% variance reduction in near month contracts of Lead. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 0.23% by selling 14.2% of underlying commodity in near month contract of Lead.

iii. According to VECM results, it is found that the commodity futures provide 44.84% variance reduction in the spot prices of Lead. It further found that, a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 50.77% by selling 14.84% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 16.11% variance reduction in near month contracts of Lead. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 45.59% by selling 16.11% of underlying commodity in near month contract of Lead.

v. The hedging effectiveness decreased to 0.327% from 3.08% in Second Sub-Period. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method. The overall hedging effectiveness is low in Lead futures market.

xi. The overall hedging effectiveness is low in Lead futures market.

xii. It reveals that Lead futures contract are not suitable for hedging i.e., there will not be a reduction in the variance of spot market by using commodity futures contracts.

ENERGY

Crude Oil

i. It is observed that the basis risk is higher than the price risk for commodity Crude Oil. It reveals that contracts will not be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 14.33% variance reduction in near month contracts of Crude Oil. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 1.63% by selling 14.33% of the underlying commodity in near month contract of Crude Oil.

iii. According to VECM results, it is found that the commodity futures provide 17.47% variance reduction in the spot prices of Crude Oil. It further found that, a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 07.84% by selling 17.47% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 17.15% variance reduction in near month contracts of Crude Oil. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 7.01% by selling 17.15% of the underlying commodity in near month contract of Crude Oil.

v. The hedging effectiveness increased to 10.13% from -93.98% in Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method. The overall hedging effectiveness is very low in Crude Oil futures market.

vii. It is found that performance of Crude Oil future is not effective in minimising the spot price risk as the hedge ratio and hedging effectiveness is very low.

viii. It reveals that Crude Oil futures contract are not suitable for hedging i.e., there will not be a reduction in the variance of spot market by using commodity futures contracts.

Natural Gas

i. It is observed that the basis risk is higher than the price risk for commodity Natural Gas. It reveals that contracts will not be suitable for hedging.

ii. As per the OLS model, the hedge ratio provides 10.26% variance reduction in near month contracts of Natural Gas. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 0.91% by selling 10.26% of the underlying commodity in near month contract of Natural Gas.

iii. According to VECM results, it is found that the commodity futures provide 0.07% variance reduction in the spot prices of Natural Gas. It further found that, a trader who is trying to minimise price risk by hedging in futures markets is able to reduce the risk by 05.35% by selling 0.07% of the underlying commodity.

iv. As per the VECM-GARCH model, the hedge ratio provides 0.075% variance reduction in near month contracts of Natural Gas. It further reveals that, a trader who is trying to minimise price risk by hedging in futures market is able to reduce the risk by 5.02% by selling 0.075% of the underlying commodity in near month contract of Natural Gas.

v. The hedging effectiveness increased to 3.56% from -89.13% in Second Sub-Period.

vi. There is no much difference in the estimates of VECM and VECM- GARCH model. In the case of constant hedge ratio estimates, VECM gives higher and provide greater variance reduction than OLS method. The overall hedging effectiveness is low in Natural Gas futures market.

vii. It is found that performance of Natural Gas futures is not effective in minimising the spot price risk as the hedge ratio and hedging effectiveness is low.

viii. It reveals that Natural Gas futures contract are not suitable for hedging i.e., there will not be a reduction in the variance of spot market by using commodity futures contracts.

Summary

VECM model out performs OLS model in providing the greatest variance reduction. Hence VECM model is superior in estimating the hedge ratio for the hedgers to adjust their futures positions to that of the spot price fluctuations. Reduction in variance (price risk reduction) that is obtained by holding the futures contract is low and on an average range between 15%-40% in most commodities. Therefore, null hypothesis is rejected which means there is significant decrease in the variance of commodity spot returns (price risk) by hedging through commodity futures. Hedging effectiveness of Indian commodity futures markets has declined in the Second Sub- Period with decline in turnover in the futures market, except for commodities Natural Gas and Crude Oil. Therefore, null hypothesis is rejected which means there is significant difference in hedging performance among different time periods. Non-agricultural commodities provide higher hedging effectiveness in comparison to agricultural commodities in Indian futures market. The estimates of hedge effectiveness of Copper, Crude oil and Natural Gas is very low during the study period (0.08%, 5%, 8%). The estimates of hedge effectiveness of near month futures of Crude Oil and Natural Gas is negative -0.93 and -0.89 during First Sub-Period. It reveals that the variance of hedged portfolio is increasing as compared to the variance of unhedged portfolio.

7.2 Conclusion

Indian commodity markets have undergone enormous restructuring and transformation because of core reforms initiated in the year 2003. Electronic multi commodity exchanges in India have been operative since the year 2002-2003. Broadly, the commodities market exists in two forms in India, Over-the-Counter (OTC) market and the exchange-based market (Derivatives market). Spot markets are essentially OTC markets and participation is restricted to people who are involved with that commodity, such as the farmer, processor, wholesaler, etc. A majority of the derivatives trading takes place through the exchange-based markets with standardized contracts, settlements, etc. The Indian commodity market comprises of certain structure which is based on some hierarchical system. It contains three tier structure of trading functions. The Indian Commodity Market can be divided into three layers to control the functioning of the Commodity Market in India. First and the top most layer consist of the Government of India (Ministry of Consumer Affairs), Second layer or the Middle layer consist of Forward Market Commission which is now merged with SEBI (Securities and Exchange Board of India) and third layer consists of Commodity Exchanges.

The commodity futures traded in commodity exchanges was regulated by the Government under Forward Contracts Regulations Act, 1952 and the rules framed there under. The regulator for the commodities trading was the FMC up to the year 2015, which was merged with the capital market regulator SEBI in September, 2015. Presently SEBI is controlling all derivatives market trading activities along with the investor's protection measures. SEBI, in order to effect the merger of FMC, has amended Securities Contract (Stock Exchanges and Clearing Corporation) Regulations, 2012 (SECC) and SEBI (Stock Broker and Sub Broker Regulations) 1992, and SEBI (Regulatory Fee on Stock Exchanges). These regulations enabled functioning of the commodity and derivative exchanges and their brokers under SEBI norms. SEBI has also created a separate commodity derivatives market regulation department for the regulation of commodity derivatives. After SEBI becoming regulator, commodity markets have seen various positive policy changes such as strengthening of risk management, by reviewing the position limits linked with the size of the spot market, strengthening of delivery mechanism by mandating the Good Delivery Obligations as a legal responsibility of the exchange, strengthening of surveillance of the market, introduction of the new products and participants including options, trading in indices and intangibles such as weather and permitting category III AIF funds.

The efficient functioning of a futures market presumes the existence of efficient spot markets. In reality, however, the absence of well- established grades; adequate infrastructure in the form of as Sayers, graders, warehouse, presence of unwanted intermediaries in the value chain, inadequate availability of credit have let to multiple inefficiencies in the spot market. There has been a policy push from the Government of India for developing the spot market for various agricultural and non-agricultural commodities. The e-Nam, Goods and Service Tax, regulation of warehousing sector, development of electronic warehouse receipt repositories and identifying measures for integration of spot and derivatives markets for commodities are some of the prominent steps taken for the development of India's commodity spot market.

Phenomenal growth is witnessed in early years of establishment of national commodity exchanges up to the year 2005-2006, then a stable growth is recorded averaging to 40% per annum up to the year 2011-12. Then, there is a sudden decline in volumes and trade transactions since the year 2013-14 due to the introduction of Commodity Transaction Tax on non -agricultural futures contracts and a major scam at the functioning of National Spot Exchange Ltd., (NSEL) in the year July 2013. The mega fraud of NSEL sent shock waves across futures exchanges indicating the poor regulatory infrastructure of commodity markets. The loss of confidence of traders and investors ultimately caused sharp decrease in total transactions at exchanges and accordingly the total volume and value of futures transactions report. The NSEL failure made FMC to function under the control of Ministry of Finance from the Ministry of Consumer Affairs. Govt. of India and subsequently led to merger of FMC with SEBI in the year 2015.

The popularity of derivative securities can be gauged from the data of an increase in the total turnover of major commodity exchanges MCX and NCDEX. There are two exchanges that dominate the commodity derivatives market in India, the MCX and the NCDEX, while both the exchanges trade all types of commodities, NCDEX is more known for the trading of agricultural commodities. In the year 2019-2020, MCX derivatives trade comprises of 98.8% share in non-agricultural commodities. At NCDEX, 100% share was accounted by agricultural commodities. In 2017, MCX introduced commodity options contract by launching gold options, since then, the exchange has expanded its options universe and now includes copper, crude oil, zinc and silver contracts. NCDEX started options trading in the year 2018, announcing the launch of option contract in Gur seed futures, a commodity which contributes to over a fifth of the exchange total annual turnover.

The values depict that turnover in NCDEX has decreased manifolds from Rs. 14,10,602 crores to Rs. 4,41,967 crores in the time period of ten years whereas the trading volume has registered uptrend in the turnover of MCX. MCX is presently the largest commodity derivatives exchange in India in terms of trading volumes. With regard to the trading pattern, though there are more than 100 commodities being traded at MCX, but only four commodities contribute to more than 80% of total trade volume. The major traded commodities at MCX are gold, silver and crude oil. Among the agricultural commodities being traded the major volume is contributed by Gur Seed, Soyabean, Castor seed, Refined Soya oil, CPO and Cotton, whose market size is considerably small making them exposed to market manipulations.

The share of agricultural commodities which was recorded the highest with 70% in 2004-05 in the first year of introduction of commodity trading in India, has gradually declined to 30% in the year 2018-19. On the other hand, the share of non -agricultural commodities gradually rose from 30% to 70% over the years with a dominating role of Energy (35%) and Metal (23%). In the year 2019-20, non-agricultural commodities accounted for 93.7% of the total turnover of commodity derivatives traded, while the balance 6.3 % was contributed by agricultural commodities. Analysis of volume contributions on the major national commodity derivatives exchanges revealed that majority of the trade has been concentrated in few commodities and major volume has been contributed by non -agricultural commodities namely bullion, energy and metals. Agricultural commodities have small market size in commodities like Gur Seed, Soyabean, Castor Seed, CPO, Cotton, Channa etc. There is no wide spread involvement of all the stake holders in the commodity derivatives markets. The actual benefits of commodity derivatives could have been achieved only when all the stake holders in commodity derivatives market including consumers, traders and producers trade actively in all the major commodities.

The Johansen Test of Co-integration result reveals that there is a long-run relationship, i.e., equilibrium between commodity futures market price and spot market price of commodities and market indices under study. This indicates that, there is no scope for long-run arbitrage opportunity. The VECM estimates reveal that, the coefficients of ECT of log spot price series of sample commodities and market indices are negative in sign and are significant at 5% significance level. Which implies there is a long-run causality running from futures market price to spot market price which enable the spot market to adjust to the short-run deviation from the long-run equilibrium path. The coefficients of ECT which is also termed as speed of adjustment appears to be greater for the futures market than for the spot market for all sample commodities indicating that when the cointegrated series is in disequilibrium in the short-run, it is the futures market that makes greater adjustment than the spot market in order to restore the equilibrium. The speed of adjustment in the futures market is more which shows a highly informative futures market. It indicates futures market contributes largely to the price discovery, suggesting that news is first gathered in the futures market prices and then transferred to the spot market prices.

Different patterns of causality have been found in the Indian commodity market. For some of the commodities, the futures market transmits information to the spot market. There are some commodities for which a bi-directional information flow exists. Therefore, in the Indian Commodity Market the pattern of causality is commodity specific. The results of the Granger Causality Test between futures and spot price returns suggested that there is unidirectional causality i.e., futures market dominates the spot market for seven commodities namely Cardamom, Cotton, Aluminium, Copper, Lead, Crude Oil and Silver where the spot price is discovered in the futures market. In bidirectional causality, the spot and futures both are contributing to price discovery for five commodities namely CPO, Mentha Oil, Nickel, Natural Gas and Gold. Though bi-directional information flow exists for these commodities, the flow from futures market price to spot market price is stronger. The results therefore, highlight the comparative advantage of futures markets in disseminating information and thereby leading to a significant price discovery and risk management, which would further help the underlying spot market to develop successfully. A stronger flow of information is exhibited from the futures to spot market which confirmed the efficiency of the futures market in discovering the prices for spot markets for sample commodities.

Examination of dynamic behavior of commodity futures market has focused on issues around volatility clustering and persistence, mean reversion and volatility asymmetry effect relating to the commodities chosen under the study. The symmetric volatility models such as GARCH (1,1) have been employed, which reveals that, there is high degree of volatility persistence in the commodity market. The asymmetric volatility models like EGARCH (1,1) model and TGARCH (1,1) model have been applied to analyze the leverage effect in the commodity market. Volatility is persistent in spot and futures market across all the commodities but the degree of persistence differs. Persistent high volatility existed for market Indices and commodities under study, except for the futures market of Cardamom, Cotton, Mentha oil. High volatility indicates, inefficiency of the markets. Based on co-efficient values and p-value it can be said that futures market of Cardamom, Cotton, Mentha oil is efficient because of its low volatility. Low volatility persistence value in agricultural futures shows that since agriculture sector is a government regulated market, any innovation entering the market has short-lived impact due to government intervention. Commodities from energy and metal sector are found to be most volatile markets as these markets are mostly dependent on the foreign markets. If foreign innovation enters the market, it has long lasting impact.

As per GARCH (1,1) model, sum values of ARCH and GARCH is less than 1 for all commodity futures, which indicate that return volatility will not move indefinitely upwards or downwards thus confirming mean reversion behavior. Control by government in commodity derivatives market and automatic forces of demand and supply are important factors which bring the return volatility back to equilibrium. The values of β are significantly higher than α, indicating a longer memory and volatility for all commodities under study. Coefficient values of variance equation results are statistically significant, which indicates past conditional variance has a greater impact on current change in return than recent shocks or news announcements and volatility persists over time. The presence of leverage effect is confirmed in the case of spot and futures market of MCXAGRI, MCXENERGY, Cardamom, Copper, Nickel and Crude Oil and futures market of Cotton and Lead. Here negative shock effects create much greater levels of volatility when compared to positive shock effects. Here these commodities are more sensitive to negative information and hence leads to price fluctuations in the market. Market indices and commodities which does not exhibit leverage effect are spot and futures market of MCXCOMDEX, MCXMETAL, CPO, Mentha Oil, Aluminium, Natural Gas and Silver and spot market of Cotton and Lead. Here positive shock effects create much greater levels of volatility, when compared to negative shock effects.

The study investigates risk minimising hedge ratio and hedging effectiveness of Indian commodity futures market by applying constant and dynamic hedge ratio models. As per the estimates of Basis Risk, out of twelve sample commodities only four commodities viz. Lead, Nickel, Gold and Silver are suitable for hedging. The hedge ratio and hedge effectiveness of commodity futures returns of select commodities on their spot returns reveal that, a trader or manufacturer or farmer who is trying to minimise price risk by hedging in futures markets is not able to reduce the price risk of underlying commodities as their basis risk is higher than the price risk.

During the study period, reduction in variance that is obtained by holding the futures contract is low and on an average range between 15% to 40% in most commodities. Thus, it can be concluded that the price risk reduction with futures markets is only 15% to 40% in India. Although hedge ratio is moderate for commodities Cardamom, Aluminium and Nickel is 44%, 39% and 46% respectively and hedge effectiveness 19%, 17% and 29% which is low. It indicates that though hedge ratios are moderate, investors are unable to reduce risk. Indian agricultural commodity futures markets provide lower hedging effectiveness (less than 20%) in comparison to non-agricultural commodities. Variance reduction by holding agricultural commodity futures is low. Constrained imposed by the government on agricultural goods may be the reasons for such a low hedging effectiveness in agricultural futures contracts. Minimum support price, ban on futures trading are some steps which may have hampered the effectiveness of futures contracts that do not allow the futures market to function according to market forces, resulting in low hedging efficiency. The variance reduction for some non-agricultural commodities is even smaller. It has been observed that the Natural Gas, Crude Oil and Copper has the lowest hedging effectiveness under non-agricultural commodities. Copper futures has the lowest amount of variance reduction (0.086%) followed by Natural Gas (5.02%) and Crude Oil (7.01%).

The hedging performance of Indian Commodity Futures market has declined in the Second Sub-Period (1^{st} January 2015- 31^{st} December 2020), with decrease in turnover in the market. Commodity Gold has the highest hedging effectiveness of 78.6% during First Sub-Period, which decreased to 23.9% in Second Sub-Period. The estimates of hedge effectiveness are negative -93% and -89% for commodities Crude Oil and Natural Gas during First Sub-Period. It reveals that variance of hedged portfolio is increasing as compared to the variance of unhedged portfolio. Hedge effectiveness increased to 10% and 3% for Crude Oil and Natural Gas during Second Sub-Period. Hedge effectiveness of commodity Nickel was positive 3.9% during First sub-Period. Whereas, hedge effectiveness of Nickel was negative -37% during Second Sub-Period.

The study suggests that Indian commodity futures contracts are not effective in hedging price risk. The reason for low hedging performance, may be because of low awareness of commodity futures among participants, low participation by hedgers, high transaction costs in the futures contracts and spot market, policy restrictions, a smaller number of delivery centres, inadequate contract design. Traders of futures markets use these futures contracts for more speculation purpose than hedging as demonstrated by the speculation ratio. We also find that the hedging performance of Indian commodity futures market has decreased in the Second Sub-Period with decline in turnover in the market. Some of the main reasons are NSEL scam and introduction of Commodity Transaction Tax (CTT) in the year 2013. Suspension of trading in agricultural commodities at regular intervals. Measures taken by SEBI in the year 2016 to increase the initial margin and reduce the maximum position, affected the market. In the same year demonetisation of rupee reduced the cash holdings of investors, hence affecting the commodity market.

Some key issues affecting the further growth of the commodity derivatives market which needs to be immediately addressed are:

1. The imposition of Commodity Transaction Tax (CTT) from July 2013 has significantly affected the performance of the Indian commodity futures market and led to steep decline in the trading volumes.
2. The initial margins for most of the commodities are high and ranges from 5-20% in India.
3. The Daily Price Limits (DPL) on commodity futures contract restricts price movements on daily basis. DPL jeopardize the very purpose of futures price discovery and hedging (price risk management).

7.3 Research Contribution

The present research has significantly contributed to the different spheres of commodity derivatives market functioning. In terms of contribution, the outcomes of this study are as follows:

1. The results of this study are related to advancement of theoretical understanding of the commodity futures market in India.
2. The study is bringing out a clear vision for spot market participant who can successfully use futures positions to minimise spot market price risk.
3. The study has provided a necessary platform for discussing the important issues of commodities markets and would enable us to make significant improvement in the growth of derivative market taking into account the interests of the stake holders, such as hedgers, arbitragers, traders and other stake holder.

Research Contribution to Different Stakeholders:

1. Policy Makers: Policy reformers remain in dilemma of whether to curb the commodity derivatives markets or not because various previous studies have given different kinds of outcomes. The study states that commodity derivatives market provides a platform

of price discovery and does not act as a toll of price-risk management. This will help policy makers to make reforms, which help the economy in resource allocation.

2. Market Participant: As we know financialization of commodities is gaining importance nowadays, so various market participants like speculators, arbitragers or investors may keep in view outcomes of the study to achieve the optimum level of investments.
3. Society: Society plays a major role in fundamentals of commodity market mechanism. The study has also its social implications by providing the base to regulators about how to make available a substitute of platform for suppliers of commodities to sell their manufactured commodities in more efficient manner. It helps in socio-economic set-up of the country. Society can be largely benefitted with the present study.

Thus, the outcome of this study is helpful for a variety of stakeholders who enthusiastically participate in commodity markets, whether it is spot or futures market. Commodity derivatives markets help in price discovery and moves the markets towards efficiency but some of the scholars argue that futures market destabilize the markets due to speculative trading. Present study supports price discovery mechanism through futures markets in spot markets. Study provides the strong evidences of having the causal relationship between futures prices and spot prices. Present study adds value to the existing literature because it does not only examine the relationship between futures prices and spot prices but also measures price volatility in futures and spot prices of the underlying commodities and estimate hedging effectiveness in risk management. It also strikes the minds of researchers to review this concept again.

History says that there has always been a contrast in views of researchers and policy makers. Most of the studies provided the evidences of being the derivative markets of commodities helpful in price discovery and price-risk management, but suspension of derivatives exchanges in India proved the disagreement between the vast literature made in its favor. Thus, the result of the study would sensitize by providing a new dimension of thinking to researchers, policy makers and market participants on the theme "A Study of Commodity Spot and Futures Markets in India".

7.4 Recommendations

1. The research evidence suggests that the futures market is faring relatively well on price discovery and relatively poor on hedging effectiveness across commodities. Hence, the focus of policy makers should be on improving hedging effectiveness, i.e., reducing basis risk. An essential characteristic of the marketplace which reduces basis risk is arbitrage. A vibrant ecosystem which supports frictionless trading with a large number of sophisticated arbitrageurs will give reduced basis risk and deliver the highest possible hedging effectiveness. It is observed that most of the contracts (Crude Oil, Natural Gas) are showing high basis risk, that it reveals futures market ability to provide instruments of risk management is quite poor. This is because of dominance of speculators and also some other fundamental factors like supply variability. This issue needs to be addressed both by exchanges and regulator.
2. The derivatives exchanges contribute substantially in the field of commodity derivatives. Out of the five national level exchanges, the Multi Commodity Exchange of India plays an active role and the market leader in the commodity derivatives sector by holding a share of 94%. There is only a nominal share for other four national exchanges. In a country like India with diversified markets it requires more than six national exchanges. Measures may be taken to attract a greater number of national level exchanges.
3. Market integration across the country is required and is possible only when all the existing restrictions such as stock limits, levy system, etc, are done away with. Withdrawal or reduction of the Commodity Transaction Tax (CTT) on the non-agricultural commodities and reduction in initial margin will increase the trading from

market participants in the exchanges which can improve the liquidity and price risk management function of derivatives market.

4. Commodities from metal sector behaves better than agricultural commodities in terms of hedging efficiency. Proper regulation is essential for agricultural commodities for better hedging performance. The derivatives are originated to protect the farmers from adverse price fluctuations. But they are not actively engaged in the trading of commodity derivatives. So, in order to attract them in to the derivatives market, the exchanges must give awareness to people through various programmes such as seminars and workshops etc., and induce farmers to make use of the facilities of the commodity derivative markets to hedge the price risk. Institutions like banks, NGO etc need to act as an aggregator on behalf of the farmers. Need for more awareness programmes especially amongst the farmers is required so that the best benefit of price discovery and price risk management can be availed by them.
5. The present contract size of commodity futures is large and the small and marginal farmers are not having the required amount of marketable surplus. So, there is a need for introducing mini contracts in all the commodities so as to enable small and medium investors, traders and producers to avail the benefits of commodities derivatives market.

7.4 Scope for Future Research

The following are some areas were the scope lies for further research related to the study entitled “A Study on Commodity Spot and Futures Markets in India”.

1. Integration of Indian commodity derivatives market with global commodities markets.
2. Commodity derivatives v/s financial derivatives in price discovery and risk management in India.
3. Portfolio diversification using commodity derivatives.

4. Options form a part of derivatives instruments for hedging purpose so commodity options can also be added for research study.
5. Seasonality effect may also be tested for the derivative contracts

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ANNEXURE

Annexure I: Optimal Lag Selection- Near Month Contracts

VAR lag order Selection Criteria-

Endogenous Variables: LOGSPOT LOGFUTURE

Non-Agricultural Commodities (Base Metal)

Lag	LogL	LR	FPE	AIC	SC	HQ
Aluminium						
0	4115.278	NA	0.00017	-3.001298	-2.996981	-2.999738
1	15917.97	23579.54	3.11E-08	-11.61034	-11.59739	-11.60566
2	15943.23	50.43848	3.06E-08	-11.62585	**-11.60427***	-11.61806*
3	15948.09	9.695956	3.06e-08*	-11.62648*	-11.59627	-11.61556
4	15948.65	1.116399*	3.07E-08	-11.62397	-11.58512	-11.60993
Copper						
0	2296.3	NA	0.000588	-1.762813	-1.758307	-1.76118
1	13168.14	21718.61	1.39E-07	-10.11305	-10.09953	-10.10815
2	13279.32	221.9284	1.28E-07	-10.1954	-10.17287	-10.18724
3	13322.85	86.82831	1.24E-07	-10.22578	**-10.19423***	-10.21435*
4	13329.91	14.07813*	1.24E-07*	-10.22813*	-10.18758	-10.21344
Nickel						
0	8743.814	NA	1.26E-05	-5.605524	-5.601647	-5.604132
1	17202.38	16900.87	5.57E-08	-11.02686	-11.01523	-11.02268
2	17260.05	115.1478	5.39E-08	-11.06127	-11.04189	-11.05431
3	17294.41	68.57219	5.28E-08	-11.08074	-11.0536	-11.071
4	17316.24	43.53134*	5.22E-08*	-11.09217*	**-11.05728***	-11.07965*
Lead						
0	7934.649	NA	1.65E-05	-5.338256	-5.334221	-5.336804
1	16683.27	17479.57	4.58E-08	-11.22292	-11.21082	-11.21857
2	16728.72	90.7563	4.46E-08	-11.25082	-11.23064	-11.24356
3	16780.53	103.3815	4.31E-08	-11.283	-11.25475	-11.27283
4	16806.35	51.48504*	4.25E-08*	-11.29768*	**-11.26136***	-11.28461*
Source: Computed in software E-views ** Indicates lag order selected by the criterion*						

Endogenous Variables: LOGSPOT LOGFUTURE

Non-Agricultural Commodities (Energy and Precious Metal)

Lag	LogL	LR	FPE	AIC	SC	HQ
Crude Oil						
0	6846.228	NA	3.59E-05	-4.559779	-4.555777	-4.558339
1	14609.75	15511.53	2.04E-07	-9.729349	-9.717343	-9.725031
2	14626.83	34.10445	2.02E-07	-9.738064	-9.718054	-9.730867
3	14642.58	31.41656	2.01E-07	-9.745889	-9.717875	-9.735813
4	14670.8	56.27349*	1.97E-07*	-9.762026*	**-9.726007***	-9.74907*
Natural Gas						
0	7136.169	NA	3.08E-05	-4.713689	-4.709715	-4.71226
1	14459.54	14632.23	2.44E-07	-9.549748	**-9.537825***	-9.545462*
2	14467.12	15.11806	2.44E-07	-9.552108	-9.532236	-9.544964
3	14470.24	6.225997	2.44E-07	-9.551527	-9.523706	-9.541524
4	14475.46	10.40918*	2.44E-07*	-9.552333*	-9.516563	-9.539473

Gold						
0	7795.847	NA	1.54E-05	-5.406761	-5.402622	-5.40527
1	19087.56	22559.93	6.11E-09	-13.2373	-13.22488	-13.23282
2	19546.57	916.4302	4.46E-09	-13.55295	-13.53225	-13.54549
3	19594.07	94.75663	4.32E-09	-13.58312	-13.55415	-13.57268
4	19632.13	75.88095*	4.22E-09*	-13.60675*	**-13.56950***	-13.59332*
Silver						
0	6674.799	NA	3.34E-05	-4.630672	-4.626532	-4.62918
1	15874.58	18380.42	5.66E-08	-11.0122	-10.99978	-11.00772
2	15973.81	198.1191	5.29E-08	-11.07829	-11.05759	-11.07083
3	16088.91	229.6333	4.90E-08	-11.15539	-11.1264	-11.14494
4	16121.97	65.91182*	4.80E-08*	-11.17555*	**-11.13829***	-11.16212*
Source: Computed in software E-views ** Indicates lag order selected by the criterion*						

Endogenous Variables: LOGSPOT LOGFUTURE

Agricultural Commodities

Lag	LogL	LR	FPE	AIC	SC	HQ
Cardamom						
0	1361.984	NA	0.001247	-1.011517	-1.007131	-1.00993
1	12226.33	21704.44	3.87E-07	-9.089123	-9.075965	-9.084364
2	12254.76	56.7663	3.80E-07	-9.107298	**-9.085368***	-9.099365*
3	12256.23	2.938988	3.81E-07	-9.105418	-9.074717	-9.094313
4	12262.4	12.28853*	3.80E-07*	-9.107029*	-9.067555	-9.092751
Cotton						
0	6135.109	NA	1.18E-05	-5.673551	-5.668298	-5.67163
1	13918.52	15545.22	8.82E-09	-12.87005	-12.85429	-12.86428
2	14031.04	224.5147	7.98E-09	-12.97043	-12.94417	-12.96083
3	14064.26	66.23089	7.77E-09	-12.99747	**-12.96069***	-12.98402*
4	14066.57	4.60217*	7.78E-09*	-12.9959*	-12.94862	-12.97861
CPO						
0	9518.645	NA	6.39E-06	-6.285763	-6.28179	-6.284335
1	19571.77	20086.34	8.37E-09	-12.92323	-12.91131	-12.91895
2	19807.57	470.8196	7.18E-09	-13.07634	-13.05647	-13.06919
3	19832.57	49.8779	7.08E-09	-13.0902	**-13.06239***	-13.0802
4	19841.76	18.32432*	7.06E-09*	-13.09363*	-13.05787	-13.08078*
Mentha Oil						
0	4359.706	NA	0.000184	-2.923654	-2.919629	-2.922206
1	14044.29	19349.67	2.78E-07	-9.41851	-9.406434	-9.414165
2	14227.34	365.4786	2.47E-07	-9.538635	-9.518508	-9.531393
3	14283.49	112.0496	2.38E-07	-9.573628	**-9.545450***	-9.563489
4	14297.2	27.33231*	2.37E-07*	-9.580141*	-9.543912	-9.567105*
Source: Computed in software E-views ** Indicates lag order selected by the criterion*						

LR: Sequential modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion

Annexure II: Futures Terminologies Related to Commodity Trading

Commodity Exchange

A commodity exchange is a physical or virtual market where different commodities and derivatives are sold and bought in an organized manner. In the commodity derivatives exchanges, trading of commodity futures and options contracts are conducted. A modern electronic commodity exchange provides the market participants fast, secure, transparent and regulated platforms for trading. It also provides public display of prices and trades. Commodity exchanges provide standardized contract for trading which cannot be modified by the traders. The exchange also provides the facilities for clearing, settlement and arbitration.

Derivatives

A derivative contract is an agreement between a buyer and a seller. The value of the contract depends on the value of the underlying asset. The underlying asset can be a stock, commodity, currency, bond, index, etc. There are different types of derivatives such as Forward, Future, Option, Swaps etc.

Forward

A forward contract is an agreement between two traders to undertake an exchange of the asset underlying the contract at a pre-specific future date for a specified price. It is traded over-the-counter. The contract is executed by both parties on the pre-specified date by delivery of the asset by the seller and payment by the buyer.

Future

Futures contracts are agreements between two traders to buy or sell an asset at a prespecified through the exchanges following terms and conditions specified by the exchange. The buyer and seller can determine the price. On the date of expiry of the contract, the futures contracts are settled by cash or physical delivery of the underlying asset.

Option

Options contracts provide the right, but not the obligation, to buy or sell a predetermined quantity of asset on or before a pre-specified future date.

Swaps

A swap is an agreement between two traders to exchange cash (flows) on or before a pre-specified future date based on the underlying assets. Swaps are not exchange traded contracts. The trading of swaps is arranged by banks and financial institutions.

Spot Price

It is the price at which assets are traded in the spot market.

Futures Price

In the futures market the futures contracts are traded at a price. It is called the futures price.

Hedging: The practice of offsetting the price risk inherent in any cash market position by taking an equal but opposite position in the futures market. Hedgers use the futures markets to protect their business from adverse price changes.

Convergence: A term referring to cash and futures prices tending to come together as the futures contract nears expiration.

Daily trading limit: The maximum price changes set by the exchange each day for a contract.

Long position: One who has bought futures contracts or plans to own a cash commodity.

Open interest: For a given commodity, the total number of futures or options contracts that have been neither offset by an opposite futures or option transaction nor fulfilled by delivery of the commodity or option exercise. Each option transaction has a buyer and a seller, but for calculation of open interest, only one side of the contract is countered.

Short position: One who has sold futures contracts or plans to sell a cash commodity. Selling futures contracts or initiating a cash forward contract sale without offsetting a particular market position.

Volume: The number of purchases or sales of a commodity futures contract made during a specified period of time, often the total transactions for one trading day.

Contract Cycle

A contract remains valid for a specified time period. This is called contract cycle. The length of the contract cycle can be one month, two months, three months, etc.

Expiry Date

The last day of the contract cycle is called expiry date.

Delivery Unit

A specified amount of asset has to be delivered under a contract. It is called delivery unit.

Cost of Carry

The cost of storage and the interest paid to finance the asset, together termed as cost of carry. The cost of carry establishes a relationship between spot and futures prices.

Market Participants

Day Traders

Day traders are participants who take positions for a single day in the futures contracts. They liquidate their position before the end of the day.

Scalpers

The scalpers hold their position for a few minutes. They try to make profit from the intraday movement in commodity futures prices. They offer liquidity in the futures market by providing large volumes of transactions.

Hedgers

The hedgers participate in both the spot market and the futures market simultaneously. They take one position in the spot market, and in the futures market, they take another opposite position. Thus, they eliminate the risk of investment.

Speculators

Speculators make profits from the movements of the commodity prices. They take higher risk on their investment and also expect a higher return form it. They liquidate their positions before contract expiry and carry out financial transactions. They help the market by providing liquidity.

Arbitrageurs

Arbitrageurs make profit from the difference of the price of a commodity across different markets. They simultaneously take similar positions for a commodity in different markets. They keep the prices of a commodity aliened in different markets.

Aggregators

Aggregators are farmers', cooperatives and agricultural institutions who provide liquidity to the futures market. Their objective is to collect commodities from the farmers and to sell them in the futures market. Thus, they help in the process of price discovery and risk management.

Position Traders

Position Traders retain their positions for weeks or months for favourable movement in the commodity futures prices. They take substantial risk to earn big profit.

Brokers

Brokers are intermediaries of the hedgers and speculators who buy or sell contracts of their clients and get commission for their action.

Regulator

The Forward Markets Commission (FMC) oversees the operations of the futures market for commodity in India. It also regulates the operations of the commodity futures markets.

Margin Money

Margin money is a security deposit provided to the exchange by the trading members which will enable them to trade different contracts. The clients deposit this money to the exchange through the members. There are different types of margin money payable for a futures contract.

Initial Margin

Before placing an order to buy or sell futures contracts, an amount is required to be deposited by the market participants in his margin account. It is called initial margin.

Mark-to-Market (M2M)

The gain or loss of the market participants is reflected through the adjustment of the margin account of the trader or client at the end of every trading day. This is called marking to the market.

Additional Margin

An additional margin is imposed by the exchange to deal with high volatility of the market. It is termed as additional margin. This margin varies over the commodities.

Maintenance Margin

It is the minimum level at which the equity in a futures account must be maintained. A margin call will be issued if the equity in an account falls below this level. The trader has to add funds to bring the account back to the initial margin level.

Delivery Period Margin

The extra margin taken by the exchange on the contracts at the time of delivery is called delivery period margin. In case of both outstanding buy and sell positions, this amount is to be paid by the traders.

Order Types

Various conditions attached to an order placed through electronic trading systems as per the requirements. The conditions are divided into three categories.

Time Conditions

Good Till Day Order (GTO)

The day orders are valid for the day on which it is placed. The order will be cancelled automatically by the end of the day If it remains unexecuted during the day.

Good Till Cancelled (GTC)

GTC order remains valid until the trader cancels it. The order remains active for a number of days.

Good Till Date (GTD)

A GTD order remains active up to a specified date in the system if it is not executed.

Immediate or Cancel (IOC)

In an IOC order a user can buy or sell a contract immediately until the order is released into the system, failing which the order is cancelled from the system.

Price Conditions

Limit Order

It is an order to buy or sell a specified amount of commodity at the time of execution at a pre-determined price or if possible, at a better price.

Stop Loss Order

In this order an instruction is given to the broker that when the price will reach a specified level a particular futures contract has to be bought or sell at the market price.

Other Conditions

Market Price

In case of market price orders, no price is specified at the time of placing the order.

Trigger Price

It is the price at which an order gets triggered from the stop loss book.

Spread Order

A spread order includes a long and a short. These orders are placed for a single commodity with different months or for closely related commodities.

Exchange Memberships

A person, association, co-operative societies, companies, etc. can be a member of the commodity exchange if they fulfil the eligibility criteria of the Exchange. However, Foreign Investors, Non-Residential Indians, Banks and Mutual Funds are not allowed to participate in commodity exchanges. The members of commodity exchanges can be categorized into three types.

Trading cum Clearing Member (TCM)

These members are allowed to transact on their own account and the accounts of their clients'. TCMs required to pay the necessary deposits. Also, they need to maintain net worth specified by the commodity exchange.

Professional Clearing Members (PCM)

These members are involved in settlement and clearing for their clients who have traded through TCMs or traded as TMs. PCMs required to pay the necessary deposits. Also, they need to maintain a net worth specified by the commodity exchange.

Trading Member (TM)

These members are allowed to trade through their account or the account of their clients. Through PCMs/STCMs their trade is cleared.

Strategic Trading cum Clearing Member (STCM)

These members can trade both on their account and on the clients' account. They can clear and settle their trades. Also, they can clear and settle the trades of other trading members.

Clearing

Clearing of trades is done on an exchange through the Exchange Clearing House. A clearing house is a facility which ensures the conformity of all commitments taken during the trade. The clearing house keeps record of all the transactions taken place during a day.

Settlement

The settlement includes payments and receipts for all the transactions done by the members in the exchange. Settlements are done through the settlement system of the exchange. The settlements of futures contracts have two types, the Mark-to-Market (MTM) settlement and the final settlement. Mark-to-Market happens on a continuous basis at the end of each day. Final settlement takes place on the last day of the futures contract.

Settlement Price

According to the type of settlement, there are two types of settlement price in the futures market.

Daily Settlement Price

When a trading day concludes, after the closing session, a futures contract reaches a particular price. This is called Daily settlement price. When there is no trade in the closing session, daily settlement price is computed as per the methods prescribed by the exchange.

Final Settlement Price

On the last trading day of a contract the spot price underlying the contract is called final settlement price. After the expiration day, all open positions in a futures contract are ceased.

Settlement Methods

There are two ways of settlement of futures contracts on the commodity exchange - physical delivery of the asset and closing open position. Each contract that is materialising into delivery is settled into a period notified by the exchange. There are three methods of settlement of a futures contract.

Physical Delivery of the Underlying Asset

If the buyer/seller is interested in physical delivery of the underlying asset, he has to complete the delivery marking for all the contracts within the time notified by the Exchange.

Closing Out by Offsetting Position

Closing out can be done by opposite transactions. Closing out of a buy contract can be done by a sale contract, whereas, for a sale contract, a buy can close out the position.

Cash Settlement

If the trader is not interested in physical delivery, at the last day of trading all the open positions are settled in cash. At the time of cash settlement when the last trading day arrives the contract is marked to the market and all positions become closed.

Basis

The difference between the futures price and the spot price is called basis. The basis is different for each delivery month for each contract.

Annexure III: Contract Specifications

CONTRACT SPECIFICATIONS OF CARDAMOM	
Symbol	CARDAMOM
Description	CARDAMOMMMYY
Contract Listing	Contract launch date shall be the 16th day of contract launch month. If 16th day is a holiday, then the following working day.
Last Trading Day	15th of the contract expiry month. If 15th is a holiday, then preceding working day
Trading	
Trading Period	Mondays through Fridays
Trading Session	Mondays through Fridays: 10.00 am to 5.00 pm
Trading Unit	100 KG (1 quintal)
Quotation/Base Value	Rs. per Kg
Price Quote	Ex- Vandanmedu, Dist. Idukki, Kerala (exclusive of all tax and levies)
Maximum Order Size	5000 KG (50 quintals)
Tick Size (Minimum Price Movement)	10 paisa per Kg
Daily Price Limits	DPL shall have two slabs - Initial and Enhanced Slab. Once the initial slab limit of 3% is reached in any contract, then after a period of 15 minutes, this limit shall be increased further by enhanced slab of 1%, only in that contract. The trading shall be permitted during the 15 minutes period within the initial slab limit. After the DPL is enhanced, trades shall be permitted throughout the day within the enhanced total DPL of 4%.
Initial Margin*	Minimum 4% or based on SPAN whichever is higher.
Extreme Loss Margin**	1%
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit; will be imposed in respect of all outstanding positions.
Maximum Allowable Open Position***	For individual clients: 100 MT For a member collectively for all clients: 1000 MT or 15% of the market wide open interest, whichever is higher. Near Month Limits For individual clients: 25 MT For a member collectively for all clients: 250 MT or 15% of the market wide open interest, whichever is higher
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	Delivery Unit 100 Kg, and direct multiples thereof
Delivery Period Margin	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility
Tender period****	Or b. 35%
Delivery Centre(s)	At Exchange designated warehouse at Vandanmedu in Idukki Dist of Kerala State
Additional Delivery Centre(s)	Bodinayakanur in Madurai District of Tamil Nadu up to 100 kms of municipal limits. The premium/ discount (If any) for the additional delivery center to the basis delivery centre will be announced by exchange before the launch of contract.
Source: MCX	

CONTRACT SPECIFICATIONS OF COTTON	
Symbol	COTTON
Description	COTTONMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar
Contract Start Day	1st day of contract launch month. If 1st day is a holiday, then the following working day.
Last Trading Day	Last calendar day of the contract month. If last calendar day is a holiday or Saturday then preceding working day
Trading	
Trading Period	Mondays through Fridays
Trading Session	Monday to Friday: 9.00 a.m. to 9.00 p.m.
Trading Unit	25 bales
Quotation/Base Value	Rs. Per bale (of 170 Kg)
Price Quote	Ex-Warehouse Rajkot (Within 100 km radius) excluding all taxes, duties, levies, charges as applicable.
Maximum Order Size	1200 bales
Tick Size (Minimum Price Movement)	Rs.10
Daily Price Limits	DPL shall have two slabs - Initial and Enhanced Slab. Once the initial slab limit of 3% is reached in any contract, then after a period of 15 minutes, this limit shall be increased further by enhanced slab of 1%, only in that contract. The trading shall be permitted during the 15 minutes period within the initial slab limit. After the DPL is enhanced, trades shall be permitted throughout the day within the enhanced total DPL of 4%.
Initial Margin*	Minimum 8% or based on SPAN whichever is higher
Extreme Loss Margin**	Minimum 1%
Additional and/ or Special Margin	An additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as may be deemed fit, will be imposed by the Exchange/Regulator, as and when is necessary, in respect of all outstanding positions
Maximum Allowable Open Position***	For individual clients: 3,80,000 bales For a member collectively for all clients: 38,00,000 bales or 15% of the market wide open position whichever is higher. For Near Month Delivery For individual clients: 95,000 bales Near month member level position limit shall be equivalent to the one fourth of the overall member level position limit.
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	25 bales (42.5 quintals* or 12 candy approx.) *+/- 7%
Delivery Period Margin	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility or b. 25%
Tender period****	
Delivery Centre(s)	Rajkot (Gujarat)
Additional Delivery Centre(s)	1) Yavatmal / Jalna (Maharashtra) 2) Kadi, Mundra (Gujarat) 3) Adilabad, Warangal (Telangana) The discounts (if any) for each of the additional delivery centres to the basic delivery center (Rajkot) will be announced by exchange before the launch of contract.
Source: MCX	

CONTRACT SPECIFICATIONS OF MENTHA OIL	
Symbol	MENTHAOIL
Description	MENTHAOILMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar
Contract Start Day	1 st day of contract launch month. If 1st day is a holiday, then the following working day.
Last Trading Day	Last calendar day of the contract expiry month. If last calendar day is a holiday, then the preceding working day.
Trading	
Trading Period	Mondays through Fridays
Trading Session	Monday to Friday: 9.00 a.m. to 5.00 p.m.
Trading Unit	1080 Kg (6 drums)
Quotation/Base Value	1 kg
Price Quote	Ex – Chandausi, District Moradabad, Uttar Pradesh (Inclusive of Mandi Tax, but exclusive of all taxes, purchase tax/ sales tax/ GST, if applicable and levies)
Maximum Order Size	18000 kg (100 drums)
Tick Size (Minimum Price Movement)	10 paise
Daily Price Limits	DPL shall have two slabs - Initial and Enhanced Slab. Once the initial slab limit of 3% is reached in any contract, then after a period of 15 minutes, this limit shall be increased further by enhanced slab of 1%, only in that contract. The trading shall be permitted during the 15 minutes period within the initial slab limit. After the DPL is enhanced, trades shall be permitted throughout the day within the enhanced total DPL of 4%.
Initial Margin*	Minimum 12% or based on SPAN whichever is higher
Extreme Loss Margin**	Minimum 1%
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit, will be imposed in respect of all outstanding positions.
Maximum Allowable Open Position***	For individual clients: 184 MT For a member collectively for all clients: 1840 MT or 15% of the market wide open position, whichever is higher. Near Month Limits For individual clients: 46 MT
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	1080 Kg/ 6 drums (with a tolerance limit of 1% per drum) and direct multiples thereof, though he will get the value only for the actually quantity delivered by him.
Delivery Period Margin	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility Or b. 25%
Tender period****	
Delivery Centre(s)	At Exchange designated warehouse at Chandausi
Additional Delivery Centre(s)	At exchange designated warehouse at Barabanki at a discount of Rs. 2/- per kg
Source: MCX	

CONTRACT SPECIFICATIONS OF CPO	
Symbol	CPO
Description	CPOMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar
Contract Start Day	1 st day of contract launch month. If 1 st day is a holiday then the following working day.
Last Trading Day	Last calendar day of the contract expiry month. If last calendar day is a holiday, then the preceding working day
Trading	
Trading Period	Mondays through Fridays
Trading Session	Monday to Friday: 9.00 am to 09.00 pm
Trading Unit	10 MT
Quotation/Base Value	Rs./10 Kg
Price Quote	Ex- Kandla, exclusive of Sales tax/ GST
Maximum Order Size	200 MT
Tick Size (Minimum Price Movement)	10 paise
Daily Price Limits	DPL shall have two slabs - Initial and Enhanced Slab. Once the initial slab limit of 3% is reached in any contract, then after a period of 15 minutes, this limit shall be increased further by enhanced slab of 1%, only in that contract. The trading shall be permitted during the 15 minutes period within the initial slab limit. After the DPL is enhanced, trades shall be permitted throughout the day within the enhanced total DPL of 4%.
Initial Margin*	Minimum 10% or based on SPAN whichever is higher
Extreme Loss Margin**	Minimum 1%
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit; will be imposed in respect of all outstanding positions.
Maximum Allowable Open Position***	For individual clients: 90,000 MT For a member collectively for all clients 9,00,000 MT or 15% of the market wide open position, whichever is higher. Near Month Limits For individual clients: 22,500 MT Near month member level position limit shall be equivalent to the one fourth of the overall member level position limit.
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	10 MT (with tolerance limit of 250 Kgs) which means that if the seller delivers any quantity between 9.75 MT to 10.25 MT, it will be construed as adequate discharge of his delivery obligation of 10 MT, though he will get the value only for actual quantity delivered by him.
Delivery Period Margin	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility Or b. 25%
Tender period****	
Delivery Centre(s)	Within Kandla municipal limits
Source: MCX	

CONTRACT SPECIFICATIONS OF ALUMINIUM	
Symbol	ALUMINIUM
Description	ALUMINIUMMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar.
Contract Start Day	1 st day of contract launch month. If 1st day is a holiday, then the following working day
Last Trading Day	Last calendar day of the contract expiry month. If last calendar day is a holiday, then preceding working day.
Trading	
Trading Period	Mondays through Fridays
Trading Session	Monday to Friday: 09.00 a.m. to 11.30 p.m. / 11.55 p.m.* (* based on US daylight saving time period)
Trading Unit	5 MT
Quotation/Base Value	1 Kg
Price Quote	Ex-Warehouse Raipur district (excludes only GST).
Maximum Order Size	150 MT
Tick Size (Minimum Price Movement)	5 paisa per kg
Daily Price Limits	The Exchange has implemented a narrower slab of 4%. Whenever the narrower slab is breached, the relaxation will be allowed up to 6% without any cooling off period in the trade. In case the daily price limit of 6% is also breached, then after a cooling off period of 15 minutes, the daily price limit will be relaxed up to 9%. In case price movement in international markets is more than the maximum daily price limit (currently 9%), the same may be further relaxed in steps of 3% and inform the Regulator immediately.
Initial Margin*	Minimum 8% or based on SPAN whichever is higher
Extreme Loss Margin**	Minimum 1%
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit; will be imposed in respect of all outstanding positions.
Maximum Allowable Open Position***	For individual client: 25,000 MT or 5% of the market wide open position, whichever is higher for all Aluminium contracts combined together. For a member collectively for all clients: 2,50,000 MT or 20% of the market wide open position, whichever is higher for all Aluminium contracts combined together.
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	5 MT with tolerance limit of + / - 10%
Delivery Period Margin	Delivery period margins shall be higher of:
Tender period****	
Delivery Centre(s)	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility or b. 25%
Additional Delivery Centre(s)	Ex-Warehouse at Thane district in Maharashtra the premium / discount for the additional delivery centre to the base delivery centre (Raipur) will be announced by the Exchange before launch of the contract. As per SEBI circular SEBI/HO/CDMRD/DMP/CIR/P/2016/103 dated September 27, 2016, the exchanges may accredit warehouses of a WSP within 100 kms radius of the delivery centres.
Source: MCX	

CONTRACT SPECIFICATIONS OF COPPER	
Symbol	COPPER
Description	COPPERMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar.
Contract Start Day	1st day of contract launch month. If 1st day is a holiday, then the following working day
Last Trading Day	Last calendar day of the contract expiry month. If last calendar day is a holiday or Saturday then preceding working day.
Trading	
Trading Period	Mondays through Friday
Trading Session	Monday to Friday: 10.00 a.m. to 11.30/ 11.55 p.m
Trading Unit	1 MT
Quotation/Base Value	1 kg
Price Quote	Ex-Bhiwandi (exclusive of all taxes and levies relating to GST, import duty/customs and local taxes if any etc.). At the time of delivery, the buyer has to pay these taxes and levies in addition to Delivery order rate.
Maximum Order Size	70 MT
Tick Size (Minimum Price Movement)	5 paise per kg
Daily Price Limits	The base price limit will be 4%. Whenever the base daily price limit is breached, the relaxation will be allowed upto 6% without any cooling off period in the trade. In case the daily price limit of 6% is also breached, then after a cooling off period of 15 minutes, the daily price limit will be relaxed upto 9%. In case price movement in international markets is more than the maximum daily price limit (i.e 9%), the same may be further relaxed in steps of 3% beyond the maximum permitted limit, and informed to the Regulator immediately
Initial Margin*	Minimum 4% or based on SPAN whichever is higher
Extreme Loss Margin**	1%
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit; will be imposed in respect of all outstanding positions.
Maximum Allowable Open Position***	For individual clients: 7,000 MT or 5% of the market wide open position whichever is higher for all Copper contracts combined together. For a member collectively for all clients: 70,000 MT or 20% of the market wide open position whichever is higher for all Copper contracts combined together
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	9 MT with tolerance limit of + / - 1 % (90 kg)
Delivery Period Margin	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility Or b. 25%
Tender period****	
Delivery Centre(s)	Within 20 kilometers outside Mumbai octroi limit
Source: MCX	

CONTRACT SPECIFICATIONS OF LEAD	
Symbol	LEAD
Description	LEADMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar.
Contract Start Day	1 st day of contract launch month. If 1st day is a holiday, then the following working day.
Last Trading Day	Last calendar day of the contract expiry month. If last calendar day is a holiday, then preceding working day.
Trading	
Trading Period	Mondays through Fridays
Trading Session	Monday to Friday: 9.00 a.m. to 11.30 p.m. / 11.55 p.m.* (*based on US daylight saving time period)
Trading Unit	5 MT
Quotation/Base Value	1 Kg
Price Quote	Ex-Warehouse at Chennai district in Tamil Nadu (excludes only GST)
Maximum Order Size	100 MT
Tick Size (Minimum Price Movement)	5 Paisa per kg
Daily Price Limits	The Exchange has implemented a narrower slab of 4%. Whenever the narrower slab is breached, the relaxation will be allowed up to 6% without any cooling off period in the trade. In case the daily price limit of 6% is also breached, then after a cooling off period of 15 minutes, the daily price limit will be relaxed up to 9%. In case price movement in international markets is more than the maximum daily price limit (currently 9%), the same may be further relaxed in steps of 3% and will be informed to the Regulator immediately.
Initial Margin*	Minimum 8% or based on SPAN whichever is higher
Extreme Loss Margin**	Minimum 1 %
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit; will be imposed in respect of all outstanding positions.
Maximum Allowable Open Position***	For individual clients: 3,500 MT or 5% of the market wide open position, whichever is higher for all Lead contracts combined together. For a member collectively for all clients: 35,000 MT or 20% of the market wide open position, whichever is higher for all Lead contracts combined together.
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	5 MT with tolerance limit of + / - 15%
Delivery Period Margin	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility or a. 25%
Tender period****	
Delivery Centre(s)	Ex-Warehouse at Chennai district in Tamil Nadu As per SEBI circular SEBI/HO/CDMRD/DMP/P/CIR/2021/551 dated April 16, 2021, the exchanges may accredit warehouses of a WSP within 100 kms radius of the delivery centres.
Source: MCX	

CONTRACT SPECIFICATIONS OF NICKEL	
Symbol	NICKEL
Description	NICKELMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar.
Contract Start Day	1st day of contract launch month. If 1st day is a holiday, then the following working day.
Last Trading Day	Last calendar day of the contract expiry month. If last calendar day is a holiday, then preceding working day
Trading	
Trading Period	Mondays through Friday
Trading Session	Monday to Friday: 09.00 a.m. to 11.30 p.m. / 11.55 p.m.* (*based on US daylight saving time period)
Trading Unit	1500 Kgs
Quotation/Base Value	1 Kg
Price Quote	Ex-Warehouse Thane district (excludes only GST)
Maximum Order Size	24 MT
Tick Size (Minimum Price Movement)	10 Paisa per kg
Daily Price Limits	The base price limit will be 4%. Whenever the base daily price limit is breached, the relaxation will be allowed upto 6% without any cooling off period in the trade. In case the daily price limit of 6% is also breached, then after a cooling off period of 15 minutes, the daily price limit will be relaxed up to 9% In case price movement in international / local markets is more than the maximum daily price limit (currently 9%), the same may be further relaxed in steps of 3% and inform the Regulator immediately.
Initial Margin*	Minimum 10% or based on SPAN whichever is higher
Extreme Loss Margin**	Minimum 1%
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit; will be imposed in respect of all outstanding positions.
Maximum Allowable Open Position***	For individual clients: 1000 MT or 5% of the market wide open position, whichever is higher for all Nickel contracts combined together. For a member collectively for all clients: 10,000 MT or 20% of the market wide open position, whichever is higher for all Nickel contracts combined together.
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	1500 Kgs with tolerance limit of + / - 10%
Delivery Centre(s)	Ex-Warehouse at Thane district in Maharashtra As per SEBI circular SEBI/HO/CDMRD/DMP/CIR/P/2016/103 dated September 27, 2016, the exchanges may accredit warehouses of a WSP within 100 kms radius of the delivery centers.
Source: MCX	

CONTRACT SPECIFICATIONS OF CRUDE OIL	
Symbol	CRUDEOIL
Description	CRUDEOILMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar.
Contract Start Day	As per the Contract Launch Calendar
Last Trading Day	As per the Contract Launch Calendar
Trading	
Trading Period	Mondays through Fridays
Trading Session	Monday to Friday: 10.00 a.m. to 11.30/ 11.55 p.m.* * based on US daylight saving time period.
Trading Unit	100 barrels
Quotation/Base Value	Rs. Per barrel
Price Quote	Ex – Mumbai excluding all taxes, levies and other expenses
Maximum Order Size	10,000 barrels
Tick Size (Minimum Price Movement)	Re. 1
Daily Price Limits	The base price limit will be 4%. Whenever the base daily price limit is breached, the relaxation will be allowed upto 6% without any cooling off period in the trade. In case the daily price limit of 6% is also breached, then after a cooling off period of 15 minutes, the daily price limit will be relaxed upto 9%. In case price movement in international markets is more than the maximum daily price limit (currently 9%), the same may be further relaxed in steps of 3%.and informed to the Regulator immediately.
Initial Margin*	Minimum 4% or based on SPAN whichever is higher.
Extreme Loss Margin**	1%
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit, will be imposed in respect of all outstanding positions.
Maximum Allowable Open Position***	For individual clients: 4,80,000 barrels or 5% of the market wide open position, whichever is higher for all Crude Oil contracts combined together. For a member collectively for all clients: 48,00,000 barrels or 20% of the market wide open position, whichever is higher for all Crude Oil contracts combined together.
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	50,000 barrels with +/- 2% tolerance limit
Delivery Period Margin	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility or b. 25%
Delivery Centre(s)	Port installation at Mumbai/ JNPT port
Source: MCX	

CONTRACT SPECIFICATIONS OF NATURAL GAS	
Symbol	NATURALGAS
Description	NATURALGASMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar.
Contract Start Day	As per the Contract Launch Calendar
Last Trading Day	As per the Contract Launch Calendar
Trading	
Trading Period	Mondays through Fridays
Trading Session	Mondays through Friday: 10.00 am to 11.30/ 11.55 pm* * based on US daylight saving time period.
Trading Unit	1250 mmBtu
Quotation/Base Value	Rs. per mmBtu
Price Quote	Ex- Hazira exclusive of all taxes, levies and other expenses
Maximum Order Size	20,000 mmBtu
Tick Size (Minimum Price Movement)	10 paise (0.10 rupees)
Daily Price Limits	The base price limit will be 4%. Whenever the base daily price limit is breached, the relaxation will be allowed upto 6% without any cooling off period in the trade. In case the daily price limit of 6% is also breached, then after a cooling off period of 15 minutes, the daily price limit will be relaxed upto 9% In case price movement in international markets is more than the maximum daily price limit (currently 9%), the same may be further relaxed in steps of 3% and informed to the regulator immediately
Initial Margin*	Minimum 4% or based on SPAN whichever is higher
Extreme Loss Margin**	1%
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit, will be imposed in respect of all outstanding positions.
Maximum Allowable Open Position***	For individual client: 60,00,000 mmBtu or 5% of the market wide open position, whichever is higher. For a member collectively for all clients: 6,00,00,000 mmBtu or 20% of the market wide open position, whichever is higher.
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	10,000 mmBtu
Delivery Period Margin	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility or b. 25%
Delivery Centre(s)	Hazira Hub
Source: MCX	

CONTRACT SPECIFICATIONS OF GOLD	
Symbol	GOLD
Description	GOLDMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar.
Contract Start Day	16th day of contract launch month. If 16th day is a holiday, then the following working day.
Last Trading Day	5th day of contract expiry month. If 5th day is a holiday, then preceding working day
Trading	
Trading Period	Mondays through Friday
Trading Session	Monday to Friday: 10.00 a.m. to 11.30 / 11.55 p.m.
Trading Unit	1 kg
Quotation/Base Value	10 grams
Price Quote	Ex-Ahmedabad (inclusive of all taxes and levies relating to import duty, customs but excluding GST, any other additional tax, cess, octroi or surcharge as may be applicable)
Maximum Order Size	10 kg
Tick Size (Minimum Price Movement)	Re. 1 per 10 grams
Daily Price Limits	The base price limit will be 3%. Whenever the base daily price limit is breached, the relaxation will be allowed upto 6% without any cooling off period in the trade. In case the daily price limit of 6% is also breached, then after a cooling off period of 15 minutes, the daily price limit will be relaxed upto 9% In case price movement in international markets is more than the maximum daily price limit (currently 9%), the same may be further relaxed in steps of 3% beyond the maximum permitted limit, and informed to the Regulator immediately
Initial Margin*	Minimum 4% or based on SPAN whichever is higher
Extreme Loss Margin**	1%
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit; will be imposed in respect of all outstanding positions
Maximum Allowable Open Position***	For individual client: 5 MT for all Gold contracts combined together or 5% of the market wide open position whichever is higher, for all Gold contracts combined together. For a member collectively for all clients: 50 MT or 20% of the market wide open position whichever is higher, for all Gold contracts combined together.
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	1 kg
Delivery Period Margin	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility or b. 25%
Delivery Centre(s)	Designated clearinghouse facilities at Ahmedabad
Source: MCX	

CONTRACT SPECIFICATIONS OF SILVER	
Symbol	SILVER
Description	SILVERMMMYY
Contract Listing	Contracts are available as per the Contract Launch Calendar
Contract Start Day	16th day of contract launch month. If 16th day is a holiday, then the following working day.
Last Trading Day	5th day of contract expiry month. If 5th day is a holiday, then preceding working day.
Trading	
Trading Period	Mondays through Friday
Trading Session	Monday to Friday: 10.00 a.m. to 11.30/ 11.55 p.m.
Trading Unit	30 kg
Quotation/Base Value	1 kg
Price Quote	Ex-Ahmedabad (inclusive of all taxes and levies relating to import duty, customs but excluding GST, any other additional tax, cess, octroi or surcharge as may be applicable).
Maximum Order Size	600 kg
Tick Size (Minimum Price Movement)	Re. 1 per kg
Daily Price Limits	The base price limit will be 4%. Whenever the base daily price limit is breached, the relaxation will be allowed upto 6% without any cooling off period in the trade. In case the daily price limit of 6% is also breached, then after a cooling off period of 15 minutes, the daily price limit will be relaxed upto 9%. In case price movement in international markets is more than the maximum daily price limit (currently 9%), the same may be further relaxed in steps of 3% beyond the maximum permitted limit, and informed to the Regulator immediately.
Initial Margin*	Minimum 4% or based on SPAN whichever is higher
Extreme Loss Margin**	1%
Additional and/ or Special Margin	In case of additional volatility, an additional margin (on both buy & sell side) and/ or special margin (on either buy or sell side) at such percentage, as deemed fit; will be imposed in respect of all outstanding positions.
Maximum Allowable Open Position***	For individual client: 100 MT or 5% of the market wide open position whichever is higher for all Silver contracts combined together For a member collectively for all clients: 1000 MT or 20% of the market wide open position whichever is higher, for all Silver contracts combined together.
Delivery	
Delivery Unit 100 Kg, and direct multiples thereof	30 kg
Delivery Period Margin	Delivery period margins shall be higher of: a. 3% + 5 day 99% VaR of spot price volatility Or b. 25%
Delivery Centre(s)	Ahmedabad at designated Clearing House facilities
Source: MCX	

Annexure IV: Spot Price Polling Mechanism

Aluminium		
Sr. No.	**Particulars**	**Details**
1	Details of the contracts	Primary Aluminium Ingots with minimum purity of 99.70%. Only LME approved brands will be accepted. For the purpose of quality assessment, reliance shall be placed by the WSP on the Certificate of Analysis (CoA) issued by the producer.Any other Primary Aluminium producer brand as approved by MCX.
2	Mechanism of spot price polling	Prices are polled twice daily from physical market participants between 12.00 p.m. to 12.30 p.m. and 4.00 p.m. to 4.30 p.m. Spot prices displayed at around 12.30 p.m. and 4.30 p.m. on all business days in physical market.
3	How spot prices are arrived at	Spot price is determined from polled prices using Trimmed Mean methodology wherein mean is computed after discarding those falling outside pre-determined boundaries on either side.
4	Whether these prices include or excludes taxes and other levies / costs	Ex-Warehouse at Raipur district in Chhattisgarh
5	Whether spot prices polling has been outsourced to any agency and if so, the details thereof	Spot price polling is not outsourced.
6	Criteria for selection of these polling participants	The poll panel comprises of representatives from value chain of physical market.
Source: MCX		

Copper		
Sr. No.	**Particulars**	**Details**
1	Details of the contracts	LME approved brands will be accepted. For the purpose of quality assessment, reliance shall be placed by the WSP on the Certificate of Analysis (CoA) issued by the producer.
2	Mechanism of spot price polling	Prices are polled twice daily from physical market participants between 12.00 p.m. to 12.30 p.m. and 4.00 p.m. to 4.30 p.m. Spot prices displayed at around 12.30 p.m. and 4.30 p.m. on all business days in physical market.
3	How spot prices are arrived at	Spot price is determined from polled prices using Trimmed Mean methodology wherein mean is computed after discarding those falling outside pre-determined boundaries on either side.
4	Whether these prices include or excludes taxes and other levies / costs	Ex-Warehouse Thane district (excludes only GST)
5	Whether spot prices polling has been outsourced to any agency and if so,the details thereof	Spot price polling is not outsourced.
6	Criteria for selection of these polling participants	The poll panel comprises of representatives from value chain of physical market.
Source: MCX		

Lead		
Sr. No.	**Particulars**	**Details**
1	Details of the contracts	Lead Ingots with minimum purity of 99.97%. Only LME approved brands will be accepted. For the purpose of quality assessment, reliance shall be placed by the WSP on the Certificate of Analysis (CoA) issued by the producer. Any other Primary Lead producer brands as approved by MCX.
2	Mechanism of spot price polling	Prices are polled twice daily from physical market participants between 12.00 p.m. to 12.30 p.m. and 4.00 p.m. to 4.30 p.m. Spot prices displayed at around 12.30 p.m. and 4.30 p.m. on all business days in physical market.
3	How spot prices are arrived at	Spot price is determined from polled prices using Trimmed Mean methodology wherein mean is computed after discarding those falling outside pre-determined boundaries on either side.
4	Whether these prices include or excludes taxes and other levies / costs	Ex-Warehouse at Chennai district in Tamil Nadu (excludes only GST)
5	Whether spot prices polling has been outsourced to any agency and if so,the details thereof	Spot price polling is not outsourced.
6	Criteria for selection of these polling participants	The poll panel comprises of representatives from value chain of physical market.
Source: MCX		

Nickel		
Sr. No.	**Particulars**	**Details**
1	Details of the contracts	Primary Nickel Cathodes (Cut or Uncut / Full Plate) with minimum purity of 99.80%. Only LME approved brands will be accepted. For the purpose of quality assessment, reliance shall be placed by the WSP on the Certificate of Analysis (CoA) issued by the producer. Any other Primary Nickel producer brand as approved by MCX.
2	Mechanism of spot price polling	Prices are polled twice daily from physical market participants between 12.00 p.m. to 12.30 p.m. and 4.00 p.m. to 4.30 p.m. Spot prices displayed at around 12.30 p.m. and 4.30 p.m. on all business days in physical market.
3	How spot prices are arrived at	Spot price is determined from polled prices using Trimmed Mean methodology wherein mean is computed after discarding those falling outside pre-determined boundaries on either side.
4	Whether these prices include or excludes taxes and other levies / costs	Ex-Warehouse Thane district (excludes only GST)
5	Whether spot prices polling has been outsourced to any agency and if so, the details thereof	Spot price polling is not outsourced.
6	Criteria for selection of these polling participants	The poll panel comprises of representatives from value chain of physical market.
Source: MCX		

Cotton		
Sr. No.	**Particulars**	**Details**
1	Details of the contracts	Roller Ginned Cotton. Saw Ginned Cotton will be accepted with discount. 1) Basis Grade RD (Reflectance) value and +b (Yellowness): Basis 76 RD value (+2RD value/-3RD value) with premium/discount. Below 73 RD value reject and above 78 RD value no additional premium. +b up to 10.2 accept, +b above 10.2 reject. 2) Staple 2.5% span length: 29 mm (+2.5mm/- 1mm) with premium/discount. Below 28 mm reject and above 31.50 mm no additional premium. 3) Micronaire (MIC): 3.6 – 4.8 +/-0.1 with discount. Below 3.5 and above 4.9 reject. 4) Tensile Strength: 28 GPT Minimum, No premium or discount 5) Trash: 3.0% +1.5/- 1.0% with premium and discount. More than 4.5% reject. 6) Moisture: Up to 8.5%. Acceptable up to 9.5% (average) at discount.
2	Mechanism of spot price polling	Prices are polled twice daily from physical market participants between 11.30 a.m. to 12.00 p.m. and 4.00 p.m. to 4.30 p.m. Spot prices displayed at around 12.00 p.m. and 4.30 p.m. on all business days in physical market.
3	How spot prices are arrived at	Spot price is determined from polled prices using Trimmed Mean methodology wherein mean is computed after discarding those falling outside pre-determined boundaries on either side.
4	Whether these prices include or excludes taxes and other levies / costs	Ex-Warehouse Rajkot (Within 100 km radius) excluding all taxes, duties, levies, charges as applicable
5	Whether spot prices polling has been outsourced to any agency and if so,the details thereof	Spot price polling is not outsourced.
6	Criteria for selection of these polling participants	The poll panel comprises of representatives from value chain of physical market.
Source: MCX		

Crude Palm Oil		
Sr. No.	**Particulars**	**Details**
1	Details of the contracts	Crude Palm Oil of good merchantable quality in bulk and unbleached. Ex-Kandla, exclusive of sales tax/GST. Prices quoted in Rs. Per 10 kgs.
2	Mechanism of spot price polling	Prices are polled twice daily from physical market participants between 12.00 p.m. to 12.30 p.m. and 4.00 p.m. to 4.30 p.m. Spot prices displayed at around 12.30 p.m. and 4.30 p.m. on all business days in physical market.
3	How spot prices are arrived at	Spot price is determined from polled prices using Trimmed Mean methodology wherein mean is computed after discarding those falling outside pre-determined boundaries on either side.
4	Whether these prices include or excludes taxes and other levies / costs	Ex- Kandla, exclusive of Sales tax/GST
5	Whether spot prices polling has been outsourced to any agency and if so,the details thereof	Spot price polling is not outsourced.
6	Criteria for selection of these polling participants	The poll panel comprises of representatives from value chain of physical market.
7	Any other information that the clearing corporation may consider useful for improving transparency in arriving at spot price	Spot Prices are adjusted to arrive at Ex-Kandla spot price inclusive of import duty. For CPO tariff & exchange rate, please visit the website of Central Board of Indirect Taxes and Customs, Ministry of Finance, Government of India.
Source: MCX		

Mentha Oil		
Sr. No.	**Particulars**	**Details**
1	Details of the contracts	Natural Crude Mentha Oil (arvensis) L-Menthol-73% as per GLC test – Capillary column, Ex- Chandausi, District Moradabad, Uttar Pradesh (Inclusive of Mandi Tax but exclusive of all taxes, purchase tax, sales tax, GST, if applicable and levies). Prices quoted in Rs. per 1 kg.
2	Mechanism of spot price polling	Prices are polled twice daily from physical market participants between 12.00 p.m. to 12.30 p.m. and 4.00 p.m. to 4.30 p.m. Spot prices displayed at around 12.30 p.m. and 4.30 p.m. on all business days in physical market.
3	How spot prices are arrived at	Spot price is determined from polled prices using Trimmed Mean methodology wherein mean is computed after discarding those falling outside pre-determined boundaries on either side. For the purpose of computation of spot price the following weightages is assigned to the respective mandis: Sambhal - 25%, Barabanki - 25% (Rs.2 will be added to Barabanki price), Chandausi - 25%, and Rampur - 25%.
4	Whether these prices include or excludes taxes and other levies / costs	Ex – Chandausi, District Moradabad, Uttar Pradesh (Inclusive of Mandi Tax, but exclusive of all taxes, purchase tax/ sales tax/ GST, if applicable and levies)
5	Whether spot prices polling has been outsourced to any agency and if so, the details thereof	Spot price polling is not outsourced.
6	Criteria for selection of these polling participants	The poll panel comprises of representatives from value chain of physical market.
7	Any other information that the clearing corporation may consider useful for improving transparency in arriving at spot price	Spot prices are polled exclusive of mandi taxes (@1.5%) across all centres and displayed as inclusive of mandi taxes.
Source: MCX		

Gold		
Sr. No.	**Particulars**	**Details**
1	Details of the contracts	Gold 995 purity. Ex-Ahmedabad (inclusive of all taxes and levies relating to import duty, customs but excluding GST, any other additional tax, cess, octroi or surcharge). Prices quoted Rs. Per 10 grams.
2	Mechanism of spot price polling	Prices are polled twice daily from physical market participants between 12.15 p.m. to 12.45 p.m. and 4.00 p.m. to 4.30 p.m. Spot prices displayed at around 12.45 p.m. and 4.30 p.m. on all business days in physical market.
3	How spot prices are arrived at	Spot price is determined from polled prices using Trimmed Mean methodology wherein mean is computed after discarding those falling outside pre-determined boundaries on either side.
4	Whether these prices include or excludes taxes and other levies / costs	Ex-Ahmedabad (inclusive of all taxes and levies relating to import duty, customs but excluding GST, any other additional tax, cess, octroi or surcharge)
5	Whether spot prices polling has been outsourced to any agency and if so, the details thereof	Spot price polling is not outsourced.
6	Criteria for selection of these polling participants	The poll panel comprises of representatives from value chain of physical market.
7	Any other information that the clearing corporation may consider useful for improving transparency in arriving at spot price	participants either inclusive or exclusive of GST (@3%). Prices are adjusted to arrive at exclusive of GST.
Source: MCX		

Silver		
Sr. No.	**Particulars**	**Details**
1	Details of the contracts	Silver grade 999 and fineness 999. Ex-Ahmedabad (inclusive of all taxes and levies relating to import duty, customs but excluding GST, any other additional tax, cess, octroi or surcharge). Prices quoted in Rs. Per 1 Kg.
2	Mechanism of spot price polling	Prices are polled twice daily from physical market participants between 12.15 p.m. to 12.45 p.m. and 4.00 p.m. to 4.30 p.m. Spot prices displayed at around 12.45 p.m. and 4.30 p.m. on all business days in physical market.
3	How spot prices are arrived at	Spot price is determined from polled prices using Trimmed Mean methodology wherein mean is computed after discarding those falling outside pre-determined boundaries on either side.
4	Whether these prices include or excludes taxes and other levies / costs	Ex-Ahmedabad (inclusive of all taxes and levies relating to import duty, customs but excluding GST, any other additional tax, cess, octroi or surcharge as may be applicable)
5	Whether spot prices polling has been outsourced to any agency and if so, the details thereof	Spot price polling is not outsourced.
6	Criteria for selection of these polling participants	The poll panel comprises of representatives from value chain of physical market.
7	Any other information that the clearing corporation may consider useful for improving transparency in arriving at spot price	Spot prices are quoted by participants either inclusive or exclusive of GST (@3%). Prices are adjusted to arrive at exclusive of GST.
Source: MCX		