Macroeconomic Dynamics of Indian Commodity Market: An Econometric Investigation into Metal and Energy Futures

A thesis submitted during 2012 to the University of Hyderabad in partial fulfilment of the award of a Ph.D. degree in economics

By

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CERTIFICATE

This to certify that the thesis entitled "Macroeconomic Dynamics of Indian Commodity Market: An Econometric Investigation into Metal and Energy Futures" submitted by Chinmaya Behera bearing Redg. No. 08SEPH06 in partial fulfilment of the requirements for the award of Doctor of Philosophy in Economics is a bonafide work carried out by him under my supervision and guidance.

The thesis has not been submitted previously in part or in full to this or any other University or Institution for the award of any degree or diploma.

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DECLARATION

I, Chinmaya Behera, hereby declare that thesis entitled "Macroeconomic Dynamics of Indian Commodity Market: An Econometric Investigation into Metal and Energy Futures" submitted by me under the guidance and supervision of Prof. J V M Sarma a bonafide research work. I also declare that it has not been submitted previously in part or in full to this University or any other University or Institution for the award of any degree or diploma.

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Dedicated to my Beloved Parents…

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Abbreviation

ACE: Ace Derivative and Commodity Exchange

AIC: Akaike Information Criteria

API: American Petroleum Institute

ARCH: Autoregressive Conditional Hetroskedasticity

BSNL: Bharat Sanchar Nigam Limited

CBOT: Chicago Board of Trade

FMC: Forward Market Commission

FPE: Final Prediction Error

EGARCH: Exponential Generalized Autoregressive Conditional Hetroskedasticity

ETF: Exchange Traded Fund

FIGARCH: Fractional Integration Generalized Autoregressive Conditional Hetroskedasticity

GARCH: Generalized Autoregressive Conditional Hetroskedasticity

GFMS: Gold Field Mineral Services

GJR-GARCH: Glosten, Jagannathan, Runkel, Generalized Autoregressive Conditional Hetroskedasticity.

GOI: Government of India

HQ: Hannan Quin

ICE: Indian Commodity Exchange

IMF: International Monetary Fund

LME: London Metal Exchange

MCX: Multi Commodity Exchange

MGARCH: Multivariate Generalized Autoregressive Conditional Hetroskedasticity

MOSPI: Ministry of Statistics and Programme Implimentation

MT: Million Ton

MTNL: Mahanagar Telephone Nigam Ltd.

NBOT: National Board of Trade

NCDEX: National Commodity Derivative and Exchange

NMCE: National Multi Commodity & Derivatives Exchange

NYMEX: Newyork Mercantile Exchange

OPEC: Organization of the Petroleum Exporting Countries

RBI: Reserve Bank of India

SC: Schwarz Information

UK: United Kingdom

UNCATD: United Nation

USA: United States of America

WGC: World Gold Council

WPI: Wholesale Price Index

WTI: West Texas Intermediate

CHAPTER 1

Introduction, Background and Objectives of the Study

1.1 Introduction

The role of commodity futures market is still sceptical as researchers differ in their views. It is widely claimed that futures market provides platform for hedging risk and price discovery (Garbade and Silber, 1983[1]; Moosa, 2002[2]). On the contrary, a few others allege that futures market causes market volatility and increases inflation (Nath and Lingareddy, 2008[3] and Ahamad, Shah, and Saha, 2010[4]). Price discovery, price volatility, market dynamics and inflation have been prime concern for market participants including policy makers over a period of time. These features play a key role in the investment and policy decisions. Due to inconclusive evidence of previous studies on the role of futures market, this study makes an attempt to examine price discovery, price volatility, market dynamics and impact of futures trading on inflation empirically.

Hedging risk and price discovery are considered as two major economic objectives of commodity futures market. Hedging risk controls risk exposure due to adverse seasonal and cyclical price fluctuations of the commodities. While price discovery reveals information about future spot market price through futures market price. The price discovery function depends on whether new information is reflected first on futures or spot prices. If information is reflected first in futures prices and subsequently on spot prices, futures prices should lead

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[1] Garbade, K. D. and Silber, W. L. (1983): 'Price Movements and Price Discovery in Futures and Cash Markets', *The Review of Financial and Economic Studies*, Vol. 65, pp. 421-440.

[2] Moossa, I. M. (2002): Economic Note by Banca Monte dei Paschi di Siena SpA, Vol.31, pp.155-165.

[3] Nath, G. C. and Linagareddy, T (2008): 'Impact of Futures Trading on Commodity Prices, Economic & Political Weekly, Vol. XLIII, pp. 18-23.

[4] Ahmad, H., Shah, A. Z. S. and Shah, I. A. (2010): 'Impact of Futures Trading on Spot Price Volatility: Evidence from Pakistan', *International Research Journal of Finance and Econometrics*, Vol.59, pp.145-165.

the spot prices, indicating that the futures market performs the price discovery function well. If, on the other hand, spot prices lead futures prices then the spot market is said to dominate the futures market, in which case the spot price is merely a satellite of the futures price (Moosa, 2002)[5]. Moreover, spot and futures together play a major role in an efficient price discovery process in commodity futures market.

Commodity futures market is said to be efficient if it utilises all of the available information in setting the prices (Fama, 1970)[6]. The intuitive idea behind this concept of efficiency is that producers and investors process the information that is available to them and take positions according to that information. In an efficient market, there is perfect and instantaneous flow of information that helps in determining market price. In this scenario, futures price should move concurrently with its corresponding spot price without lead or lag in price movement from one market to other. However, if one market processes information faster than the other, a lead-lag relation will exist. There are many reasons why one market will react more rapidly to the arrival of new information. Possible reasons include ease of short sale, lower transaction cost, institutional arrangements and market microstructure effect (Foster, 1996)[7]. The lead-lag characteristics of futures and spot market illustrate how rapidly one market incorporates information relatively to the other. These characteristics also indicate the efficiency of their functioning as well as degree of integration between the two markets. Furthermore, futures market is linked to the underlying spot market by arbitrage which stabilises price and thus decreases the spot market volatility.

Volatility is as similar as but not exactly the same as risk. Risk is associated with undesirable outcome, whereas volatility measure strictly for uncertainty could be due to positive outcome

[5] Moossa, I. M. (2002): Economic Note by Banca Monte dei Paschi di Siena SpA, Vol.31, pp.155-165.
[6] Fama, E. (1970): 'Efficient Capital Markets: A review of Theory and Empirical Works', *The Journal of Finance*, Vol. 25, pp. 383-417.
[7] Foster, J. A. (1996): 'Price Discovery in Oil Markets: A Time Varying Analysis of the 1990-91 Gulf Conflict', *Energy Economics*, Vol.18, pp.231-246.

(Poon, 2005)[8]. Some study affirms that the cause of volatility is the arrival of unanticipated information that alters expected returns on commodities. Thus, changes in market volatility would merely reflect changes in the local or global economic environment (Engle and Ng. 1993)[9]. Others claim that volatility is caused mainly by changes in trading practices or patterns, which in turn are driven by factors such as modifications in macroeconomic policies, shifts in investor tolerance of risk and increased uncertainty. The measurement and forecasting of volatility is essential for the characterization of dynamics of market, valuation of assets, pricing of derivative instruments, and choices that affect portfolio allocation decisions. Furthermore, policy makers, including central banks often rely on volatility estimates to assess the vulnerability of markets and the economy (Khalifa, Miao and Ramchander, 2011)[10].

It is widely believed that speculative activity in the futures market is the major cause of inflation. Liquidation to the futures market, through speculation, can create discrepancies in the commodity prices that can lead to unwarranted inflation or depressions driven by supply shocks. It can distort the equilibrium between demand and supply in specific commodities on prices, weakening thereby the role of fundamentals in the price discovery process. Speculation in the futures prices of commodities has been argued to affect the spot price through the channel of arbitrage. There is also an alternative view that in increased investor activity, by providing the necessary liquidity, is simply a vehicle to translate changing views about fundamental in changing prices. In this case higher prices would be the cause (rather than effect) of increased investor participation. On the contrary, few studies (RBI, 2010[11];

[8] Poon, S. H. (2005): 'A Practical Guide to Forecasting Financial Market Volatility, (ed) book, John Wile & Sons. Ltd.
[9] Engle, R. F. and Ng V. (1993): 'Measuring and Testing the Impact of News on volatility', *Journal of Finance,* Vol.43, pp.1949-77.
[10] Khalia A. A. A., Miao, H. and Ramchandar, S. (2011): ' Measuring and Forecasting Volatility in the Metal Futures Markets', *The Journal of Futures Market,* Vol. 48, pp, 27-77.
[11] Reserve Bank of India Annual Report 2009-10: 'Impact of Futures Trading on Inflation' (pp.32).

Sen, 2008[12]) did not find any strong conclusion that futures trading causes inflation. Furthermore, there could be a two-way causality between prices and speculation, so that higher price induces an increase in speculation, which in turn pushes prices up further until a new equilibrium is achieved. Due to inconclusive evidence, this study attempts to focus on the impact of futures trading on inflation.

Aforesaid discussion has helped us to understand the importance of futures market and its association with the spot market in general. However, it is not conclusively understood in the Indian context. As a result of which, Government of India has continually remained sceptical about the functioning of the commodity futures market and its outcome. Without understanding proper nature and dynamics of the commodity futures market functioning, government has resorted to continual ban of futures trading in some commodities and engaged actively in regulating futures market functioning in India. Control and active regulations of the futures commodity market has drawn wide attention of policy makers, analysts and academicians so as to examine its impact on the economy in general and different market participants in particular. A group of intellectuals still argue that our policy makers have not understood fully the functioning of the futures market in India. Further, the benefits and drawbacks of such markets need to be understood in proper perspectives.

Some studies even claim that futures market does not cause inflation rather helps hedging risks, enables price discovery and fair pricing of the commodities, but to many others it is just not convincing. It is also understood that futures market is largely influenced by the national and international macroenviroments. The macroeconomic dynamics play major roles in futures markets' demand supply scenario, price stabilisation, pricing volatilities, volume of spread, price discovery including market efficiency. Drawing the insights from some of the

[12] Abhijit Sen (2008): ' Report of the Expert Committee to Study the Impact of Futures Trading on Agricultural Commodity Prices', *Ministry of Consumer Affairs, Food & Public Distribution*, Government of India.

existing literature, policy makers attempt to ban and regulate the futures trading owing to its potential pressure in increasing general level of prices in the economy.

1.2 Justification of Study

Producers, investors and policy makers use price discovery as barometer for their decision making process in the commodity market. Existing literature is quite diversified with its views on price discovery process and occurrences in the commodity market. A wide array of literature suggests that price discovery takes place in futures market and then transgress to spot market. On the contrary, a few studies affirm that spot is the satellite for the price discovery and futures market realises the price changes afterwards. Some studies also suggest that there is simultaneity in the price discovery process both in spot and futures commodity market. Hence, the literature on price discovery is widely divided in the commodity market context. Furthermore, not much literature on price discovery process is available in the Indian commodity market context. There is a need for an empirical investigation for price discovery process in the Indian commodity market. Efficiency of market depends on the way the market incorporates the information to discover a competitive reference price. If futures market is less volatile than the spot market then there is a chance of inefficient use of information. On the other hand, if futures market is more volatile than spot market then there is chance of excess speculative activities. A few studies are available on price volatility specifically Indian commodity futures market. Therefore, this study makes an attempt to analyse the price volatility empirically.

Commodity price movements, price persistence, price instability and price spillover either in spot or futures commodity market are undoubtedly exposed to macroeconomic dynamics. The volatility clustering, asymmetric behaviour, long memory and spillover effect of the commodity prices have not been much understood in the Indian commodity market context that necessitates a formal study.

There is a notion that futures trading causes inflation through speculation. Speculators infuse money into futures market, expecting that price of the commodities will rise in future. This speculative behaviour perhaps increases the commodity prices that exerts price pressure on general basket of commodities thereby economy experiences commodity inflation. Policy makers and researchers are not under consensus whether futures trading causes inflation. Therefore, this study has made an attempt to resolve the confusion whether futures trading causes commodity inflation in India. Hence, the study tries to fill the gap in the literature on price discovery, macroeconomic dynamics of the commodity market and futures trading causing inflation in India.

1.3 Objectives of Study

The broad objective of the study is to analyse macroeconomic dynamics of Indian commodity futures market. The specific objectives are as follows;

a) to examine price discovery and price volatility in the commodity futures market,

b) to investigate macroeconomic dynamics of commodity futures market and,

c) to examine the impact of futures market on commodity inflation.

1.4 Nature and Sources of Data

The study has resorted to the secondary sources of information, which have been drawn from Multi Commodity Exchange (MCX), Reserve Bank of India (RBI) and Ministry of Statistics and Programme Implementation (MOSPI), India. The study has made use of the data for different frequencies for empirical investigations. Due to non-availability of authentic information in certain cases the study has used the data for different time periods and frequencies.

In examining price discovery, price volatility and macroeconomic dynamics, daily spot and futures closing prices of gold, silver, copper, crude oil and natural gas are collected from MCX. Here we have considered closing price of commodities as it is believed that closing price incorporates all the information during the trading day. The commodities are chosen based on MCX's world ranking in terms of number of futures contracts traded in 2011, where silver stood 1st followed by gold, copper, natural gas and crude oil.

The nearby futures price series of gold, silver, copper, crude oil and natural gas are taken for the analysis. The futures series of the aforesaid commodities are constructed by taking into account the nearby futures contract (i.e. contract with the nearest active trading delivery month to the day of trading). The nearby futures contract is used because it is highly liquid and the most active. Daily futures and spot closing prices are taken from September 1, 2005 to December 30, 2011 for gold, silver, copper, and crude oil. Natural gas futures and spot closing prices are taken from November 1, 2006 to December 30, 2011 based on availability. Data period includes 38 gold futures contracts with 1872 observations, 32 silver futures contracts with 1876 observations, 31 copper futures contracts with 1893 observations, 76 crude oil futures contracts with 1894 observations and 62 natural gas futures contracts with 1554 observations. Futures contracts and observations differ from commodity to commodity as official allocation of contracts differs commodity wise. For example, gold has six futures contracts per year where as crude oil have 12 contracts per year. All the observations are reported excluding Sundays and holidays. Further, we have created data series in such a way that both spot and futures data are available in a given date. In other words, in a specific trading day, if both spot and futures data are available then we consider that data for analysis.

In examining the impact of futures trading on commodity inflation, the study uses monthly Wholesale Price Index (WPI) from November 2006 to December 2011. WPI data are collected from RBI database and MOSPI. Average monthly crude oil and natural gas futures prices data from November, 2006 to December, 2011 are collected from MCX. In examining the macroeconomic dynamics and impact of futures trading, data are transformed into log return[13].

1.5 Tools of Time Series Analysis

Different time series techniques are applied to examine above objectives. Engle-Granger co-integration technique and error correction mechanism are used to examine price discovery in Indian commodity futures market. To examine macroeconomic dynamics of Indian commodity futures market, ARCH family models are used for different sub-objectives, e.g., ARCH and GARCH models are used for volatility clustering effect. E-GARCH and GJR-GARCH models are used to examine asymmetric properties. FIGARCH is applied to examine long memory. Multi-variate GARCH (BEKK) model is used to examine spillover effect. Granger causality test is used to show the impact of futures trading on commodity

[13] Data are transformed into log return i.e., $\log\left(\frac{R_t}{R_{t-1}}\right)$

inflation. We have used econometric software i.e. Eviews 7 and RATs 7.3 for the analysis of the above mentioned time series models.

1.6 Commodity Futures Market in India

Commodity futures market in India has a long history. The first organised futures market was established in 1875 with the setting up of the Bomaby Cotton Trade Association Limited. It has been claimed that futures market plays many roles such as standardization, guarantor of all trades, and provider of platform for risk transfer and long-term price signals. Five national multi-commodity exchanges are operating in India viz., Multi Commodity Exchange (MCX), Mumbai; National Commodity and Derivatives Exchange (NCDEX), Mumbai; National Multi Commodity Exchange (NMCE), Ahmedabad; Indian Commodity Exchange ltd. (ICEX), Mumbai and ACE derivatives and commodity exchange, regulate forward trading in 113 commodities. The commodities traded at these exchanges are edible oilseeds, food grains metals, spices, fibers, guar, rubber, natural gas and crude oil. Apart from five national exchanges, there are 16 commodity specific exchanges recognised for regulating trading in various commodities approved by the commission under the Forward Contracts (Regulation) Act, 1952. MCX, NCDEX, National Board of Trade (NBOT), NMCE and the ACE Derivatives & Commodity exchange ltd. contributed 99% of the total value of the commodities traded during the year 2011-12. Out of the 113 commodities, regulated by the FMC, in terms of value of trade, gold, silver, copper, zinc, guar seed, soy oil, jeera, pepper and chana are the prominently traded commodities. The total volume of trade across all exchanges in 2011-12 was 14,025.74 lac metric tonnes at a value of Rs.181,26,103.78 crores. The total of deliveries of all commodities on commodity exchange platform is 8,88,250 metric tonnes during the year 2010-11.

The share of different commodity group in terms of value during the year 2011-12, in value terms, bullion accounted for the maximum share of traded value among the commodity groups i.e. 57.7 percent followed by energy 15.9 percent, metals 15.2 percent, and agricultural commodities 11.2 percent.

1.7 Limitation of the Study

The period of the study has been limited to a restricted period (2005-2011) due to non-availability of data because the continual ban of futures trading in India, which could be considered as a limitation. Examining the impact of futures trading on inflation requires an index construction. Due to non-availability of data on many series, the study is restricted to examine the impact of crude oil and natural gas futures trading on inflation could be considered as another limitation of study.

1.8 Thesis Design

The present study is divided into six chapters. First chapter deals with introduction, background and objectives of the study. The second chapter provides theoretical perspective of commodity futures market. The third chapter deals with the price discovery and price volatility in commodity futures market. The fourth chapter talks about macroeconomic dynamics of Indian commodity futures market. The fifth chapter deals with impact of futures trading on inflation. Finally, the sixth chapter deals with summary, conclusion and policy recommendations.

The next chapter will throw light on the evaluation of commodity futures market in India: a theoretical perspective.

CHAPTER 2

Commodity Futures Market in India: A Theoretical Perspective

2.1 Introduction

Commodity futures market has experienced phenomenal growth in recent years. Policy makers have been trying to put their policies to stabilise the market where producers and investors can extract benefit from the futures trading. However, due to complexity in understanding futures market, lack of proper information and large contract size, marginal producers are unable to participate in futures trading. Therefore, it is indispensable to understand fundamentals of futures market and the way the mechanism works. The study devotes this chapter on evolution, theoretical underpinning and recent developments of commodity futures market in India.

Hedging, speculation and arbitrage are key concepts used by market participants during trading period that need to be clarified fundamentally. These features help market participants to hedge risk and reap profit from futures market. Therefore, this chapter gives the fundamental ideas of these features including other features. Five different commodities i.e. gold, silver, copper, crude oil and natural gas are selected for the analysis as those commodities are playing significant role in growth and development of Indian economy. Therefore, the study gives glimpse of description of commodities, and factors affecting demand and supply of the commodities under study.

2.2 Evolution of Global Futures Market

Commodity futures market has an old history globally. The development of modern futures trading began in the US in the early 1800 A.D. which was tied up closely to the development of commerce in Chicago. There was glut of commodities at the time of harvest and severe shortages in off-harvest time and lack of proper storage facilities that led farmers and merchants to contract for forward delivery. Some of the first forward contracts were in corns. To reduce the price risk of storing corns in winter, these merchants went to Chicago in spring and entered into forward contracts with processors for the delivery of grain. The grain was received from farmers during late fall or early winter.

The first forward contract was introduced on March 13, 1851. As the grain trade expanded, a group of 82 merchants gathered at a flour store in Chicago to form the Chicago Board of Trade (CBOT). Forward contracts dominated in the futures exchange. However, certain drawbacks of forwards such as lack of standardization and non-fulfillment of commitments made CBOT step in 1865 to formalize grain trading. Commodity futures trading has also long history in other developing countries. The Buenos Aires Grain Exchange in Argentina set up in 1854 is one of the oldest exchanges in the world. In India, futures trading was introduced in 1875.

2.3 Evolution of Indian Commodity Futures Market

The institution of formal commodity futures market in India is almost as old as in the USA and the UK. The Indian Experience, however, is much older as references to such markets in India appear in Kautialya's Arthasastra (FMC). The first organized futures market was established in 1875 with the setting up of the Bombay Cotton Trade Association Limited. However, very soon, leading cotton mill owners and merchants expressed discontent over its functioning. This led to the establishment of the Bombay Cotton Exchange Limited in 1893. Following cotton, futures trading was introduced in other agricultural commodities. In 1900, the Gujarati Vyapari Mandali was established to carry out futures trading in oilseeds, groundnut, castor seed and cotton. The states of Punjab and Uttar Pradesh were also trading futures on wheat. The Hapur Chamber of Commerce established the futures exchange for wheat in 1913 at Hapur (NICR)[14].

Futures trading in raw jute and other jute goods began in Kolkata with the setting up of the Calcutta Hessian Exchange limited in 1919. However, organized futures trading in raw jute started only in 1927 with the establishment of the East Indian Jute Association limited. These two associations were merged in 1945 to form the East Indian Jute and Hessian limited to conduct organized trading in both raw jute and jute goods. Futures trading in bullion began in Mumbai in 1920 and were later introduced at Rajkot, Jaipur, Jamnagar, Kanpur, Delhi and Kokata.

The Union Government prohibited futures trading during the Second World War. After independence, futures markets were brought under the union list in the constitution of India. The responsibility or the regulation of commodity futures markets hence came under the central government. In the early stage, forward markets functioned under the rules and procedures laid down by individual trade associations. Wide differences in regulations followed by various associations led to variety of malpractices which resulted in frequent disputes among traders. Enactment of the Bombay Forward Contract Act, 1947 felt the need of regulation. The Indian Constitution (1950) placed the matter of futures market in the Union list, hence the responsibility of regulating the market devolved on the Central Government. The Government drafted a bill, modelled on the Bombay Act and set up a

[14] NCDEX Institute of Commodity Markets & Research (May, 2008): 'Introduction to Commodity Derivatives' The Approved and Official Learning Manual.

Committee under the chairmanship of Shri A. D. Shroff to frame model Rules for Associations. The committee submitted its report in August, 1950. The Forward Contracts (Regulations) Bill, 1950 was revised in the light of the A.D Shroff Committee and was forwarded to a Select Committee of Parliament. The Committee submitted its report in August, 1951, but the Bill lapsed with the dissolution of the Parliament in 1952. A new Bill was drafted and after scrutiny by another Select Committee, the Forward Contracts (Regulation) Act was passed by parliament in December, 1952. The Forward Markets Commission (FMC) was established in 1953 to regulate and develop commodity futures market in India (Karande, 2006)[15].

Futures markets prospered in India during the early 1960s. In the mid 1960s, due to the war in 1965, and natural calamities, there was a shortage in commodities. As a result, in order to have control on price movement of many agricultural and essential commodities, futures trading was banned in 1966 in most commodities except pepper and turmeric. Futures trading in some commodities like guar (Muzaffarnagar and Hapur, 1982), potatoes (Hapur, 1985) and castor seed (Mumbai and Ahmeadabad, 1985) were permitted. With liberalization of the Indian economy in early 1990s, there was renewed emphasis on development of commodity futures market in India. The Government in 1993 set up a Committee under the chairmanship of Shri Kamal Nayan Kabra to examine the feasibility and role of commodity futures market in India. The Committee submitted its report in September, 1994. The main recommendations of Kabra Committee that had been implemented were, introduction of futures trading for several commodities such as coffee (Bangalore, 1998), cotton (Mumbai, 1999), soya oil (Indore, 1999), sugar (2001), tea (2002) and bullion (2003) and introduction of international

[15] Karende, K. (2006): 'A Study of Castor seed Futures Market in India', *PhD thesis* submitted to the Indira Gandhi Institute of Development and Research (IGIDR).

futures contract for pepper (Cochin, 1997) and castor oil (Mumbai, 1999). In 2007, Government of India set up a committee under the chairmanship of Prof. Abhijit Sen to look into whether futures trading causes inflation. The committee submitted its report in 2008. The report found that there was no strong evidence that futures trading caused inflation.

2.4 Fundamentals of Commodity Futures Market

Commodity is defined as any goods, merchandise or produce of land that can be bought and sold. As we know, prices of commodities are generally at their lowest at the time of production as the supply far exceeds the immediate, short term demand by the consumers, processors and other stakeholders associated with the commodity markets. On the other hand, the prices of commodities increase substantially in the lean season when the demand by the consumers, processors etc exceeds the supply. This adversely affects the producers as they realize lower prices of their produce in the time of production. It also unfavourably affects the consumers as they have to pay higher prices in the lean season to meet their requirements. Furthermore, manufacturers can not rely on spot market for their smooth and flexible production in a year as seasonal variations in demand of their product and supply constraint of raw materials. Therefore, futures market gives platform to producers for managing risk which arises from price fluctuations of their produces. Similarly, manufacturers get their raw materials in time through futures market for smooth and flexible production.

Futures market provides a market mechanism to balance this inequality of the supply-demand pattern of commodities. Futures trading provides a means of appraising the supply and demand conditions and dealing with price risks over time and distance. Trading in futures not only provides price signals to the market of today, but also of months ahead, and provides guidance to sellers (farmers/ growers/ processors) and buyers (consumers) of the commodities in planning ahead, and in financing and marketing commodities from one season to another. Futures markets, therefore, has two broad economic objectives, i.e. price discovery and price risk management which are beneficial to all sectors of the economy including farmers and consumers (Bhattacharya, 2007)[16]. However, due to lack of knowledge, complexity in understanding futures terminology and complication in mechanisms, marginal farmers and investors are often away from the participation in futures market.

Practically, the mechanism of commodity futures market is very simple. For example, in futures market, a buyer agrees to buy the commodity from a seller with a specified price and on a specified date in the future. The agreement between buyer and seller is called 'contract'. The contract specifies both the quantity and quality of the commodity, price, delivery date, and delivery location. The act of buying is called 'taking long position', while the act of selling is called 'taking short position'. At the time of delivery, there may arise the risk of default in payments, known as 'credit risk'. Here, the clearing house plays a key role to sort out the issues related to the default payment. Clearing house is an agency associated with one or more futures market exchanges with the objectives: (i) to match, process, register, confirm, settle, reconcile, or guarantee trades; (ii) to become a party to each trade so as to nearly eliminate credit risk; (iii) to operate the mark-to-market process (collecting and paying variation margin); and (iv) to handle the delivery process. Futures markets act as market surveillance through monitoring price and volume movements, detecting potential market manipulation at the early stages and neutralizing market participants' ability to collude and

[16] Bhatacharya, H. (2007): 'Commodity Derivatives Market in India', *Economic & Political Weekly*, Vol. XLII, pp.1151-1162.

influence prices. Proper monitoring and surveillance bring confidence among participants and increase market liquidity. If futures market fails to deliver its objectives (hedging risk and price discovery) then the market is likely to be riskier as it destabilises the spot market prices and fails in discovering fair price of commodity. Pricing of the commodity futures plays an important role for the participants who involve in the futures trading. Spot price and cost of carry play a key role in deciding fair value of futures contract. Cost of carry is defined as the cost incurred on account of an investment position taken by a participant in the futures market. Cost of carry comprises storage costs, financing costs, insurance costs and transport costs. Thus, the fair value of a futures contract is the sum of the spot price and cost of carry.

All the open positions of members are marked to market every day, based on the settlement price for each contract. The difference is settled in cash on a T+1 basis. In other words, the daily profits or losses of the traders, due to daily price movement, are calculated every day and settled the next day. On the day of entering into the contract, the difference between the entry price and daily settlement price is calculated. On the expiry date, if a member has an open position, the difference between the final settlement price and the previous day's settlement price is taken into account. On the intervening days when the member holds an open position, the difference between the daily settlement price for that day and the previous day's settlement price is calculated. All members and their constituents are bound by the daily settlement price notified by exchange. Whenever members have to pay to the exchanges to cover losses, the pay-in must be made before 10:30 AM the same day or on the next day. This ensures that the obligations of members are valued at the most recent market prices and adequate margins are maintained to mitigate default risk. In case of profit, pay out would be made by 10:30 AM on the next day.

Mark-to-Market settlement system is described through suitable example in the table 2.1. Suppose, that on a particular day in March, a trader buys a May futures contract for wheat at Rs. 1500 per quintal. The daily settlement price for that day is Rs. 1550 per quintal. Hence, the buyer of the contract will get a profit of Rs.50 per quintal, which he can collect in the form of pay-out during the following day. However, the seller of the contract would incur a loss of Rs. 50 per quintal, which he must settle in the form of pay-in by or before 10:30 AM during the subsequent day. Next day, both the buyer and the seller would start their day's position with Rs.1550 per quintal. The contract would be marked-to-market in the same manner at the end of the day. The table 2.1 gives an example of continuous mark-to-market settlements till the contract is squared off. On the day of squares off, net gain is Rs. 25 and net loss is Rs. 20.

Table 2.1 Mark to Market Settlement

Date	Buy Position	Sell Position	Daily Settlement price	Profit/(loss)
16/03/2012	Rs.1500/-Per Qt.	Rs 1500/-Per Qt.	Rs. 1550/-Per Qt.	Buyer gain=Rs50 Seller loss=Rs.50
17/03/2012	Rs. 1550/-Per Qt.	Rs. 1550/-Per Qt.	Rs. 1525/-Per Qt.	Buyer loss=Rs.25 Seller gain=Rs.25
18/03/2012	Rs. 1525/-Per Qt.	Rs. 1525/-Per Qt.	Rs. 1535/-Per Qt.	Buyer gain=Rs 10 Seller loss=Rs. 10
19/03/2012	Squares off @ Rs.1525/-Per Qt.	Squares off @ Rs.1520/-Per Qt.		
Total	**Net gain=Rs.25**	**Net loss=Rs.20**		

Note: Example set by author

2.5 Hedging in the Futures Market

Commodity trading involves sizeable price risks due to volatile prices in the spot market, which may affect the value of the underlying commodity. Hedging is an important strategy to manage price risk. Hedgers include various types of people such as producers, consumers, processors and traders. Producers want to transfer the risk arising from the possibility that price could decline by the time their produce is ready for sell. Therefore, he uses commodity futures market platform for hedging (hedging means to prevent risk of price fluctuations of the commodity) for their commodity. They prefer hedging to protect themselves from the risks of potential adverse price changes in commodity. Through hedging operation, the value change (profit or loss) of a commodity in spot market can be covered by value change (loss and profit) in futures market, thereby, minimizing price risk, which is one of the objectives of hedgers. Consumers, on the other hand, want to transfer the risk arising from the possibility that the prices will increase before purchases are made. Therefore, consumers also use hedging to manage price risk.

2.6 Speculation in the Futures Market

Speculation is one of the integral parts in any futures markets. Groups of speculators, acting in unison and completely controlling large spot and futures positions in commodities with the intent of manipulating prices may obviously have a detrimental effect on the market. Despite this, it is widely acknowledged that speculation, in general, improves the efficiency of the futures market. This is so because speculators are willing to enter the market to take advantage of even small changes in prices as they bear the price risk that hedgers seek to transfer. Speculators also provide liquidity to the futures market so that hedging in large volumes may be conducted with minimal execution costs.

There are two contradictory views concerning the effects of speculation on price variability. One view is that, speculation increases price variability as speculators tend to buy as prices rise and tend to sell as prices fall. The additional buying when price rise exacerbates the price rise even more. Similarly, the increased selling when prices fall causes them to fall even more. This results in larger swings in commodity prices and thus more price volatility. The opposing view argues that speculation actually reduces price variability. Speculators naturally buy commodities when they are cheap, and store them until be brought again into the market when they become costlier. The tendency of this operation is to equalize price, or at least to moderate its variability. The prices of commodities are neither so much depressed at one time, nor so much raised at another, as they would be if speculative dealers did not exist (Kamara, 1982)[17].

2.7 Arbitrage in the Futures Market

Arbitrage is one of the important tools to restore equilibrium among spot and futures of a commodity, if any distortions in prices exist when futures contract matures. It is a process of taking advantage of price differences in futures of same or identical commodities between two market places. An arbitrage could also take benefit of the excess price difference between spot and future prices. An arbitrager might also exploit an opportunity to make profit, presented by the future prices for the same commodity at two different points of time in future. Arbitrage opportunities also become available in two commodities which are substitutes. Prior to the delivery day or days, the futures price will not necessarily be equal to

[17] Kamara, A. (1982): 'Issues in Futures Markets: A Survey', *The Journal of Futures Markets*, Vol. 2, pp.261-294.

the spot market price of the deliverable commodity. However, during the delivery period, the futures market price should converge to the related spot market price. If convergence has not occurred during delivery period, there will be opportunity for arbitrage profits, for example if the futures price is greater than the spot market price during delivery period, arbitrager could buy the spot market commodity, sell the futures contract, and deliver the commodity at the higher futures market price. On the other hand, if the futures price is less than cash market price, the arbitrager could buy the futures contract and short the spot market commodity. Such arbitrage transactions which generate profits for the arbitrager tend to make the futures price converge to the spot market price (Jones, 1982)[18].

2.8 Convergence of Spot and Future Market

Basis is one of the important concepts in the futures trading which refers to the difference between spot and futures prices. As futures contract nears expiration, the basis keeps reducing till it reaches zero on expiration, i.e. at expiration, there is a convergence of the futures price with spot price of the underlying asset, e.g. the closing price for August gold futures contract is the closing value of gold in the spot market on that day. As the delivery date approaches, both cost of carry and the convenience yield approach to zero where convenience yield refers to the benefit or premium associated with holding an underlying commodities rather than the contract or derivative commodities.

[18]Jones, F. J. (1981): 'The Interaction of the Cash and a Futures Markets for Treasury Securities' *The Journal of Futures Markets*, Vol.1, pp.33-57.

The basic reason for convergence is that, if any one of the prices, spot price or future price, exceeds to the other, there is scope for arbitrage. Exploitation of the arbitrage opportunity by traders will bring back convergence. If the futures price is above the spot price during the delivery period, the traders can short the futures contract, by the underlying asset and make the delivery. This will lead to a profit equal to Futures-Spot. As other traders follow this opportunity, the futures price will fall, leading to convergence of the futures price with the spot price. If, on the other hand, the futures price is below the spot price during the delivery period, traders will go long on the futures contract, sell the underlying asset in the spot market and make a profit equal to Spot-Futures. As more traders take the long position, future prices would rise, leading to convergence.

2.9 Backwardation and Contango in Futures Market

As for the spot and futures price variation there are two major theoretical strands, namely, 'backwardation' and 'contango'. 'Backwardation' is the market condition wherein the price of a futures contract is trading below the expected spot price at contract maturity. The opposite market condition to backwardation is known as 'contango', Keynes (1930)[19] observed that the futures price should be below the expected spot price in order that this "backwardation" provides speculators with a risk premium for holding a long position in the futures contract. Keynes regarded hedgers as primarily holding short positions. Later, subsequent development of this topic in the literature (Cootner, 1960)[20] led to the understanding that hedgers would sometimes prefer long positions to reduce their risk. Such a case would arise when inventories are small prior to a harvest, and producers "hedge" by

[19] Keynes, J. M. (1930): 'Treatise on Money, Vol. 11: The Applied Theory of Money, Harcourt, New York.

[20] Cootner, P. H. (1960) : 'Returns to Speculator: Telser Versus Keynes', as reprinted in Peck (1977), pp.41-45.

going long. In that case speculators must take short positions, and contango must prevail in order for speculators to receive a risk premium. Thus, the "complete" risk premium theory demonstrates that backwardation or contango would occur depending on whether speculators were "net long" or "net short,'' which would be a seasonal phenomenon (O'Brien and Schwarz, 1982)[21].

2.10 Regulation of Indian Commodity Futures Market

The forward markets commission (FMC) is the regulator for commodity futures trading in India under the provisions of the forward contracts (Regulation) Act 1952. The regulations generally aim to control both the entry into and operation of futures markets and also focus on the operation or performance of the market. They provide a market place that fulfils the economic functions of futures markets by prohibiting practices that can interfere with the process of price discovery or the efficient transfer of risks. Major challenges for regulation are to prevent distortion of prices through price manipulation and insider trading. The major functions of the FMC are to advise the central government in respect of the recognition or the withdrawal of recognition of any association. FMC keeps forward markets under observation and may exercise, if necessary, the powers assigned to it by or under the Act. It publishes information, if necessary, regarding the trading conditions in respect of goods including information regarding supply, demand and prices. It also makes recommendations generally with a view to improving the organization and working of forward markets. FMC undertakes the inspection, whenever it considers it necessary, of the accounts and other documents of any recognized association or registered association.

[21] O'Brien T J and Schwarz P M (1982):' *Ex Ante* Evidence of Backwardation / Contango in Commodities Futures Markets', *The Journal of Futures Markets*, Vol. 2, pp. 159-168.

Acting on another recommendation of Kabra Committee to strengthen the FMC, the Government upgraded the post of FMC Chairman to Additional Secretary. The Government in 1995 set up a separate Department of Consumer Affairs to focus on commodities. The idea of a National multi-Commodity Exchanges (NCE) was proposed in 1999. A Core group was set up to work out modalities for constituting NCE and a decision to set up the NCE was taken in July, 2000 (Karnade, 2006)[22].

2.11 Description of the Commodity

Five commodities are taken for this study i.e. gold, silver, copper, crude oil and natural gas. The commodities are chosen according to MCX's world ranking in terms of number of futures contracts traded in 2011. All the commodities under the study have their special characteristics and applications, and also different factors affect demand and supply of the commodities. This section is devoted to description of the commodities, and demand and supply situation in the world.

2.11.1 Gold

The symbol of gold is Au. It is a dense, soft, shiny, malleable and ductile metal. Pure gold has bright yellow colour and lustre. It is one of the most precious metals since the ancient times. There is a number of intrinsic features that separate gold from the rest of the commodities, such as its function in central banks' reserve asset management, and the exceptional physical and chemical properties that make it ideal for use in technological

[22] Karende, K. (2006): 'A Study of Castor seed Futures Market in India', *PhD thesis* submitted to the Indira Gandhi Institute of Development and Research (IGIDR).

applications. The combination of these and many other features make gold stand out from other commodities. It is widely acknowledged that gold is synonymous with luxury and wealth. Half of all gold in above ground stocks still exists in the form of jewellery, yet it is also an important financial asset and is considered by many as a currency in its own right. It is accepted that gold is a store of wealth and an efficient diversifier of risk. It also acts as a reliable and essential component used in a range of electronics, medical and dental applications, and is continually proving its wider significance as an innovative enabler to new technologies. Gold's ability to reduce credit and counterparty risk by which gold can add liquidity, increase diversification and preserve wealth even during the times of economic uncertainty or in the presence of systemic market risk (WGC)[23].

A) Factors Influencing Gold Prices

There are several factors that affect gold prices such as inflation, interest rate, exchange rate, financial uncertainty etc. Some of the factors affect positively while others affect negatively to gold prices.

i) Gold and Inflation

Inflation is one of the determinants of gold price. There have been many different institutional settings for gold such as the gold standard, the Bretton Woods system, free floating price for gold, and the migration of gold for use as an everyday currency to an investment vehicle. Still, on the long run, purchasing power of gold has remained remarkably stable over time. The tendency for gold to hold its real terms value over long periods has

[23] World Gold Council

often led to gold being described as an “inflation hedge”. Therefore, gold is used as hedge against inflation.

ii) Gold and Real Interest Rate

It is widely studied that there is inverse relationship between real interest rates and price of gold. Real interest rates fall and therefore, investors buy gold. Besides, there is a number of reasons for which investors buy gold. Firstly, lower real interest rates could imply higher inflationary expectations in the future therefore gold is bought as a hedge against this possible inflation. Secondly, lower real returns in Treasuries drives investors into risk assets in search of a higher return which also makes gold price higher. Finally, when real interest rates go down then it sends a message that the economy is in a bad place therefore investors buy gold as it is safe haven asset.

iii) Gold and Exchange Rate

In early 1970s, floating exchange rates had been adopted by most of the countries. Therefore, exchange rate has had a significant influence on short-term gold price movements. Some of the studies (IMF, 2008) also find relations between price of gold and exchange rate. This relationship exists because of the two major reasons. Firstly, for example, falling dollar increases the purchasing power of non-dollar area countries (and a rising dollar reduces it) driving up prices of commodities including gold (or driving them down in case of a stronger dollar). Secondly, in periods of dollar weakness, investors look for an alternative store of value, driving up gold prices. This includes dollar-based investors concerned about possible inflationary consequences of a weak dollar. In strong dollar periods the dollar itself is often seen as an appropriate store of value. Recent history confirms the close association of the gold price with the value of the dollar.

iv) Gold and Financial Uncertainty

Significant and commonly observed influence on the prices of gold is the level of financial uncertainty which is called financial/economic crisis. In the recent financial crisis 2008, gold demand and prices increased significantly. Therefore, gold is used as "a crisis hedge" at the time of financial/economic crisis. During financial crisis gold demand may rise for a number of reasons: Steep declines in the value of other assets such as equities and high volatility of asset prices, lead to demand for a more stable store of value uncorrelated with other assets. Fear of the security of other assets such as bonds due to the possibility of default, and even fears of cash if the health of the banking system is in question. Therefore, investors prefer gold as investment asset at the time of financial uncertainty in the economy.

v) Demand and Supply Scenario of Gold

The total gold demand in 2010 reached a 10 year high of 3,812.2 tonnes as a result of strong growth in jewellery demand and a paradigm shift in the official sector, where central banks became net purchasers of gold for the first time in 21 years. China was the world's largest gold producer with 340.88 tonnes in 2010, followed by the United States and South Africa. In 2010, India was the world's largest gold consumer with an annual demand of 953 tonnes. The total supply of gold coming into the market in 2010 reached 4,108 tons, a rise of 2% from 2009 levels. India is the largest market for gold jewellery in the world. 2010 was a record year for Indian jewellery demand at 745.7 tonnes, annual demand was 13% above the previous peak in 1998. In local currency terms, Indian jewellery demand was more than double in 2010. A 20% rise in the rupee price of gold combined with a 69% rise in the volume of demand, pushed up the value of gold demand by 101% to `1,342 billion. It can be compared with 2009 demand of `669 billion. The rising price of gold particularly in the latter half of 2010, created a ‘virtuous circle’ of higher price expectations among Indian consumers, which fuelled purchases, thereby further driving up local prices (*Source*: GFMs Ltd. WGC).

2.11.2 Silver

Silver is a metallic chemical element whose chemical symbol is Ag. It has unique properties such as its strength, malleability, ductility, electrical and thermal conductivity, sensitivity, high reflectance of light, and reactivity. Many well known uses of silver are precious metal properties, including currency, decorative items and mirrors. It has also long been used to confer high monetary value as objects such as silver coins and investment bar. Industrial uses, photography, and jewellary account almost 77% of annual silver consumption. These are the major applications of silver which increase its demand.

A) Demand and Supply of Silver

The demand for silver in India approximates 2500 tonnes per year, whereas the country’s production was around 206.95 tonnes in 2010. Nearly 60% of Indian demand comes from farmers, who store their saving in silver bangles and coins. Silverware achieve an increase of 4.6%, owing to stock related gains in India. Demand for coins and metals surged yet higher from 2008, rising by 20.70% to reach a new high of 2447 tonnes on the back of heavy investment demand. In 2009, implied net investment soared to 4258 tonnes buoyed by safe havens concerns, which led to strong inflows into ETFs and physical investment.

Scrap supply continued to decrease in 2009 by almost 6 percent, despite a strong recovery in prices over the year. Most notable increases were seen in Bolivia and Argentina with by largest single decline coming from Australia. Net government sales fell by just over one half to 426 tonnes in 2009, primarily driven by lowest stock sales from Russia, coupled with the continued absence of any disposal from China and India. World silver mine production grew by almost 4 percent in 2008. Higher mine output from primary silver and gold sectors drove the increase. Peru was the world's largest silver producing country in 2009, followed by Mexico, China, Australia, and Bolivia. Global primary silver supply recorded a percent increase to account for 30 percent of total mine production in 2009.

2.11.3 Copper

Copper is a chemical element whose symbol is Cu. It is a ductile metal with very high thermal and electrical conductivity. Pure copper is soft and malleable; a freshly exposed surface having a reddish orange colour. Copper is the best metal conductor of electricity. The metal's exceptional strength, ductility, and resistance to creeping and corrosion, makes it the preferred and safest conductor for building wiring. Copper is also used in power cables, either insulated or non-insulated, for high, medium, and low voltage applications. Copper is an essential component of energy efficient motors and transformers and automobiles.

i) Demand and Supply Scenario of Copper

Copper mine production was up nearly 2 percent from 15.805 million metric tonnes (MT) in 2009 to 16.099 million MT in 2010. Global refined copper production was 19.186 million MT in 2010, up from 18.653 million MT in 2009, and global refined copper consumption was

19,200 million MT, compared with 18.243 million MT in the previous year. While Chile accounts for 34 percent of the total world copper mine production, Peru, the USA, China, Australia and Indonesia, together are responsible for around 32 percent.

India’s production of refined copper is approximately around 4 percent of the total world production and in terms of figures it is around 600,000 MT. Consumption of refined copper per annum is around 535,000 MT, which accounts for only 3 percent of the world copper market. Sterilite Industries, Hindalco, and Hindustan copper are three major producers of copper in India. India is emerging as net exporter of copper from the status of net importer on account of rise in production by these three companies. Copper goes into various usage such as building, cabling for power and telecommunications, automobiles etc. Two major state owned telecommunications service providers; BSNL and MTNL consume 10 percent of country's copper production[24]. Growth in the building construction and automobile sector would keep demand of copper high.

2.11.4 Crude oil

Crude oil is a mixture of molecules formed by carbon and hydrogen atoms. There are different types of crude oil existing on the earth. Heavy crude oil is very thick and viscous and is difficult to produce, whereas light crude oil is very fluid and much easier to exploit. Crude oil is therefore compared and described by density, the most commonly used scale is ^{o}API (American Petroleum Institute, the association based in Washington, DC that standardizes the industry’s equipment and procedures), which is inversely, linked to specific gravity.

[24] Data Source: Multi Commodity Exchange

Crude oil is also classified as sweet and sour on the basis of their sulfur content. By definitions, sweet crude oil has less than 1 percent sulfur by weight. The adjective sour refers to other, less desirable grades. Sulfur in hydrocarbons is burden: when it is burnt, it forms sulfur dioxide, a gas that pollutes the air and contributes to acid rain. By definition, a benchmark is a standard crude oil against which other grades are compared and prices are set. There are three major benchmarks in the world of international trading today as follows:

a. West Texas Intermediate, or WTI, in the US (38-40^{o}API and 0.3% S) and, to a lesser extent, West Texas Sour (33% ^{o}API and 1.6%S).
b. Brent blend, the reference crude oil for the North Sea, which is very similar to WTI in quality: 38^{o}API and 0.3%S.
c. Dubai, the benchmark crude oil for the Middle East and Far East (32^{o}API and 2%S), which comes from off-shore local fields: Fateh, SW Fateh, Falah and Rashid.

A) Factors Influencing Price of Crude Oil

i) Crude Oil and OPEC

Crude oil production by the Organization of Petroleum Exporting Countries (OPEC) is an important supply side factor that affects crude oil prices. This organization seeks to produce oil actively in its member countries by setting a production target. Historically, crude oil prices had been increaseing in time when OPEC production targets were reduced and vice versa. OPEC member countries produce about 40 percent of the world’s crude oil and OPEC’s oil exports represent about 60 percent of the total petroleum traded internationally. Therefore, OPEC’s actions (production as well as exports) influence crude oil prices.

ii) Crude Oil and Non-OPEC

Another supply side factor is non-OPEC production which is a determinant of crude oil price. Share of oil production from countries outside the Organization of the Petroleum Exporting Countries (OPEC) currently is around 60 percent of world oil production. Non-OPEC producers make independent decisions about oil production as its production is mostly in the hands of national oil companies (NOCs), international or investor-owned oil companies (IOCs) do most of the production activities in non-OPEC countries. IOCs seek primarily to increase shareholder value and make investment decisions based on economic factors. While some NOCs operate in a similar manner as IOCs, many have additional objectives such as providing employment, infrastructure, or revenue that impact their country in a broader sense. As a result, non-OPEC investment, and thus future supply capability, tends to respond more readily to changes strictly in market conditions.

iii) Crude Oil and Inventories

Inventories act as the balancing point between supply and demand. During periods when production exceeds consumption, crude oil and petroleum products can be stored for unexpected future use. In the economic downturn of late 2008 and early 2009, for example, the unexpected drop in world demand led to record crude oil inventories in the United States and other OECD countries. In contrast, when consumption outstrips current production, supplies can be supplemented by draws on inventories to satisfy the needs of consumers. Given the uncertainty of supply and demand, petroleum inventories are often seen as a precautionary measure.

Refineries and storage terminals can store crude oil and/or finished products like motor gasoline, heating oil, and diesel to stay prepared for seasonal fluctuations, refinery maintenance, or unexpected weather. Some petroleum products, such as heating oil and gasoline, have pronounced seasonal demand variance; inventories rise when consumption is low and are drawn down when consumption increases. For this reason, inventory levels are most usefully assessed in relation to prior year levels for the same calendar quarter. Therefore, inventories also major fact that affects price of the crude oil.

iv) Crude oil and Futures Market

Market participants not only buy and sell physical quantities of oil, but also trade contracts for the future delivery of oil and other energy derivatives. One of the roles of futures markets is price discovery, and as such, these markets play a role in influencing oil prices. Oil market trading activity involves a range of participants with varying motivations, even within individual participants. Some, such as oil producers and airlines, have a significant commercial exposure to changes in the price of oil and petroleum-based fuels, and may seek to hedge their risk by buying and selling energy derivatives. For example, an airline may want to buy futures or options in order to avoid the possibility that its future fuel costs will rise above a certain level, while an oil producer may want to sell futures in order to lock in a price for its future output.

v) Crude Oil and Non-OECD

The Organization of Economic Cooperation and Development (OECD) consists of the United States, much of Europe, and other advanced countries. At 53 percent of world oil consumption in 2010, these large economies consumed more oil than the non-OECD countries, but had much lower oil consumption growth. Oil consumption in the OECD countries actually declined in the decade between 2000 and 2010, whereas non-OECD consumption rose 40 percent during the same period.

Structural conditions in every country's economy influence the relationships among oil prices, economic growth, and oil consumption. Developed countries tend to have higher vehicle ownership of per capita. Because of this, oil use within the OECD transportation sector usually accounts for a larger share of total oil consumption than that of non-OECD countries. Economic conditions and policies that affect the transport of goods and people thus have a significant impact on the total oil consumption in OECD countries. Many OECD countries have higher fuel taxes and policies to improve the fuel economy of new vehicles and increase the use of bio-fuels. This tends to slow down the growth in oil consumption even in times of strong economic growth. Furthermore, the economies in OECD countries tend to have larger service sectors related to manufacturing. As a result, strong economic growth in these countries may not have the same impact on oil consumption as it would have in non-OECD countries.

vi) Demand and Supply Scenario of Crude Oil

India ranks among the top 10 largest oil-consuming countries. Oil accounts for about 30 percent of India's total energy consumption. The country's total oil consumption is about 2.2 million barrels per day. India imports about 70 percent of its total oil consumption and it does not export. India faces a large supply deficit as domestic oil production is unlikely to keep pace with the demand. India's rough production was only 0.8 million barrels per day. The oil reserves of the country are located primarily in Mumbai High, Upper Assam, Cambay, Krishna-Godavari and Cauvery basins. Balance recoverable reserve was about 733 million tons in 2003 of which offshore was 394 million tons and on shore was 339 million tonnes. India had a total of 2.1 million barrels per day in refining capacity. Government has permitted foreign participation in oil exploration, an activity restricted earlier to state owned entities.

2.11.5 Natural Gas

Natural gas is a colourless, odourless, environment friendly energy source. It mainly consists of methane which occurs naturally in the earth's crust. It is often found in association with crude oil. It is naturally occurring hydrocarbon gas mixture consisting primarily of methane with up to 20% of other hydrocarbon as well as impurities in varying among such as carbon dioxide. Natural gas is widely used as an important energy source in many applications including heating building, generating electricity, providing heat and power to industry, as fuel for vehicles and as chemical feed stock in manufacture of products such as plastics and other commercial important organic chemicals.

A) Demand and Supply of Natural gas

The proven natural gas reserves of the world as on January 1, 2009 are estimated at 185.2 trillion cubic meter, of which almost three-quarters is located in the Middle East and Eurasia. Russia, Iran, and Qatar together account for about 57 percent of the total reserves. Natural gas consumption has increased largely over the past decade. The total global production of natural gas in 2008 is estimated to be 3065.6 billion cubic meter (bcm) with the main producing countries being Russia Federation with 602 bcm , US with 582 bcm, Canada with 175 bcm and Iran with 116 bcm. The total global consumption of natural gas in 2008 is estimated to be 3018.7 billion cubic meter with the main consuming countries being US with 657 bcm, Russia Federation with 420 bcm, Iran with 117 bcm, Canada with 100 bcm. The total global trade in 2008 as piped natural gas and as LNG is reported to be 587.3 bcm and 226.5 bcm. While major exporters of piped natural gas are Russia with 154 bcm, Canada with 103 bcm and Norway with 93 bcm, the major importers are US with 104 bcm, Germany with 87 bcm and Italy with 75 bcm. The major exporters of CNG are Qatar with 40 bcm, Malaysia with 29 bcm, Indonesia with 27 bcm and the major importers are Japan with 92 bcm, South Korea with 36 bcm and Spain with 30 bcm (Source: MCX).

Natural gas has gained prominence in India too as in the rest of the world over the last decade. India has consumed around 41.4 bcm of natural gas in 2008, out of which domestic production is 30.6 bcm and imports as LNG has been 10.79 bcm. The share of imports is expected to increase in the coming years and cross 30 percent from current level of around 25 percent. Fertilizer (41 percent) and power (37 percent) are the major users of natural gas in

India[25]. The fertilizer sector in India is highly subsidized by the Government and it fixes the rate at which natural gas is provided to the fertilizer manufacturing units.

2.12 Conclusion

For the efficient function of futures market, least regulation is desirable so that market fundamentals can play major role in hedging risk and price discovery. Least regulation encourages market participants to process information quickly and therefore, it reflects in the prices of the commodities. However, policy makers in India have been regulating futures market in such a manner that fundamentals have least role to play in hedging risk and price discovery. Options, (it is a right but not an obligation to buy and sell an asset with specified price and date) on the other hand, should be allowed into the commodity futures market as Indian futures market is mature enough to handle options trading. Small and marginal producers are unable to participate in the futures market due lack of information, large contract size and complexity in the market functions. Therefore, regulators as well as exchanges should arrange awareness programme so that small and marginal producers can be part of futures market.

[25] Data Source: Multi Commodity Exchange

CHAPTER 3

Price Discovery and Price Volatility in the Commodity Futures Market

3.1 Introduction

Price discovery is one of the important functions of commodity futures market which typically documented by noting the speed at which prices of commodities react to new information (Booth, W. S. and Tse, 1999)[26]. It is believed that price discovery takes place first in the futures market then transfers to the spot market due to inherent leverage, low transaction cost, and lack of short sell restrictions (Tse, 1999)[27]. For an efficient price discovery, commodity futures market needs to be informationally efficient. Commodity futures market is said to be informationally efficient if it utilizes all the available information in setting the prices. The idea behind this concept of efficiency is that producers and investors process the information that is available to them and take positions in response to that information as well as to their personal situations. The market aggregates all this diverse information and reflects it in the price discovery process (Kaminsky and Kumar, 1989[28]; Fama, 1970[29]).

Price discovery is an imminent indicator in the futures market that exerts economic impact on a wide array of players in the market including policy makers. All the stakeholders in the

[26] Booth, G. G., So, R. W. and Tse, Y. (1999): 'Price Discovery in the German Equity Index Derivatives Markets', *The Journal of Futures Markets*, Vol.19, pp.619-643.
[27] Tse, Y.(1999): 'Price Discovery and Volatility Spillovers in the DJIA Index and Futures Markets', *The Journal of Futures Markets*, Vol. 19, pp.911–930.
[28] Kaminsky, G. and Kumar, M. S. (1989): 'Efficiency in Commodity Futures Markets' *Working papers,* International Monetary Fund.
[29] Fama, E. (1970): 'Efficient Capital Markets: A Review of Theory and Empirical Work', *The Journal of Finance*, Vol. 25, pp. 383-417.

futures market use price discovery as barometer and try to extract benefits using diversified strategies. The hedgers try to make necessary hedging strategies via diversified tools available in the market so that their cash flow remains unaffected. The traders attempt in advance to manage their inventories to handle the futures price changes in the market and try to get benefitted out of such changes. The speculators are those sections of participants in the market who try to exploit the market due to changes in the short term prices of the underlying assets in the market. The speculative buying and selling of commodities exert tremendous impact on the behaviour of the market. This is also very true for the commodity futures market. The arbitrageurs always make attempt to find the differences in prices in different markets so as to enjoy the profit out of the differential prices. They buy the commodities at the cheaper market and sell the commodities in the dearer market to obtain profit out of the price differentials. The consumers use price discovery as an indicator and allocate the resources accordingly for consumption. Above all, the regulators and policy makers are the one, who take the information on price discovery and try to formulate the policies that provide better stability to the market and avoid unnecessary interruptions that may cause worries to the economy.

The essences of price discovery is to establish a competitive reference (futures) price from which the spot price can be derived and depends on whether information is reflected first in changed futures price or in changed spot price. The futures price serves as the market's expectation of subsequent spot price. However, the literature on price discovery is quite rich and has had thrown light on diversified derivative market segments but still researchers are widely divided in their intellectual churning. The evidence is not conclusive in any derivative market. Some literatures strongly support that price discovery takes place in futures market and that transmits to the spot market (Garbade and Siber, 1983[30]; Oellermann and Farris, 1985[31]; Herbst, McCormack and West, 1987[32]). On the other hand, there are some contrasting literature that ascertains that the price discovery takes place in spot market and gets transmitted to futures market (Silvapulle and Moosa, 1999[33]; Quan, 1992)[34]. Some literature reveal the fact that the price discovery process is bi-directional, i.e. futures leads to spot and spot leads to the futures (Chan, Chan and Karolyi, 1991[35];). Looking at the dearth of conclusive evidence, the study attempts to examine the price discovery process.

Producers or investors can potentially offset losses in the spot market by taking positions in the futures market. However, price insurance is possible if spot and future price move exactly together, otherwise perfect insurance is not feasible (Telser, 1981)[36]. Pre-condition for commodity futures market efficiency is the convergence of both future and spot prices across the market spectrum. For future price to be an unbiased predictor of spot price, the future and spot price must be proportional, i.e. the basis should be constant and the market is said to be efficient. Price discovery and lead-lag relationship between futures and spot prices have followed a procedure that is based on price series being non-stationary (Asche and Guttormesen, 2002)[37], i.e. to test the existence of a long run relationship between the spot and future prices by investing whether the data series are co-integrated.

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[36] Telser, L. G. (1981): 'Why there are Organised Futures Markets'. *Journal of Law and Economics*, Vol. 24, pp. 1-22.
[37] Asche F. and Guttormsen (2002): ' Lead Lag Relationship between Futures and Spot Prices', *Working Paper* No.2/02, Institute for Research in Economics and Business Administration, Bergen.

3.2 Literature Review

There are studies on price discovery but with differences in views. Some studies claim price discovery takes place first in futures market then transfers to spot market, while other studies say price discovery takes place first in the spot market then transfers to futures market. This study reviews some important studies on price discovery as follows:

Garbade and Silber (1983) use their model to seven commodities i.e. wheat, corn, oats, orange juice, gold and silver. They find that, in general, futures markets dominate spot market. Their evidence suggests that the spot markets in wheat, corn, and orange juice are largely satellites of the futures markets for those commodities, with about 75% of new information incorporated first in futures prices and then flowing to cash prices. The pricing of silver and especially oats and copper are more evenly divided between the cash and futures markets. However, the spot market also plays a role in the price discovery. Silvapulle and Moosa (1999) find more evidence for causality from futures prices to spot prices than otherwise. They also claim that although the futures market may play a major role in the price discovery process, the spot market also plays a role in this respect.

Foster (1996) examines the behaviour of crude oil spot and futures markets in the UK and USA during the 1990-91 Gulf conflict. He applies generalized model of price discovery and Kalman Filter to study dominance relationship within time-varying framework. He finds that relationships between spot and futures are strongly temporal.

Schwarz and Szakmary (1994) find that futures dominates in price discovery process in three petroleum product markets i.e. crude oil, heating oil and unleaded gasoline traded at the NYMEX. Their results concerning the supply of arbitrage services in these markets are similar to those of other commodities where the price discovery role of futures has been fully established. Schroeder and Goodwin (1991) examine short and long run price relationship between Omaha cash and CME futures daily prices for live hogs. Using Garbade and Silber model, they find that price discovery generally originates in the futures market with an average of roughly 65% of new information being passed from the futures to the cash market. However, at times, especially during large price moves that are not necessarily anticipated in the futures market, the cash market price discovery dominates the futures market.

Quan (1992) focuses on the role of price discovery. He uses crude oil market as example and determines whether the crude oil futures price is capable of providing some relevant information for predicting the spot price. Using Garbade and Silber and Granger causality test, he finds lead-lag relationships between the spot and one month-out futures price. Both tests indicate that the crude oil spot price generally leads to the futures price in incorporating new information, and that the crude oil spot market always dominates the futures markets. Moreover, his study claims that crude oil futures price does not play a very important role in the price discovery process. However, because the two markets converge rather quickly, investors tend to believe that futures prices move together with the spot. He also believes that futures prices are able to provide information for predicting spot prices.

Ollermann and Farris (1985) find that in most instances the futures market is the center of price discovery for the commodity. A likely explanation of these results is that the futures market serves as a focal point of information assimilation, where large numbers of market participants meet to assess and evaluate supply and demand conditions and to act on the basis of their evaluations. Because futures price information is available at such a low cost, producers and packers depend heavily on price changes in the futures market when making their own pricing decisions. Given the belief that the futures market for the commodity tends to efficiency, its use appears to contribute to a more efficient price discovery process in the commodity market. Similarly, Ollermann, Brorsen and Farris (1989) find futures prices generally lead cash prices incorporating new pricing information. They consider daily closing price data of live cattle and feeder futures contracts on the Chicago Mercantile Exchange (CME) from 1979-1982 and 1983-1986. Using GS model, they claim that cattle futures markets serve as the price discovery for feeder cattle.

Sahadevan (2002) investigates twelve markets in six commodity items over 38 months from January, 1999 to August, 2001. He finds that price discovery does not exist in the futures market and the price volatility in the spot market does not have any impact on the futures market. The exchange specific problems such as low volume and market depth, lack of participation of trading members and irregular trading activities along with state intervention in many commodity markets are major ills retarding the growth of futures market. Sahadevan (2008) analyses futures trading in mentha oil. He finds that the excessive speculative interests lead to spurious price discovery and distortion in spot prices.

Kumar and Pandey (2011) study the cross market linkages of Indian commodity futures for nine commodities with futures markets outside India. They use Johansen's cointegration test, error correction model, Granger causality test and variance decomposition techniques. Their study finds that price discovery in the agricultural metal and energy commodities in different markets. Lokare (2007) finds the evidence of price discovery in almost all the commodities under the study. Moreover, he also finds volatility in the futures prices is substantially lower than the spot price indicating an inefficient utilization of information in some commodities. However, several other commodities also appear to be attracting wide speculative trading.

From the above reviews on price discovery, it is quite clear that still researchers are widely divided in their intellectual churning. The evidence is not conclusive in any derivative markets. Some literature strongly support that price discovery takes place first in futures market and that transmits to the spot market and some other contrasting literature ascertains that the price discovery takes place first in spot market and gets transmitted to futures market. Some literature revealing the fact that the price discovery process is bi-directional i.e. futures leads to the spot and spot leads to the futures. Looking at the dearth of conclusive evidence, the study makes an attempt to examine the price discovery process.

3.3 Graphical Analysis

In examining gold futures and spot price trend, it is seen that there is continuous increase in both gold futures and spot prices over the study period (see figure 3.1 and 3.2). The trend further shows that gold futures is following a smooth upward trend, while spot price of gold is following upward trend with spikes. By superimposing gold futures on spot trend (see figure 3.3), it is clearly observed that both gold futures and spot move in tandem over the study period. It is also understood from the figure that long run relationship does exist between spot and futures. The global recessionary impact has been reflected in the prices of gold. It is also quite clear that the gold futures prices are not negatively influenced by the cyclical factors such as financial uncertainty as gold is the safe haven for the investment and it restores positive sentiment during uncertainty. Due to crash in prices of equity, bond, forex and other forms of market at the time of recession, investors considered mostly gold investment opportunities and as a result, the demand for gold had increased. The upward demand pressure on gold has resulted in rise in prices of gold over the period. However, from this graphical presentation we cannot conclude whether spot follows futures or vice versa. Though graphical presentation of gold shows that both spot and futures have long run relationship yet they need to be tested empirically. To examine the process of price discovery in the gold market, the present study has applied econometric techniques in subsequent section.

The graphical representation of silver futures and spot price trend show continuous spikes in silver prices during study period (see figure 3.4 and 3.5). It reveals that both futures and spot trend upward with spikes during sample period. Further, price of silver fluctuates continuously over sample periods. Possible reasons may be the seasonal and cyclical variations that affect demand for silver. By superimposing silver futures on spot trend (see figure 3.6), it is clearly observed that both silver futures and spot move in tandem manner during the sample period. It is also found long run relation between spot and futures indicates the existence of price discovery process in the silver market. The financial crisis has also impacted prices of silver as price of silver came down during that period. Demand for silver is negatively influenced by the cyclical factors such as financial crisis, economic slowdown etc. Slow industrial growth might be the major reason for sluggish demand for silver during that period. Afterwards, demand for silver increases due to economic restoration. From the graphical analysis, it indicates the existence of long run relation between spot and futures of silver market but empirical analysis is necessary to confirm the relationship.

Figure 3.1 Gold Futures Price Trend

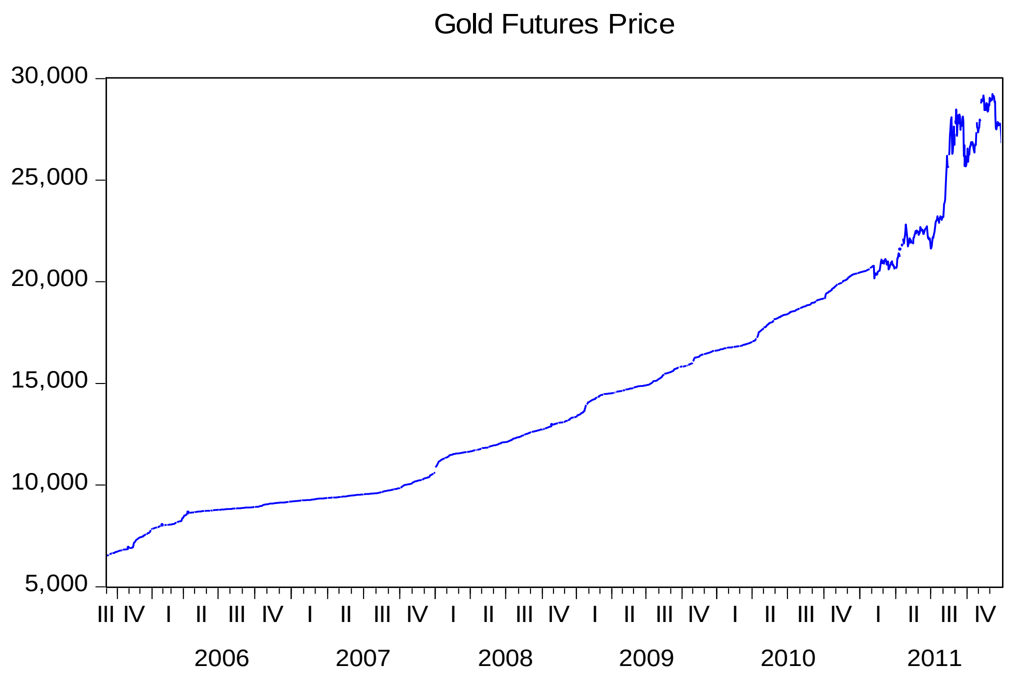
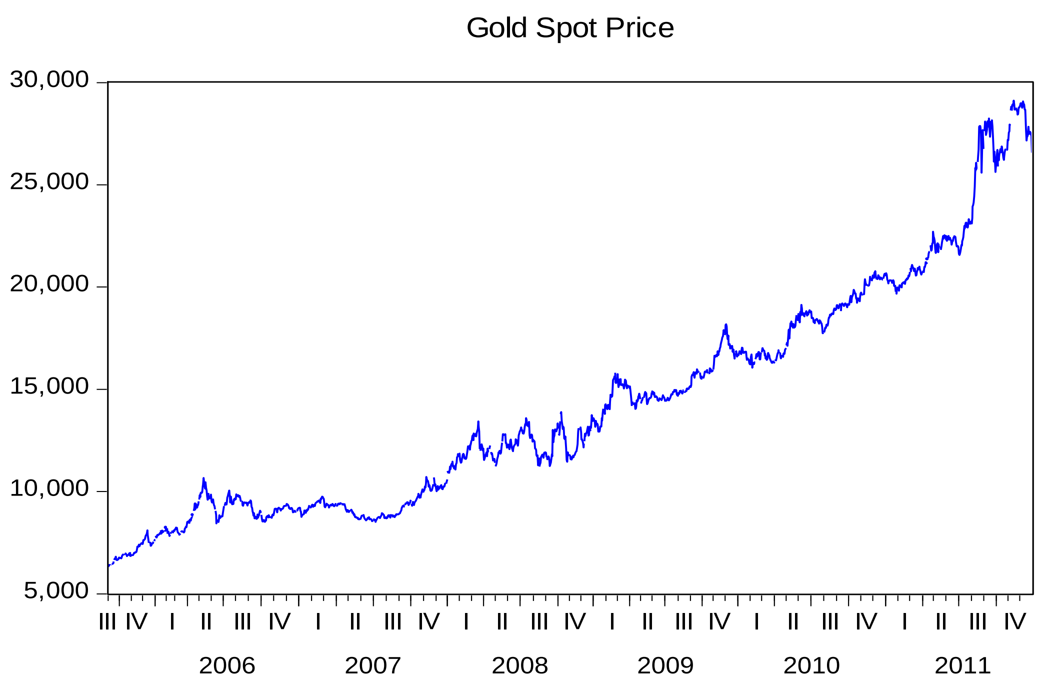


Figure 3.2 Gold Spot Price Trend



3.3 Gold Futures and Spot Trend

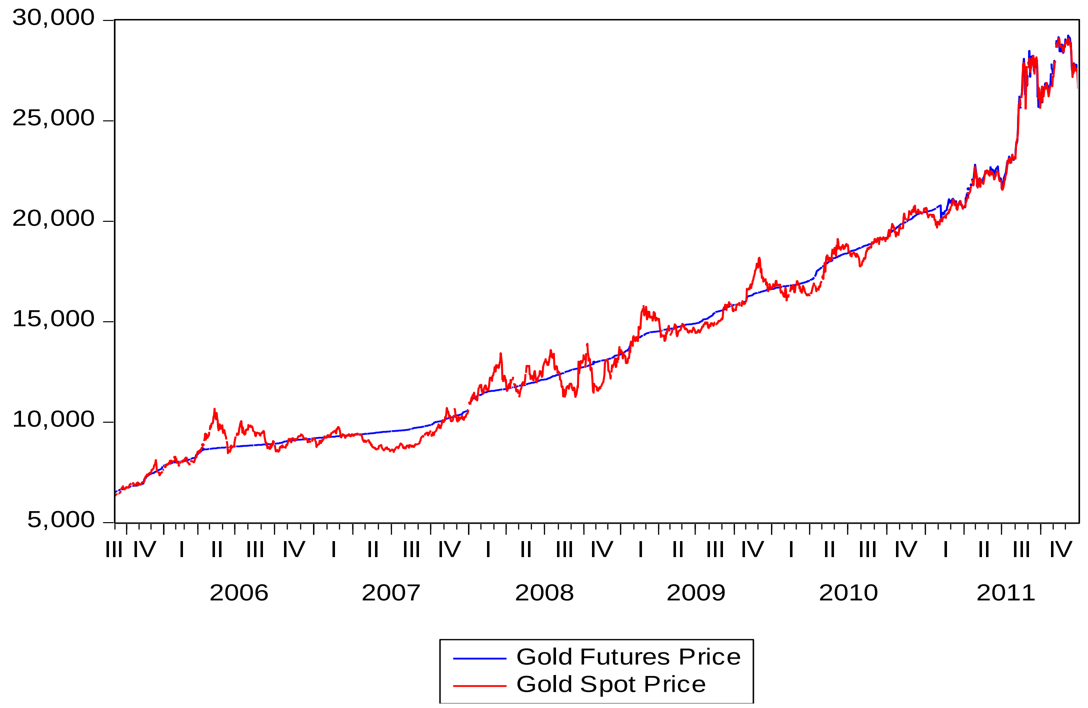


Figure 3.4 Silver Futures Price Trend

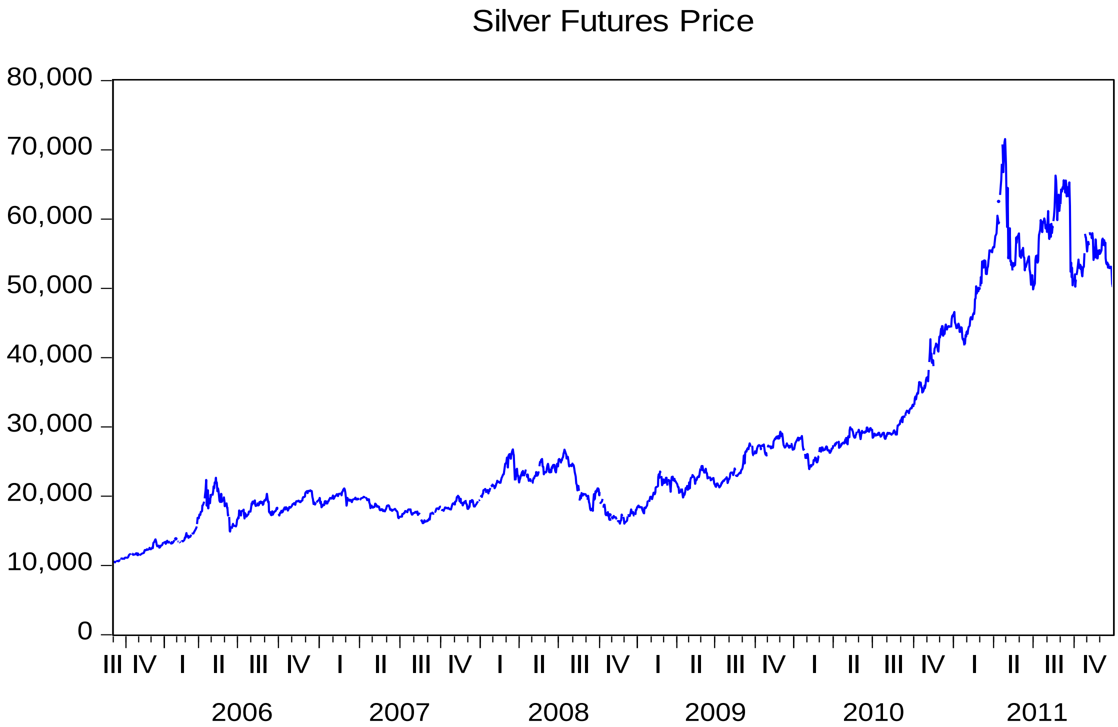


Figure 3.5 Silver Spot Price Trend

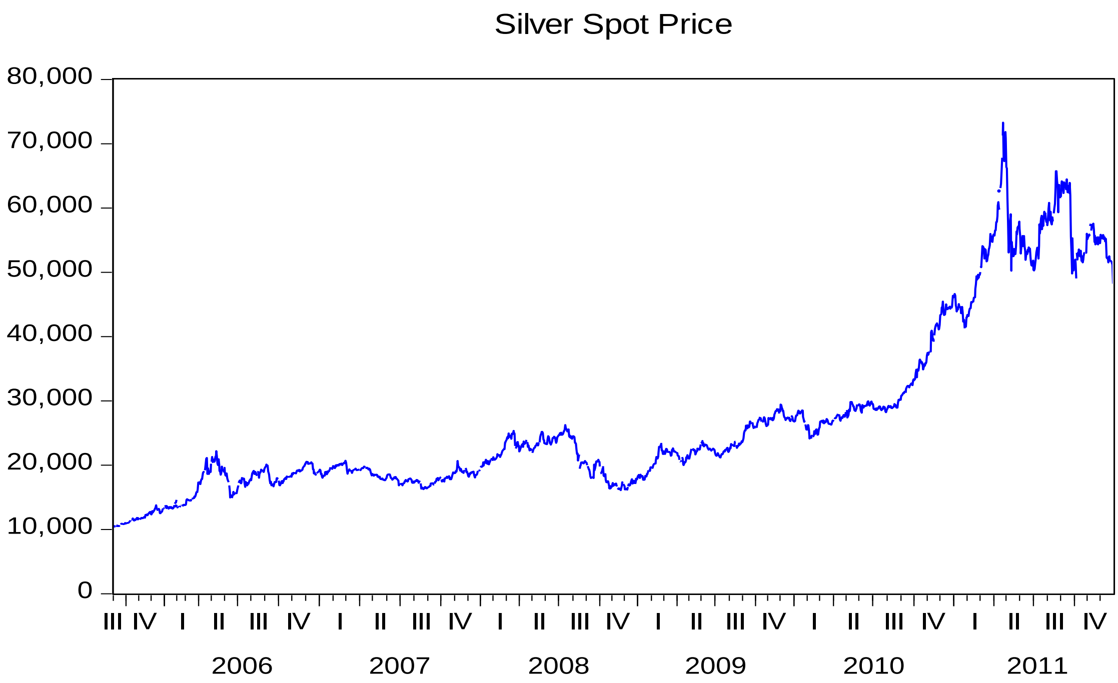


Figure 3.6 Silver Futures and Spot Price Trend

Copper futures and spot price trends are shown in the figures 3.7 and 3.8 respectively. It is seen from figures that copper futures price fluctuates more than the copper spot price during sample period. The global recessionary impact has been reflected in the prices of copper too. Copper futures and spot price are severely affected by the financial crisis due to sluggish industrial growth. By superimposing copper futures on spot trend (see figure 3.9), it is clearly observed that both copper futures and spot move in tandem manner over the study period. Both copper futures and spot show long run relationship during sample period and hence indicate price discovery in that market. Recovery of economy restored industrial growth on track, led copper demand to rise. Thereafter, copper demand reaches its peak then started falling due to sluggish industrial growth again. From graphical presentation, hardly can we draw any strong conclusion regarding price discovery in the cooper market. Therefore, copper market needs to be tested and justified empirically.

The schematic presentation of crude oil futures and spot price trends reveal that crude oil futures prices fluctuate more than the copper spot prices during sample period (see figure 3.10 and 3.11). By superimposing crude oil futures on spot trend (see figure 3.12), it is clearly observed that both crude oil futures and spot move in tandem manner over the study period. Their trend indicates the existence of long run relationship between futures and spot. The global recessionary impact has been reflected in the prices of crude oil too. It is also quite apparent that the crude oil futures price and spot prices are negatively influenced by financial crisis. During financial crisis, crude oil futures as well as spot prices fall significantly as demand weaken in that period. Afterwards, as a result of economic recovery, demand for crude oil increases. Similarly, crude oil spot price also highly fluctuates like crude oil futures price over the study period. However, from schematic presentation we cannot conclude whether spot follows futures or futures vice versa. Therefore, process of price discovery needs to be examined empirically.

The graphical representation of natural gas futures and spot price trends discloses that natural futures and spot prices fluctuate during sample period (see figure 3.13 and 3.14). By superimposing copper futures on spot trend (see figure 3.15), it is clearly observed that both natural futures and spot move in tandem manner over the study period. The global recessionary impact has been reflected in the prices of the natural gas too. It is also quite clear that the natural gas futures price and spot prices are negatively influenced by financial crisis. During financial crisis, natural gas futures as well as spot prices come down significantly as demand weakens. Due to recovery of Indian economy, natural gas demand increases early in 2010. In mid 2010, natural gas demand reaches its peak then started falling due to low investment sentiment. Natural gas prices are somehow consistent during sample period. However, from this schematic presentation also we cannot conclude that spot follows futures or vice versa. To examine the process of price discovery in the natural gas market, the present study has applied econometric techniques in subsequent section.

Figure 3.7 Copper Futures Price Trend

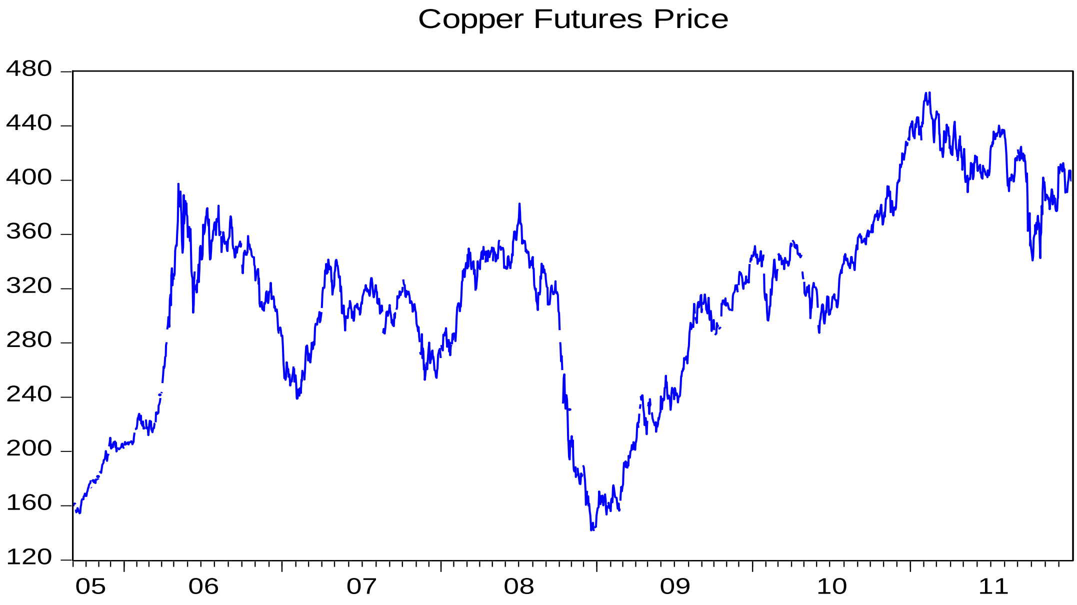


Figure 3.8 Copper Spot Price Trend

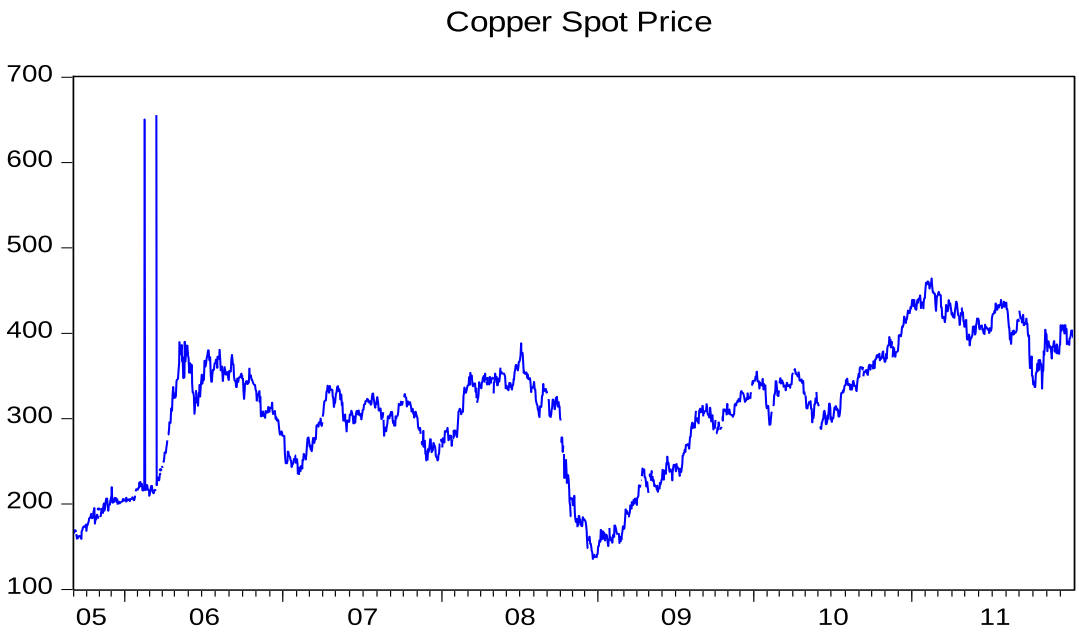


Figure 3.9 Copper Futures and Spot Trend

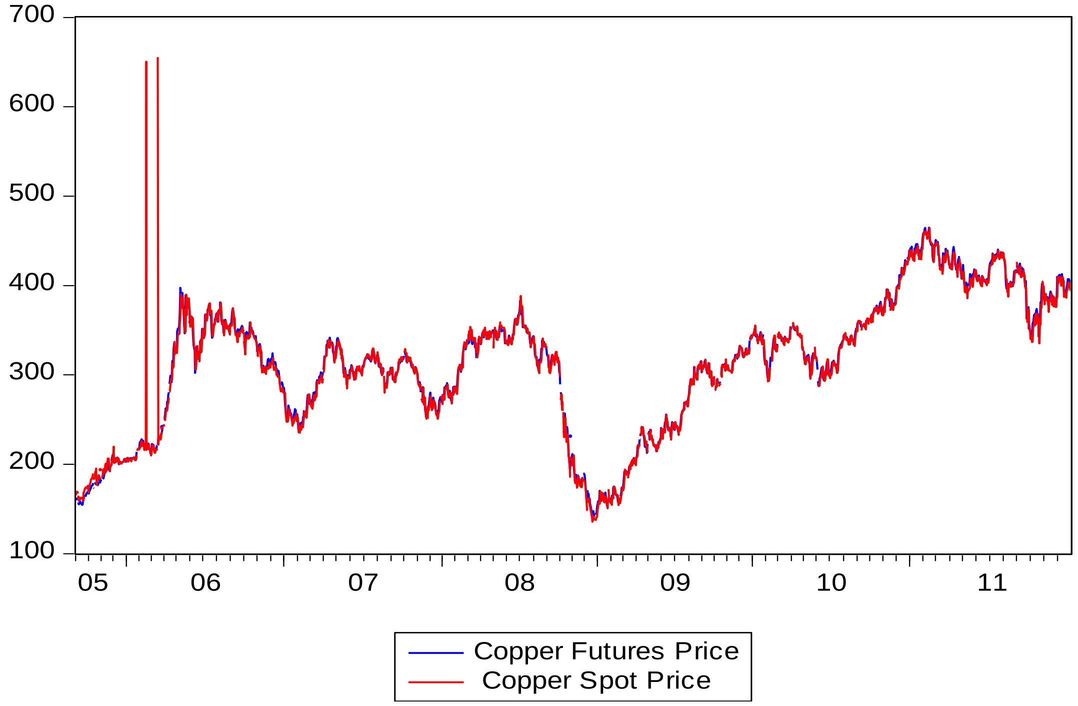


Figure 3.10 Crude Oil Futures Price Trend

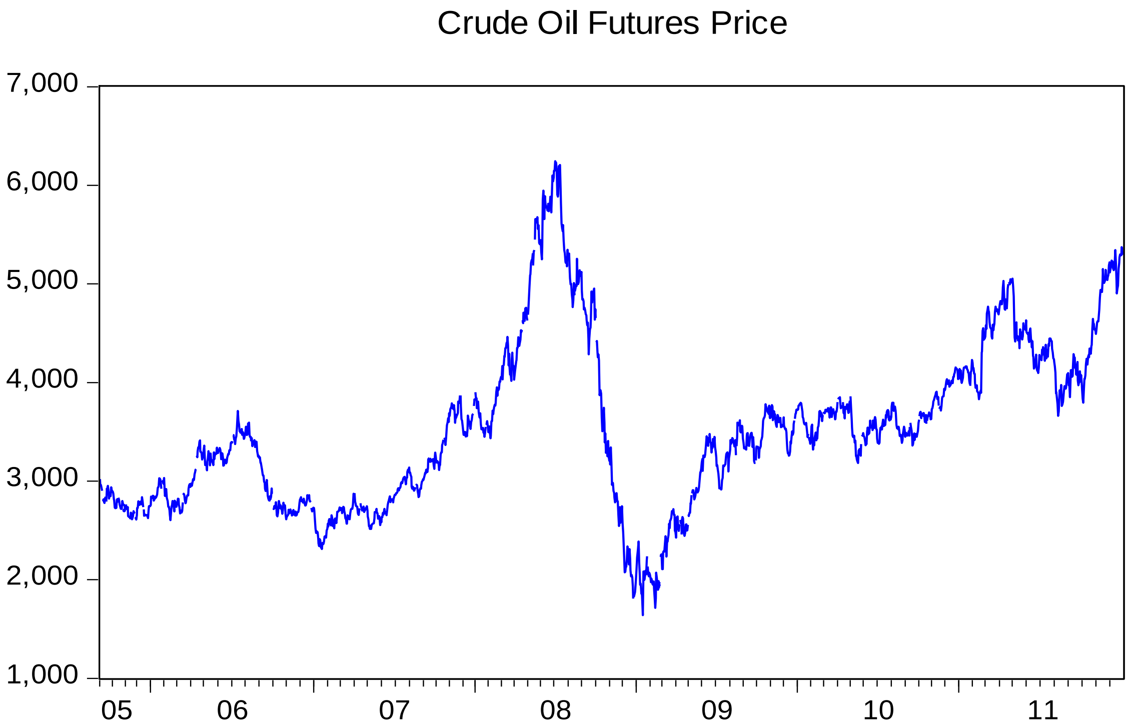


Figure 3.11 Crude Oil Spot Price Trend

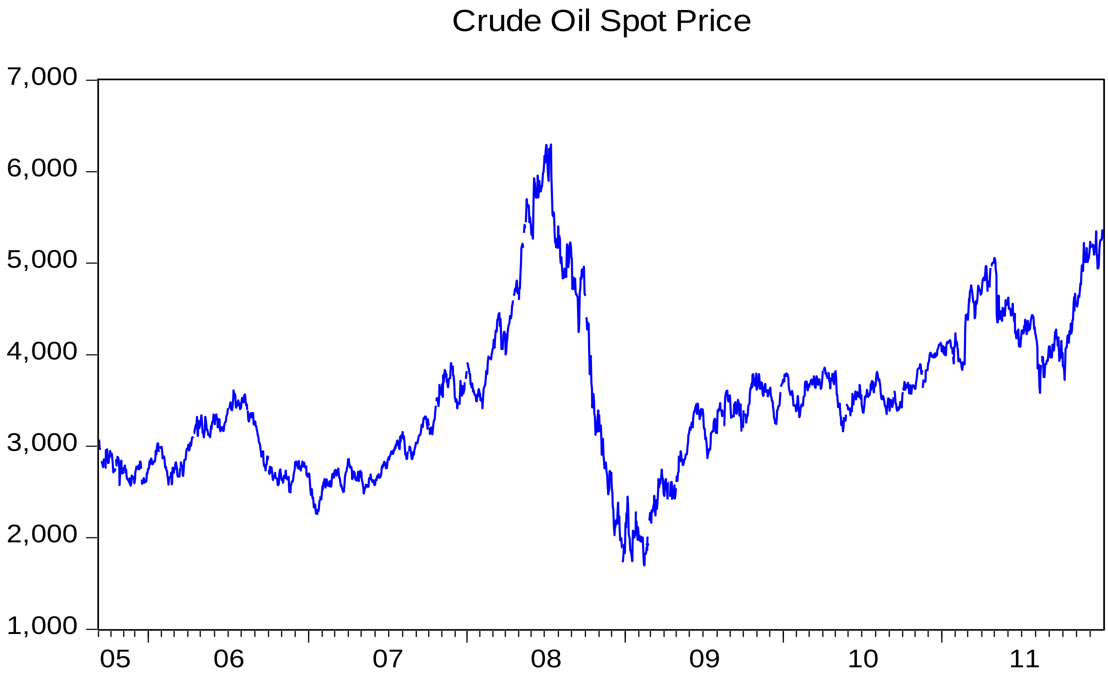


Figure 3.12 Crude Oil Futures and Spot Trend

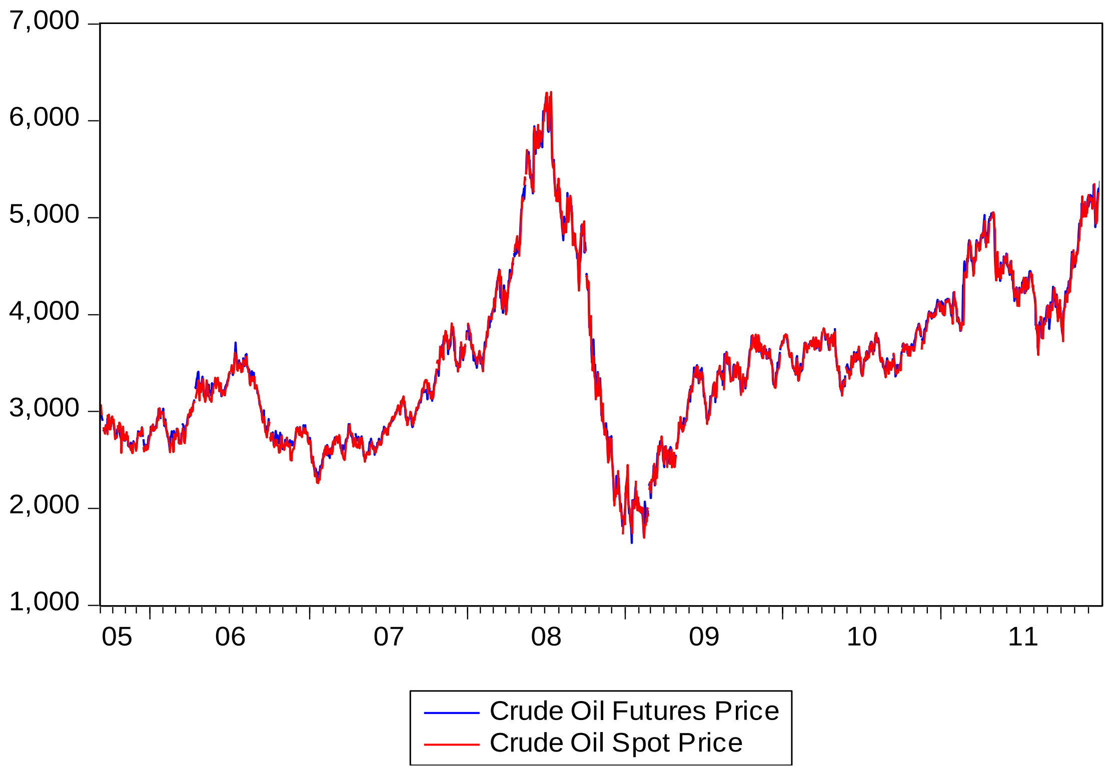


Figure 3.13 Natural Gas Futures Price Trend

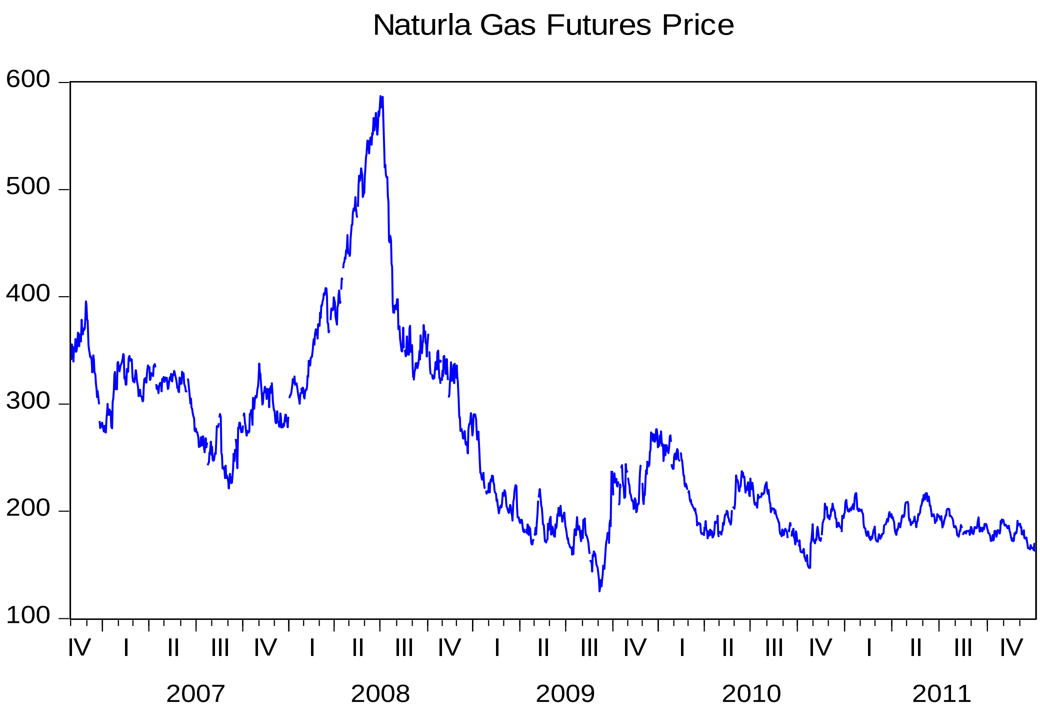


Figure 3.14 Natural Gas Spot Price Trend

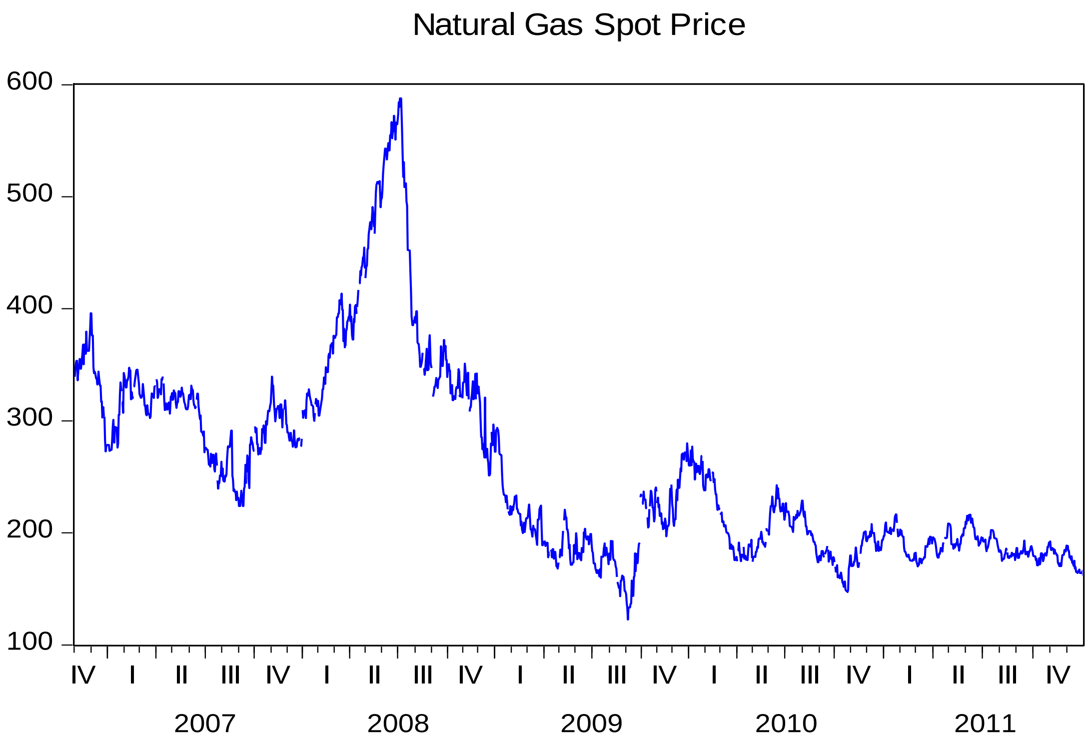
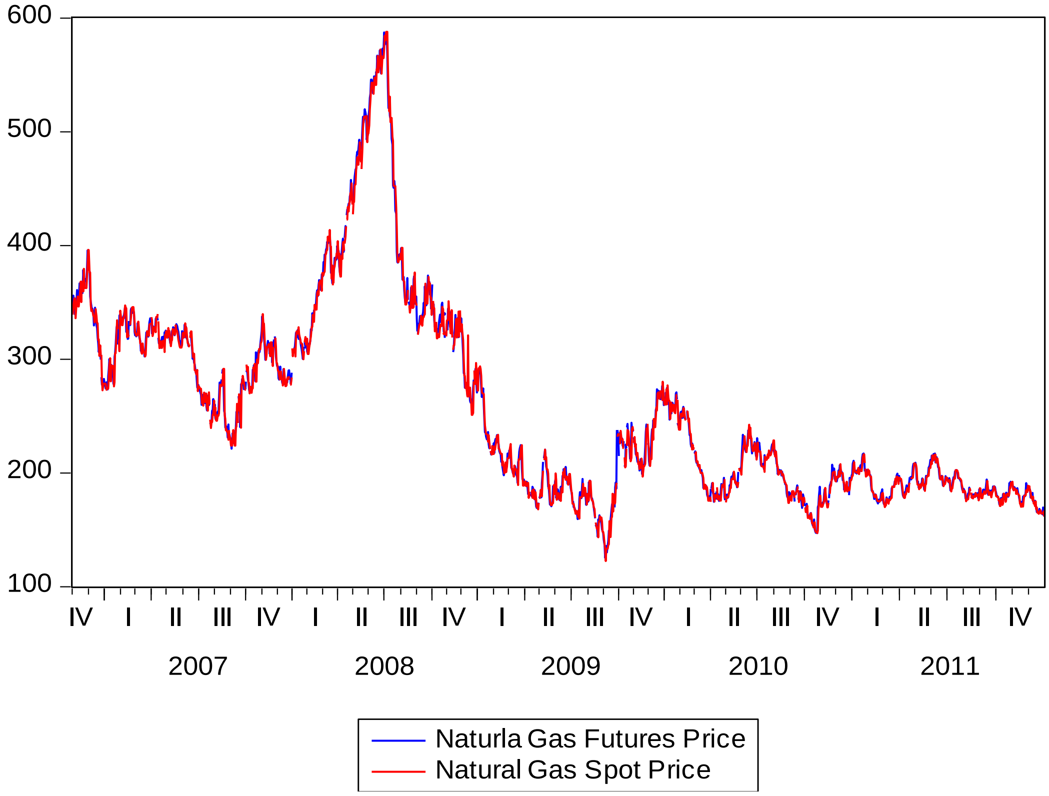


Figure 3.15 Natural Gas Futures and Spot trend



3.4 Nature and Sources of Data

It is already mentioned in the introduction chapter that this study has considered secondary sources of information for analysis, where data are collected from Multi Commodity Exchange (MCX). The study has made use of the data for different frequencies for empirical investigations. Due to non-availability of authentic information in certain cases the study has used the data for different time periods and frequencies.

In examining price discovery, daily spot and futures closing prices of gold, silver, copper, crude oil and natural gas are collected from MCX. Here we have considered closing price of commodities as it is believed that closing price incorporates all the information during the trading day. The commodities are chosen based on MCX's world ranking in terms of number of futures contracts traded in 2011, where silver stood 1st followed by gold, copper, natural gas and crude oil. The nearby futures price series of gold, silver, copper, crude oil and natural gas are taken for the analysis. The future series of the aforesaid commodities are constructed by taking into account the nearby futures contract (i.e. contract with the nearest active trading delivery month to the day of trading). The nearby futures contract is used because it is highly liquid and the most active. Daily futures and spot closing prices are taken from September 1, 2005 to December 30, 2011 for gold, silver, copper, and crude oil. Natural gas futures and spot closing prices are taken from November 1, 2006 to December 30, 2011 based on availability of data. Data period includes 38 gold futures contracts with 1872 observations, 32 silver futures contracts with 1876 observations, 31 copper futures contracts with 1893 observations, 76 crude oil futures contracts with 1894 observations and 62 natural gas futures contracts with 1554 observations. Futures contracts and observations differ from commodity to commodity as official allocation of contracts differs commodity wise, e.g., gold has six futures contracts per year where crude oil has 12 contracts per annum. The contracts size of commodity is decided by futures exchanges with the consultation of Forward Market Commission. All the observations are reported excluding Sundays and holidays. Furthermore, we have created data series in such a way that both spot and futures data are available in a given date. The data matching has been done for all the series taking into account of availability of the data both for futures and the spot in any given day. The non-availability of data either on spot or futures for any given day has been deleted from both the series.

3.5 Tools of Time Series Analysis

Before conducting the cointegration test, we have made an attempt to examine whether the individual spot and futures price series chosen under the study are non-stationary. We have deployed ADF and PP test to examine the nature of the futures and spot price series, whether these series are having unit root. Augmented Dickey-Fuller (ADF) test is conducted by "augmenting" the Dickey-Fuller equations by adding the lagged values of the dependent variable. So, the ADF test can be modelled as follows;

$$\Delta Y_t = \alpha_1 + \alpha_2 t + \delta Y_{t-1} + \sum_{i=1}^{m} \beta_i \Delta Y_{t-i} + \varepsilon_t \qquad (3.5.1)$$

Where ε_t is a pure white noise error term.

This test determines whether the estimates of δ are equal to zero or not. Fuller (1976) has provided cumulative distribution of the ADF statistics by showing that if the calculated value of the coefficient is less than the critical value from Fuller table, then Y is said to be stationary. In other words, strong negative numbers of unit root reject the null hypothesis of unit root at some level of confidence.

PP unit root model is the one of the models for the stationary. The ADF test adjusts the DF test to take care of possible serial correlation in the error terms by adding the lagged difference terms of the dependent variables. PP model uses non-parametric statistical methods to take care of the serial correlation and heteroskedasticity in the error terms. The regression model for the PP test is:

$$\Delta Y_t = \alpha'^{D_t} + \beta Y_{t-1} + \varepsilon_t \qquad (3.5.2)$$

In the equation (3.5.2), ε_t is *I(0)* and may be heteroskedastic. The PP test corrects any serial correlation and heteroskedasticity in the errors ε_t of the test regression directly modifying the test statistics.

It is widely accepted that price change in one market transgress into the other market. The price change may occur first at futures market and in turn influences the spot market and vice versa. This price change may continue to persist for a longer period of time, which could be due to other fundamental factors associated with the futures and spot market. To capture the long run equilibrium between futures and spot market the following equation can be written as a regression framework:

$$F_t = \alpha + \beta S_t + \varepsilon_t \qquad (3.5.3)$$

Where $F_t$and S_t are spot and futures price at time t. $\alpha \ and \ \beta$ are the intercept and coefficient terms. Equation (3.5.2) can be expressed in the residual as:

$$F_t - \alpha - \beta S_t = \hat{\varepsilon}_t \qquad (3.5.4)$$

Where $\hat{\varepsilon}_t$ is the estimated white noise disturbance term. Ordinary least squares (OLS) inappropriate if $F_t$and S_t are non-stationary because standard errors are not consistent. If F_t and S_t are non-stationary but the estimated disturbance term ($\hat{\varepsilon}_t$) is stationary then S_t and $F_t$are said to be cointegrated. That means they have a long run relationship or price discovery takes place in the market. If each series ($F_t and\ S_t$) is non-stationary in the level but the first difference (ΔF_t and ΔS_t) and deviation ($\hat{\varepsilon}_t$) are stationary, the series are said to be cointegrated of the order (1, 1) with β as a cointegrating parameter.

We have mentioned that if each series ($S_t \ and \ F_t$) is non-stationary at the level but the deviation $\hat{\varepsilon}_t$ is stationary then S_t and F_t are said to be cointegrated or they have long run equilibrium. But, in the short run there may be disequilibrium. Therefore, we can treat error term ($\hat{\varepsilon}_t$) as the equilibrium error. The error correction mechanism (ECM) states that if two variables F_t and S_t are cointegrated then the relationship can be expressed as ECM which includes last period's equilibrium error as well as lagged values of first difference of each variable. Therefore, temporal causality can be assessed by examining the statistical significance and relative magnitude of the error correction parameter and parameter of lagged variables. The error correction model is (Pizzi, Economopoulos and O'Neill, 1998; Wahab and Lashgari, 1993):

$$\Delta F_t = \delta_s + \alpha_s \hat{\varepsilon}_{t-1} + \beta_s \Delta S_{t-1} + \gamma_s \Delta F_{t-1} + e_{s,t} \qquad (3.5.5)$$

$$\Delta S_t = \delta_f + \alpha_f \hat{\varepsilon}_{t-1} + \beta_f \Delta F_{t-1} + \gamma_f \Delta S_{t-1} + e_{f,t} \qquad (3.5.6)$$

In the above two equations, the first part ($\hat{\varepsilon}_{t-1}$) is the equilibrium error. This measures how the left hand side variable adjusts to the previous period's deviation from long run equilibrium. The remaining portion of the equation is lagged first difference which represents the short run effect of previous period's change in the price on current period' s deviation. The parameter of the equilibrium error, α_s and α_f, is the speed of the adjustment parameter and have important implication in an error correction model. At least one speed of adjustment parameter must be non-zero for the model to be ECM. The parameter serves the role of identifying the direction of causal relation and shows the speed at which departure is corrected.

3.6 Empirical Analysis

All price series are found to be non-stationary with no tendency to revert back to an underlying trend value as they typically exhibit 'random walk' properties, i.e., today's prices cannot be used to predict future prices. However, differencing the data runs the disadvantage of losing information about underlying long run relationships between prices. Thus, the relationship and co-movement between the prices is examined in a co-integration framework in which linear combinations of non stationary variables could be identified.

ADF and PP test results for gold, silver, copper, crude oil and natural gas are reported in the table 3.1. The results of both ADF and PP test show that the null hypothesis (that all the series for gold, silver, copper, crude oil and natural gas are non-stationary $H_0 : \beta\iota=0$) can not be rejected either at 1 percent significance level. Therefore, the spot and futures prices are non-stationary in the levels model. This non-stationarity raises the possibility of spurious regressions in the levels model and requires a test for stationarity at the difference level.

The results of applied ADF and PP tests to the first-order difference of the sample spot and futures series of gold, silver, copper, crude oil and natural gas are also reported thereof in the table 3.1. It is apparent that the hypothesis that the first-order differences of the prices are rejected significantly across the commodities under the study, and therefore, all the first differences series are stationary at 1 percent level of significance. Thus, all the prices are integrated of the first order; *I(1)*. This implies that the levels of all the five spot price and futures prices series show similar temporal properties. However, whether the levels of the spot price and futures prices are statistically linked over the long run has to be examined by the cointegration test.

Table 3.1 Stationary Test for Commmodities				
Variable	ADF		PP	
	Level	1st Difference	Level	1st Difference
Gold Futures	1.354	-11.167*	1.646	-44.684*
Gold Spot	0.572	-43.751*	0.647	-43.78*
Silver Futures	-0.623	-46.98*	-0.688	-46.86*
Silver Spot	-0.785	-44.85*	-0.73	-44.85*
Copper Futures	-2.021	-44.74*	-2.006	-44.74*
Copper Spot	2.209	-8.916*	-2.329	-10.13*
Crude Oil Futures	-1.168	-43.157*	-1.175	-43.157*
Crude Oil Spot	-1.382	-45.415*	-1.27	-45.454*
Natural Gas Futures	-1.541	-40.09*	-1.514	-40.102*
Natural Gas Spot	-1.571	-43.27*	-1.575	-43.22*

*Note: * indicates 1 percent level of significance*

Engle-Granger cointegration technique is applied to examine price discovery process in the metal and energy market. Price discovery can be accessed by close relationship between spot and futures in the long run. Cointegration technique is used to check long run equilibrium relationship between spot and futures. Once the long run relationship is established then it can be concluded that price discovery does exist in the commodity market.

Engle-Granger Cointegration

In Engle-Granger cointegration model, rgression has been performed between spot and futures for all the commodities under study separately. From the regression results, we have calculated residual values for the commodities. Then, ADF and PP tests are applied to the resudial values for stationary check. As per theory, if residual values are stationary in the level, then it can be said, long run equilirbrum relationship exists between spot and futures, and hence price discovery takes place in that market. On the contrary, if residual values are not stationary in the level, then it can be said, long run equilibrium relationship does not exist and hence price discovery does not take place in that market.

Table 3.2 Regression Results for Commodities

Variable	Coefficient	Values
Gold	α	74.161 (2.35)
	β	0.992 (485.24)
	R^2	0.99
Silver	α	55.016 (1.80)
	β	0.99 (987.18)
	R^2	0.99
Copper	α	4.37 (2.84)
	β	0.98 (205.32)
	R^2	0.95
Crude Oil	α	-25.45 (-4.10)
	β	1.004 (586.46)
	R^2	0.99
Natural Gas	α	0.185 (0.33)

	$\boldsymbol{\beta}$	0.99 (484.9)
	$\boldsymbol{R^2}$	0.99

Note: Figures in parenthesis are t-statistics value

Regression results are reported in the table 3.2 for the commodities under study. As it is already mentioned that all the variables are non-stationary in the level, therfore regression results are likely to be spurious in nature. However, our major focus is to check stationarity of residual values of commodities drawn from the regression results.

ADF and PP tests are applied to the residual values for stationarity. These results are reported in the table 3.3. It is observed from the ADF and PP test results that residual values for gold is stationary in the level which indicate gold futures and spot are cointegrated. In other words, futures and spot have long run equilibrium relationship, i.e. price discovery does exist in the Indian gold market. Similary, residual values of other commodities such as silver, copper, crude oil and natural gas are also stationary in the level. Therefore, both futures and spot in these markets are cointgrated. Hence, price discovery does also exist in the above mentioned commodities markets.

Table 3.3 Stationary Test Results for the Residual		
Variable	**ADF**	**PP**
	Level	**Level**
Gold	-5.864*	-7.448*
Silver	-12.46*	-41.46*
Copper	-5.57*	-43.33*
Crude Oil	-26.167*	-38.54*
Natural Gas	-39.88*	-48.29*

Note: indicates 1% level of significance*

Error correction results for gold, silver, copper, crude oil and natural gas are reported in the table 3.4. In the parenthesis t-statistic values are reported. For the digonistic checking, we have used Ljung Box Q statistics for first order serial correlation. The empirical reuslts say Ljung Box Q statistics are siginficant at the 5 percent level of significance as it is well below its critical value of 3.84. The results for the error correction model are consistent with and support the results for cointegration. At least one error correction coefficient is significant in all cases where Engler-Granger technique indicates the presence of a cointegration vector. If coefficient α_s is always significant indicating that causality exists from futures to spot for all the commodities under study. In other words, price discovery occurs in futures market for all commodities. Price discovery occurs additionally in the spot market if β_f is significant. The magnitude of β_s is at least twice that of β_f indicating stronger feedback from futures to spot market for all commodities under study.

The error correction results indicate that there is unidierctional causality from futures to spot. Price discovery occurs in the futures market then transgress to spot market for all commodities under study.

Table 3.4 Error Correction Results for the Commodities

Equations	**Coefficients**	**Gold**	**Silver**	**Copper**	**Crude Oil**	**Natural Gas**
Futures	δ_f	11.586* (4.32)	21.73 (1.35)	0.131 (1.05)	1.159 (0.74)	-0.119 (-0.66)
	α_f	0.001 (-0.11)	-0.203* (-5.46)	0.01 (0.86)	0.082** (2.26)	0.057 (0.99)
	β_f	0.004 (0.26)	-0.028 (-1.0)	0.00 (0.01)	0.005 (0.21)	0.015 (0.61)
	γ_f	-0.041 (-1.69)	0.026 (0.801)	-0.02 (-0.79)	0.059 (1.67)	0.033 (0.57)
Ljung Box Q	Q(1)	0.003	0.008	0.0002	0.0008	0.001
Spot	δ_s	6.47 (1.75)	17.48 (1.37)	0.11 (0.35)	0.896 (0.73)	-0.111 (-1.27)
	α_s	-0.04* (-5.22)	-0.454* (-15.28)	-0.967* (-30.7)	-0.004* (-21.06)	-0.938* (-33.06)
	β_s	0.52* (15.61)	0.262* (9.71)	-0.061 (-0.906)	0.283* (10.07)	0.051 (1.80)
	γ_s	-0.103* (-4.55)	-0.088* (-3.83)	-0.01 (-0.506)	-0.056* (-2.85)	0.031 (1.09)
Ljung Box Q	Q(1)	0.27	1.001	0.0003	0.78	0.001

*Note: Figure in parenthesis is t-statistic values, and * & ** indicate 1 percent and 5 percent level of significance respectivley.*

3.7 Price Volatility

In an efficient market, day- to-day variation in spot and futures prices are purely a result of new information that is ariving in the market. For storable commodities, in the efficient market, the extent of variation in both spot and futures markets should be similar. If the spot market is efficient, the relative magnitude of variation in prices can help assess whether the futures market is able to incorpoarte information efficiently.

The study has analysed the ratio of standard deviations of futures and spot prices on a monthly basis to assess the futures market's perpformance. Assuming cost of carry in the month is negligible, A ratio of standard deviation of future and spot prices that is closer to one indicates that futures market is efficient, viz., markets are incorporating all the information efficiently, A ratio grater than one close to the maturity period indicates speculative activities. Conversely, a ratio less than one shows that markets are not able to incorporate the information fully and efficiently. For the sake of interpretation, a cut-off has been assumed at 0.7 and 1.3 as the lower and upper levels to provide indication of extent of variabilty in the spot and futures markets. This assumption is on the same lines as adopted in the previous study (Naik and Jain, 2002).

In case of gold, the ratio were less than 0.7 (see table 3.5) in most of the casses suggesting that futures price variablity is substantially less than the spot price variablity. As mentioned earlier, this pattern is an indication of inefficient utilisation of information in the market. However, in 2011, ratio were close to one in all contracts except February indicates the efficient utilisation of information in the gold market.

Table : 3.5 Ratio of Standard Deviation of Futures Price to that of Spot Price for Gold								
Year	February	April	June	August	October	December	Percent times the ratio was (PTR)	
							<0.7	>1.3
2006	0.73	0.76	0.10	0.06	0.07	0.25	50	0
2007	0.28	0.25	0.13	0.31	0.26	0.35	100	0
2008	0.67	0.12	0.20	0.29	0.17	0.17	100	0
2009	0.59	0.28	0.34	0.82	0.40	0.28	83.33	0
2010	0.29	0.40	0.44	0.45	0.44	0.59	100	0
2011	0.55	0.79	0.89	0.88	1.02	0.91	16.66	0
<0.7(%)	83.33	66.66	83.3	66.66	83.33	83.33		
>1.3(%)	0	0	0		0			

Ratio of standard deviation of futures price to that of spot price for silver is reported in the table 3.6. In most of the cases, ratio for silver were close to one, indicates silver futures prices are able to incorporate information efficiently.

Table 3.6 Ratio of Standard Deviation of Futures Price to that of Spot Price for Silver							
Year	March	May	July	September	December	the percent time ratio	
						<0.7	>1.3
2006	0.86	1.08	1.07	0.90	0.91	0	0
2007	1.04	1.29	1.18	1.22	0.80	0	0
2008	1.10	1.58	1.13	1.10	1.05	0	20
2009	0.43	0.99	1.97	0.91	0.88	20	20
2010	1.00	0.99	0.94	1.08	1.01	0	0
2011	1.01	0.95	0.97	0.90	1.08	0	0
<0.7(%)	20	0	0	0			
>1.3(%)	0	20	20	0			

In case of copper, the ratio of standard deviation of futures to spot is reported in the table 3.7. The resutls show that the ratio of standard deviation of futures to spot were close to one in most of the cases, indicate copper futures prices incorporate information effciently.

Table 3.7 Ratio of Standard Deviation of Futures Price to that of Spot Price for copper

Year	February	April	June	August	November	the percent times the ratio was	
						<0.7	>1.3
2006	0.14	0.54	1.04	0.96	0.98	20	0
2007	1.018	0.94	1.00	0.90	0.92	0	0
2008	0.97	0.99	0.97	0.90	0.95	0	0
2009	0.87	0.94	0.98	0.97	0.96	0	0
2010	0.95	0.95	0.91	0.91	1.04	0	0
2011	0.94	1.03	0.89	1.01	0.95	0	0
<0.7(%)	20	20	0	0	0		
>1.3(%)	0	0	0	0	0		

Ratio of standard deviation of futures price to that of spot price for crude oil is reported in the table 3.8. In most of the cases, ratio for crude oil were close to one, indicate crude oil futures prices are able to incorporate information efficiently.

Table 3.8 Ratio of Standard Deviation of Futures Price to Spot Price for Crude Oil

Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	PTR	
													<0.7(%)	>1.3(%)
2007	1.04	0.77	0.86	0.65	1.23	1.06	0.83	0.83	1.04	0.92	1.08	0.84	8.33	0
2008	0.98	1.09	1.03	1.03	1.06	1.04	0.98	0.94	1.16	1.00	0.91	1.08	0	0
2009	1.02	0.85	0.85	0.85	0.88	0.96	1.01	0.84	0.82	0.87	1.07	0.94	0	0
2010	0.84	1.07	0.81	0.97	1.05	0.88	1.07	1.04	0.90	0.89	0.94	0.84	0	0
2011	0.92	1.13	0.61	0.94	0.98	1.13	0.95	1.01	0.92	0.97	0.95	1.02	8.33	0
<0.7(%)	0	0	20	20	0	0	0	0	0	0	0	0		0
>1.3(%)	0	0	0	0	0	0	0	0	0	0	0	0		

In case of natural gas, ratio of standard deviation of futures to spot is reported in the table 3.9. The resutls show that ratio of standard deviation of futures to spot were close to one in most of the cases, indicate natural gas futures prices incorporate information effciently.

Table 3.9 Ratio of Standard Deviation of Futures Price Spot Price for Natural Gas

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	PTR	
													<0.7	>1.3
2007	0.90	0.91	0.97	0.88	0.68	1.13	0.99	0.97	0.92	0.59	0.75	1.08	16.6	0
2008	0.87	1.14	0.96	0.93	1.00	0.94	1.13	0.92	0.93	0.94	0.95	0.99	0	0
2009	1.02	1.20	0.88	1.01	0.99	0.95	0.99	1.09	1.03	0.85	1.07	0.96	0	0
2010	0.90	1.06	1.04	0.94	1.03	0.86	1.02	1.03	1.09	1.06	0.82	1.14	0	0
2011	0.88	1.04	0.97	0.97	0.98	1.03	0.91	0.84	0.96	0.98	0.95	1.04	0	0
<0.7(%)	0	0	20	20	20	0	0	0	0	20	0	0		0
>1.3(%)	0	0	0	0	0	0	0	0	0	0	0	0		

3.7 Conclusion

Using a novel and comprehensive dataset of MCX India daily data, this chapter provides systematic study of price discovery process in the spot and future commodities market of India. This chapter investigated whether spot and futures commodities price are cointegrated or not. The daily closing price series of the commodities under the study are cointegrated and therefore both futures and spot series exhibit a stable long-run equilibrium relationship. The error correction results indicate the futures and spot are cointegrated which support long run relationship. This evidence appears to suggest that more information flows from the futures to the spot market. In other words, price discovery takes place in the futures market first and transgress into the spot market in the commodities under study. In examining price volatility, we find that gold market does not incorporate information efficiently. On the contrary, silver, copper, crude oil and natural gas incorporate information efficiently.

CHAPTER 4

Macroeconomic Dynamics of Indian Commodity Futures Market

4.1 Introduction

Macroeconomic fundamentals, apart from the commodity specific factors drive a permanent shift in price of the commodities. The political, economic, social and technological macroeconomic environments exert pressure on commodity prices. A coordinated policy effort that facilitates optimal level of production, distribution and consumption of commodities may stabilise the commodity market. However, the dynamism in internal and external macro environments adds up to the market uncertainties as a result markets in general and commodity market in particular runs into price instability, price spillover and price asymmetry. The contagion effect is also widely felt in the commodity market. The increase in energy price or metal price will not only reshape energy markets but non-energy and non-metal markets as well. There are numerous channels through which energy and metal prices affect other commodities production and distribution. On the supply side, energy and metal enters the aggregate production function of most of the primary commodities. To avoid the price instability many a times responsive government resort to policy tools like rationing of the commodity prices, setting price floor, price ceiling to achieve the socio-economic objectives. The changes in the real market, monetary market, bond market, credit market and stock market are also responsible for commodity market movement, instability and volatility.

Time series econometrics literature has documented some specific attributes with regard to the time series data. However, all these features may not be applicable to each and every series. These attributes are namely, unit root property of asset prices, fat tail phenomenon, volatility clustering, volatility spillover etc. Volatility measures the state of instability in any market. Commodity futures market also experiences the volatility. The degree of volatility varies over time and tends to clusters in periods of large volatility and dampens at the periods of tranquillity which is termed as heteroskedasticity in econometric terminology. The volatility is seen to be autocorrelated, where today's volatility depends on that of the previous period volatility. The possible factors of high volatility may be due to supply and demand conditions, speculative trade, weather events, international price pressure, regulatory practices and the government policy changes. Higher volatility may induce investors to increase trading in futures because futures contracts constitute a convenient means to adjust their investment positions (Chen, Cuny and Haugen, 1995)[38]. 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 futures market volatility can be used as a leading indicator of spot market volatility. This suggests that futures market volatility can be used to forecast changes in spot market volatility based on readily available low-cost historical information (Bhattacharya, Ramjee and Balasubramani, 1986)[39]. The nature of flow of information to the market also attributes towards the differential degree of market volatility. The bad information leads volatility to rise in market than good information of similar magnitude which in turn named as asymmetric volatility (Black, 1976)[40]. Hence, the measurement and forecasting of asymmetric volatility is essential for investors as well as policy makers in their decision making process.

[38] Chen, N.F., Cuny, C. J., & Haugen, R. A. (1995): 'Stock Volatility and the Levels of the Basis and Open Interest in Futures Contracts', *Journal of Finance*, Vol. 50, pp. 281–300.

[39] Bhattacharya, A. K., Ramjee, A. and Ramjee, B. (1986): 'The Causal Relationship between Futures Price Volatility and the Cash Price Volatility of GNMA Securities' *The of Futures Markets,* Vol. 6, pp.29-39.

[40] Black, F. (1976), Published (1986) 'Noise', *Journal of Finance*, Vol. 41, pp.529-43.

The persistence of price over a longer period of time is seen to have been one of the features of the commodity futures market. This feature in technical econometric jargon is termed as long memory process. In a common parlance, long memory means a spell of high volatility followed by another spell of high volatility, where the price persistence can be realised over a long stretch of time. Conducting analysis on return series the study in the context of commodity futures market revealed that the return series is in possession of long memory (Helms, Kaen, and Rosenman, 1984)[41]. Understanding of the long memory process in the commodity futures market context is utmost important, since during periods of high volatility the risk of an investment increases dramatically – the investor may win or lose large amount of money if one trades commodities over that period. Ferrettti and Gilbert (2008)[42] find that spot, three-month aluminium and copper volatilities follow long memory process.

It is widely accepted that volatilities move together more or less closely over time across the assets or markets. Even there has been evidence that shocks of one market affect other market which is called spillover effect. In that case, uni-variate analysis may not be useful for the investors as well as policy makers. Baillie and Mayers (1991)[43] examine six different commodities using daily data over two futures contract and they find spillover impact among the commodities.

[41] Helms, B. P., Kaen, F. R. and Rosenman, R. E. (1984) ‘Memory in commodity futures contracts’, *The Journal of Futures Markets* , Vol. 4, pp.559–567.
[42] Ferretti, F. I. and Gilbert, L. C. (2008): ‘Commonality in the LME Aluminum and Copper Volatility Processes Through A FIGARCH Lens’, *The Journal of Futures Markets,* Vol. 28, pp.935-962.
[43] Baillie, R. T. and Myers, R. J. (1991): ‘Bivariate Garch Estimation of Opitmal Futures Hedged’, *Journal of Applied Econometrics,* Vol.6, pp. 109-124.

This chapter has made attempts to examine the Indian commodity future market dynamics in the context of metal and energy in India. Specifically, the study has examined the following macroeconomic dynamic behaviour of the futures commodity market:

(i) presence of volatility and volatility clustering in the commodity futures market,

(ii) prevalence of asymmetric behaviour in the commodity futures market,

(iii) persistence of long memory in the commodity futures market and

(iv) emergence of volatility spillover effect of futures commodity market on spot market

The rest of the chapter would deal with the nature and sources of the data, graphical presentation of return series of commodities under the study, time series econometrics tools used, examination of volatility clustering, volatility asymmetry, long memory process and volatility spillover for the chosen commodities.

4.2 Nature and Sources of data

The study has resorted to the secondary sources of information, which has been drawn from Multi Commodity Exchange (MCX). The study has made use of the data for different frequencies for empirical investigations. Due to non-availability of authentic information in certain cases, the study has used the data for different time periods and frequencies.

In examining macroeconomic dynamics, daily spot and futures closing prices of gold, silver, copper, crude oil and natural gas are collected from MCX. Here we have considered closing price of commodities as it is believed that closing prices incorporate all the information during the trading day. The commodities are chosen based on MCX's world ranking in terms of number of futures contracts traded in 2011, where silver stood 1st followed by gold, copper, natural gas and crude oil.

The nearby futures price series of gold, silver, copper, crude oil and natural gas are taken for the analysis. The future series of the aforesaid commodities are constructed by taking into account the nearby futures contract (i.e. contract with the nearest active trading delivery month to the day of trading). The nearby futures contract is used because it is highly liquid and the most active. Daily futures and spot closing prices are taken from September 1, 2005 to December 30, 2011 for gold, silver, copper, and crude oil. Natural gas futures and spot closing prices are taken from November 1, 2006 to December 30, 2011 based on availability. The reasons for choosing close price for the analysis emanates from the fact that the day wise information shocks are mostly reflected in the closing price. Data period includes 38 gold futures contracts with 1872 observations, 32 silver futures contracts with 1876 observations, 31 copper futures contracts with 1893 observations, 76 crude oil futures contracts with 1894 observations and 62 natural gas futures contracts with 1554 observations. Futures contracts and observations differ from commodity to commodity as official allocation of contracts differs commodity wise, e.g., gold has six futures contracts per year where as crude oil has 12 contracts per year. The commodity contract over a specific time frame does not remain the same for all the commodities due to the time differential contract design of the commodity exchange. All the observations are reported excluding Sundays and holidays. Furthermore, the study has created data series in such a way that both spot and futures data are available in a given date. The data matching has been done for all the series taking into account availability of the data both for futures and the spot in any given day. The non-availability of data either on spot or futures for any given day have been deleted from both the series. Commodities prices are transferred into the continuous log return i.e., $\log\left(\frac{R_t}{R_{t-1}}\right)$.

In examining the macroeconomic dynamics of futures market in India, five commodities spanning across 3 metals (Gold, Silver and Copper) and 2 energy (Crude oil and Natural gas) commodities have been taken into account. This examination of macroeconomic dynamics of futures commodity market is carried out at two different levels i.e., graphical analysis and econometric investigation.

4.3 Graphical Analysis

The gold futures and spot return series reveal that the gold futures return is lesser volatile than gold spot return during the study period (see figure 4.1 and 4.2). The degree of volatility for the gold return series is seen to have been fluctuating over the time. The higher is the level of volatility the riskier is the investment in the market. Further, it is affirmed that volatilities remain high for a certain period of time and remain low for another stretch of time, which perhaps indicates the volatility clustering behaviour of the series. To ascertain such behaviour of the series, there is a need for robust econometric examination, which has been attempted in the subsequent section.

The volatility of commodity returns generally exhibits an asymmetric reaction to positive and negative shocks. Economic explanations for this phenomenon are leverage and a volatility feedback effect. This sub-section of the present chapter studies the volatility asymmetric behaviour of the five commodities under consideration. The graphical presentations of gold and silver price series reveal that the persistent increase in gold and silver prices over the years. The sudden increase in prices of precious metal went up around the global financial crisis, due to the greater investment demand. The intensity of volatilities is found to be very high in gold spot price as compared to the futures prices during the study period (see figure 4.1, 4.2, 4.3 and 4.4). While the intensity of silver price volatility is observed to be high in the futures market as compared to the spot market. It could be attributed to the low industrial demand owing to decreasing economic activity due to the recession. Slow recovery of the US economy, Euro zones' sovereign debt crisis and sustained economic growth across the major emerging economies has kept retaining the investment demand for gold high. The study uses different econometric techniques to analyse above mentioned issues empirically.

However, the copper futures price and spot price during the study period are found to be highly instable but the degree of instability is more prominent in former series. The period of global financial crisis has pulled down both futures and spot copper price series to their lowest ebb which could be due to the lack of industrial demand owing to worldwide recession (see figure 3.7 and figure 3.8). However, the examination of log return series of copper futures and spot affirms that the intensity of volatilities is found to be very high in copper futures price as compared to the spot price during the study period. The degree of high volatility to the copper future return series could be attributable to the global financial crisis (figure 4.5 and Figure 4.6). To ascertain such behaviour of the series, there is a need for robust econometric examination, which has been attempted in the following section.

The crude oil price series both for futures and spot are found to be highly instable and it is clearly visible that the crude oil price series follows the path of business cycle. The higher is the level of economic activity the greater is the demand for crude oil, and as a result, price of crude oil triggers ahead and vice versa. The degree of economic prosperity is directly linked up with the crude oil prices in the world. The degree of volatility for the crude oil return series is seen to have been fluctuating over the time. The higher is the level of volatility riskier is the investment in the market. Further, it is affirmed that volatilities remains high for a certain period of time and remains low for another stretch of time, which perhaps indicates the volatility clustering behaviour of the series(see figure 4.7 and 4.8). The crude oil prices have attended its lowest level at the time of 2008 economic crisis. Further the Euro zone crisis has also exerted impact on crude oil futures and spot prices but the impact of global financial crisis has brought down the crude oil futures and spot series towards their respective lowest price floor. Slow global economy recovery and on set of Euro zones sovereign debt crisis and slow down of economic growth in major emerging economies like India and China have kept putting pressure on oil futures and spot prices. To ascertain such behaviour of the series, the study uses econometric techniques in the next section.

However, the examination of natural gas futures and spot price data are found to be highly instable and volatile in nature. During the global financial crisis the natural gas price have attended their peaks. The period other than the crises, where natural gas price series have shown their downward price spiral (see figure 3. 13 and 3.14).   The natural gas series both for future and spot show peculiar behaviour and follow a price reversal with the level of economic activities. This could be due to the fact that the availability of natural gas and the new natural gas site discoveries, better exploration methodologies and alternative sources of energies which might have put downward pressure on natural gas price over the period. However, the examination of the return series affirms high volatility and volatility clustering during the study period. But the level of volatility clustering is found to be the most prominent around the global financial crisis (see figure 4.9 and 4.10). To ascertain such behaviour of the series, there is a need for robust econometric examination, which has been dealt with in the subsequent section.

Figure 4.1 Gold Futures Returns

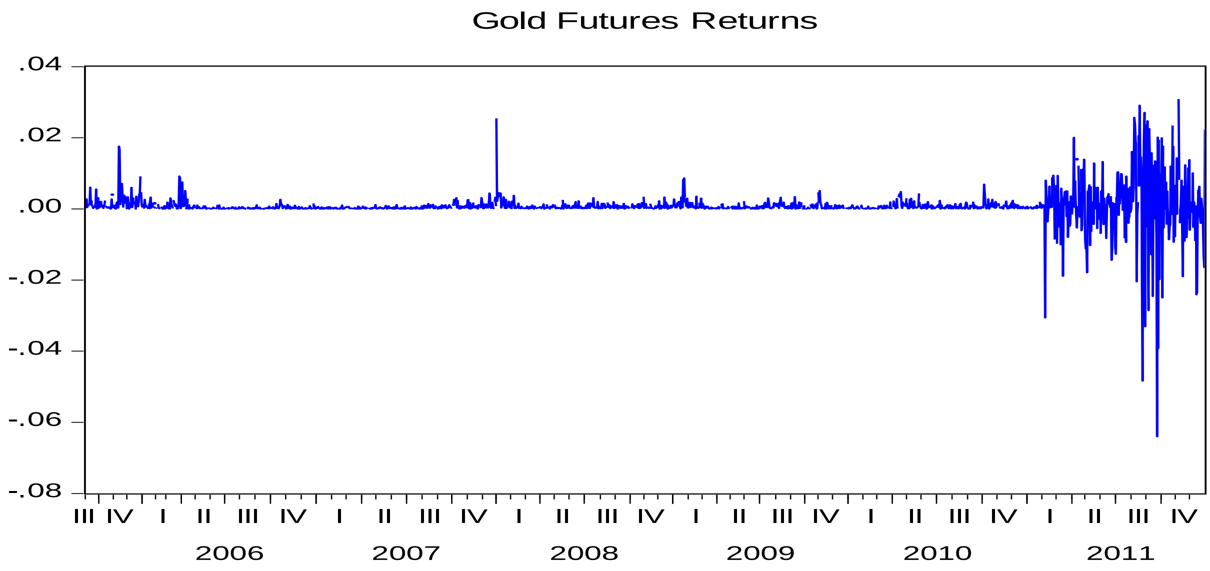


Figure 4.2 Gold Spot Returns

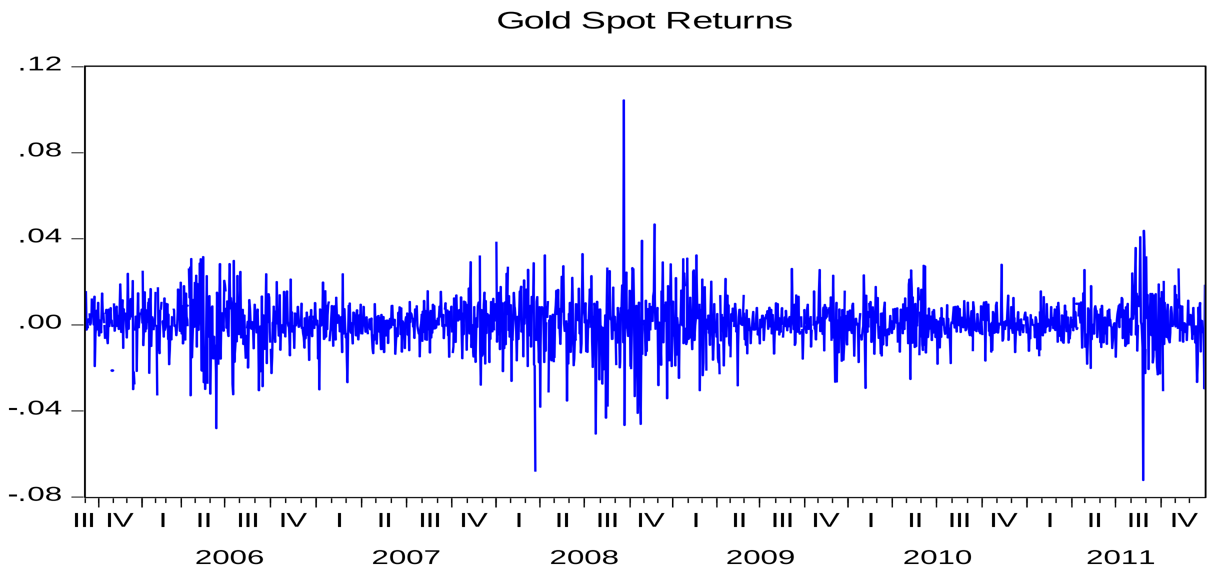


Figure 4.3 Silver Futures Returns

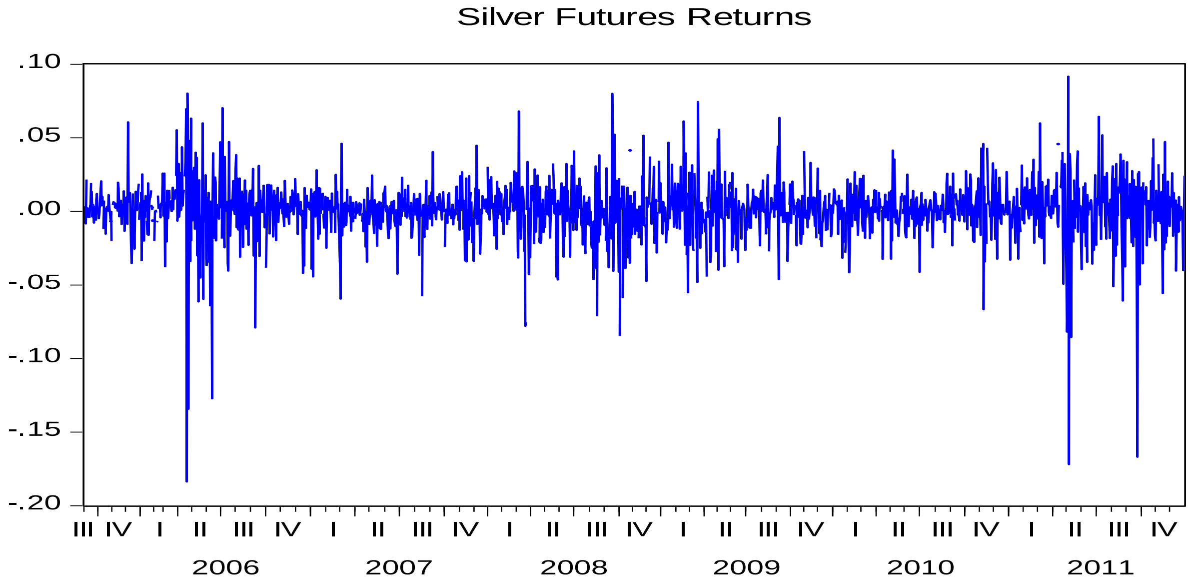


Figure 4.4 Silver Spot Returns

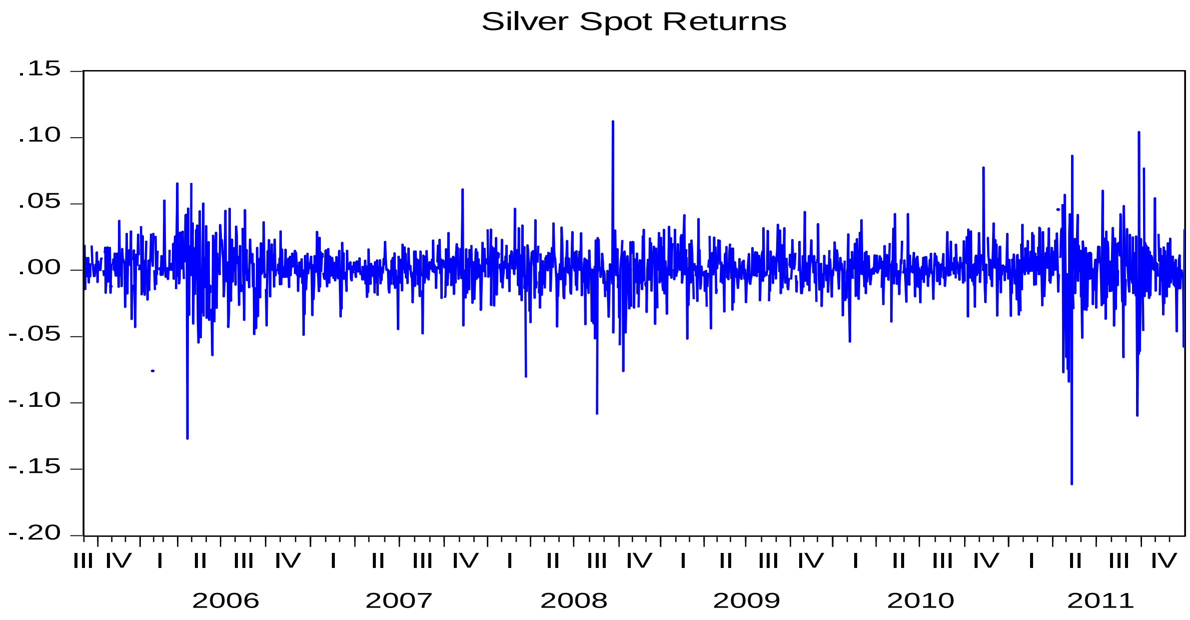


Figure 4.5 Copper Futures Returns

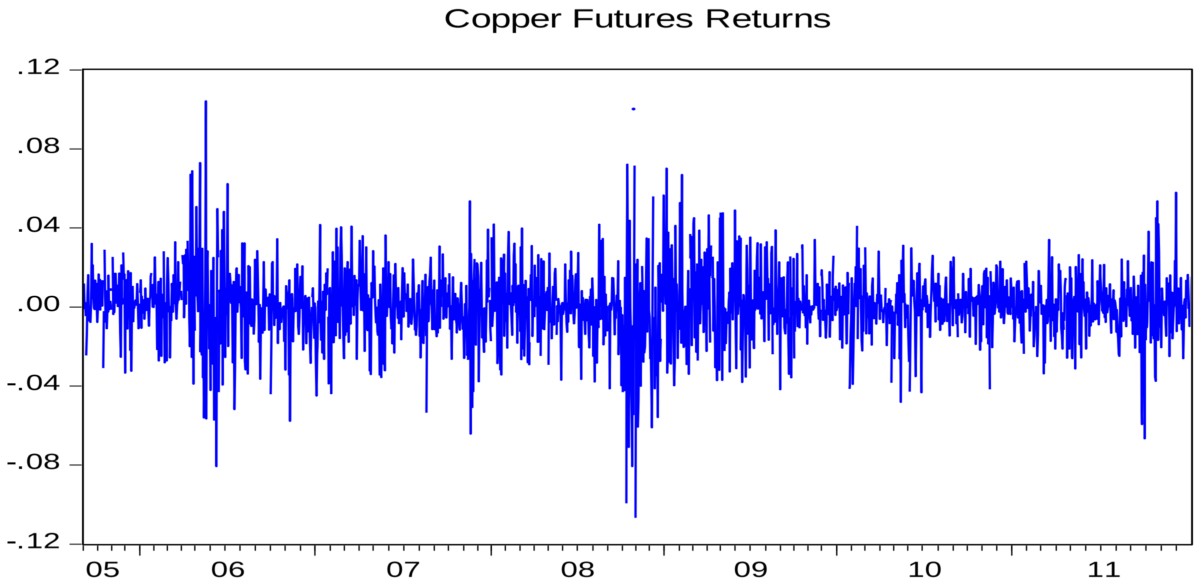


Figure 4.6 Copper Spot Returns

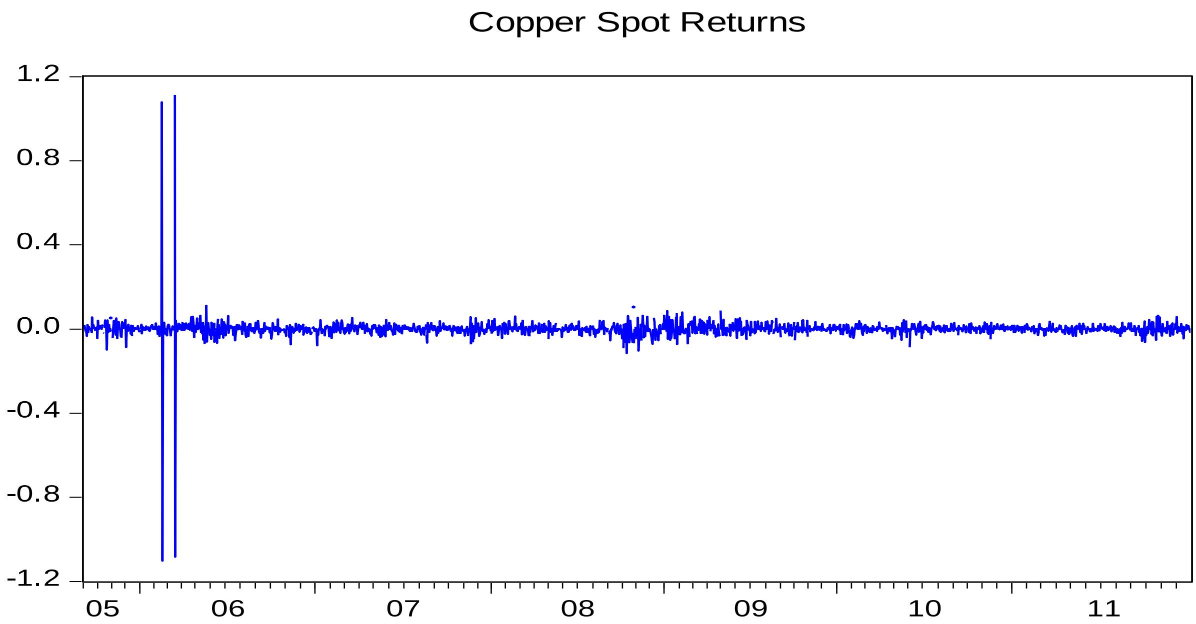


Figure 4.7 Crude Oil Futures Returns

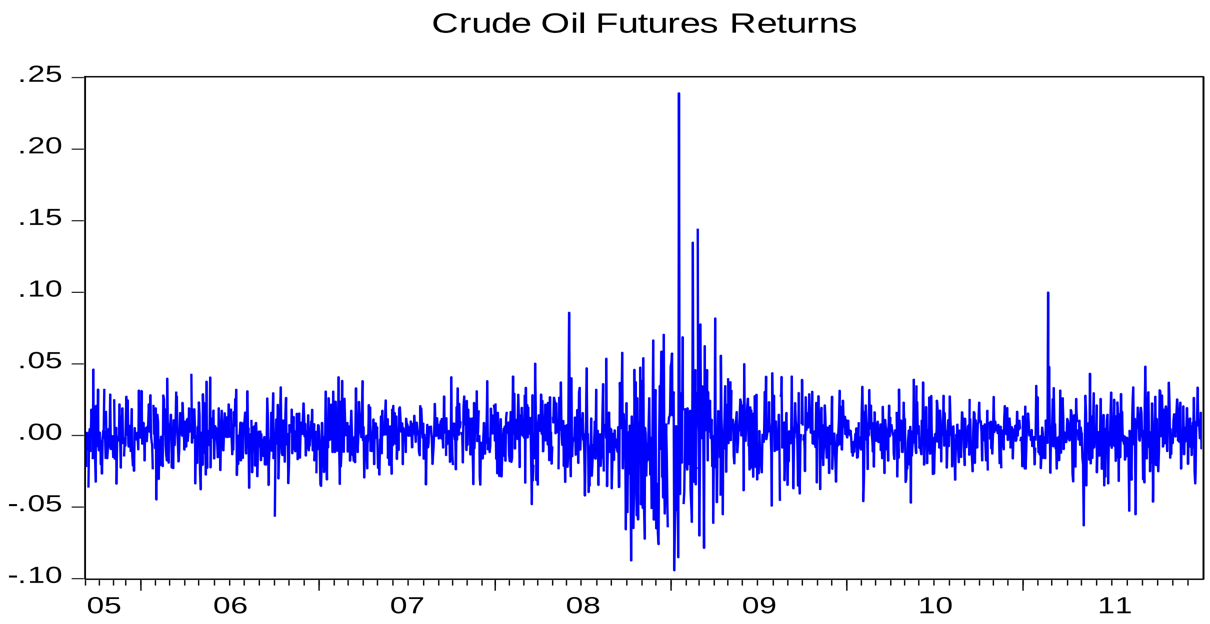


Figure 4.8 Crude Oil Spot Returns

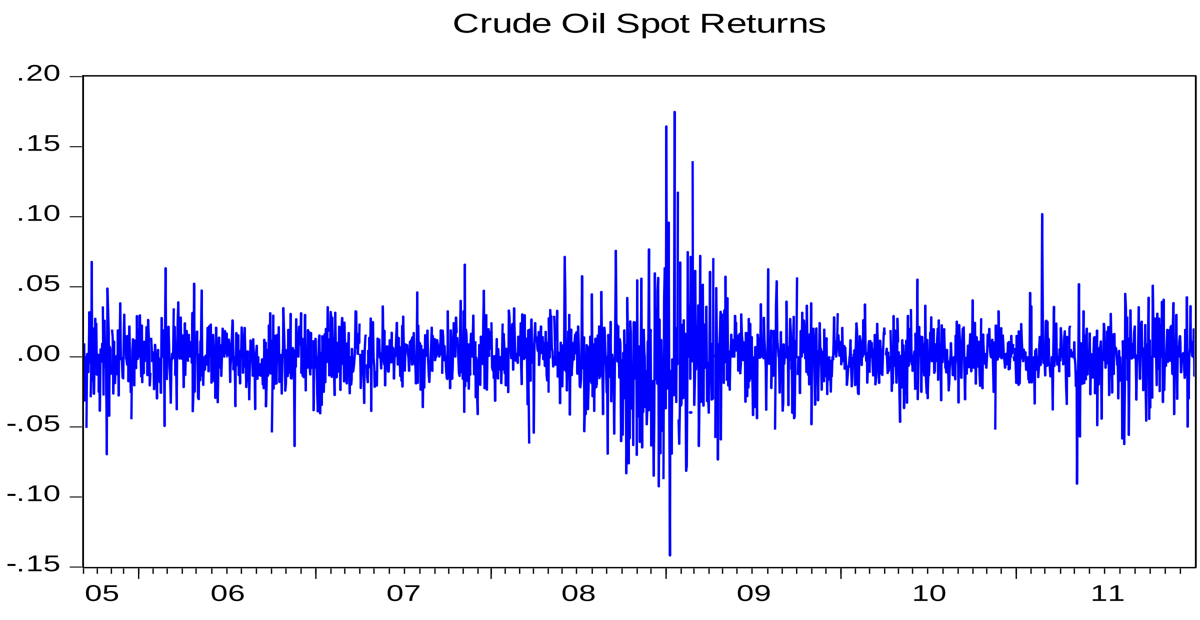


Figure 4.9 Natural Gas Futures Returns

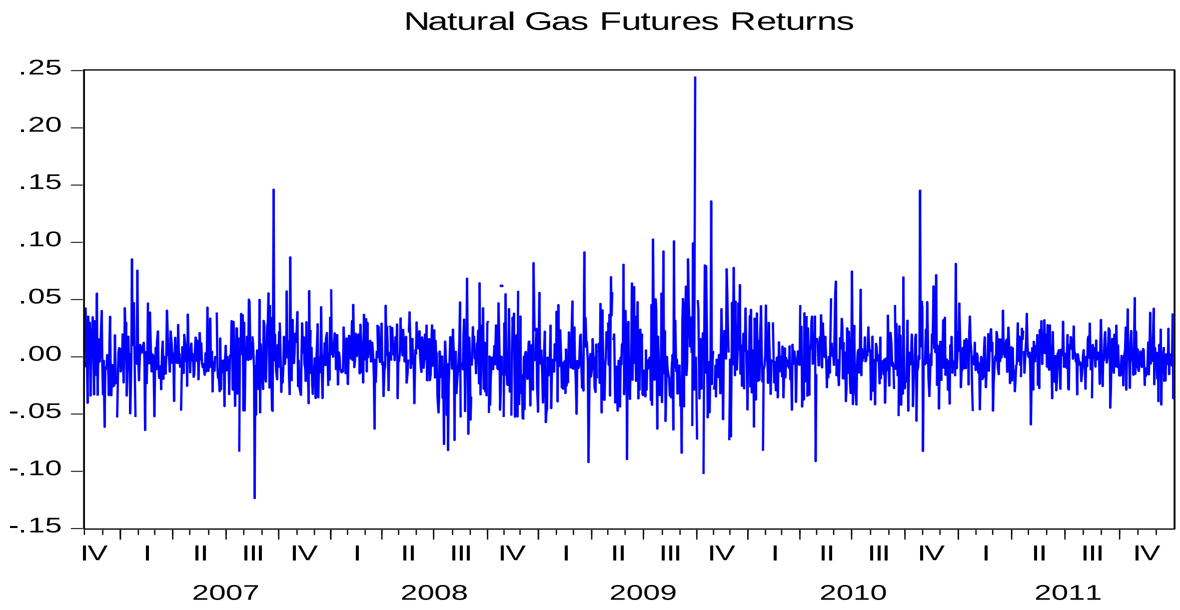
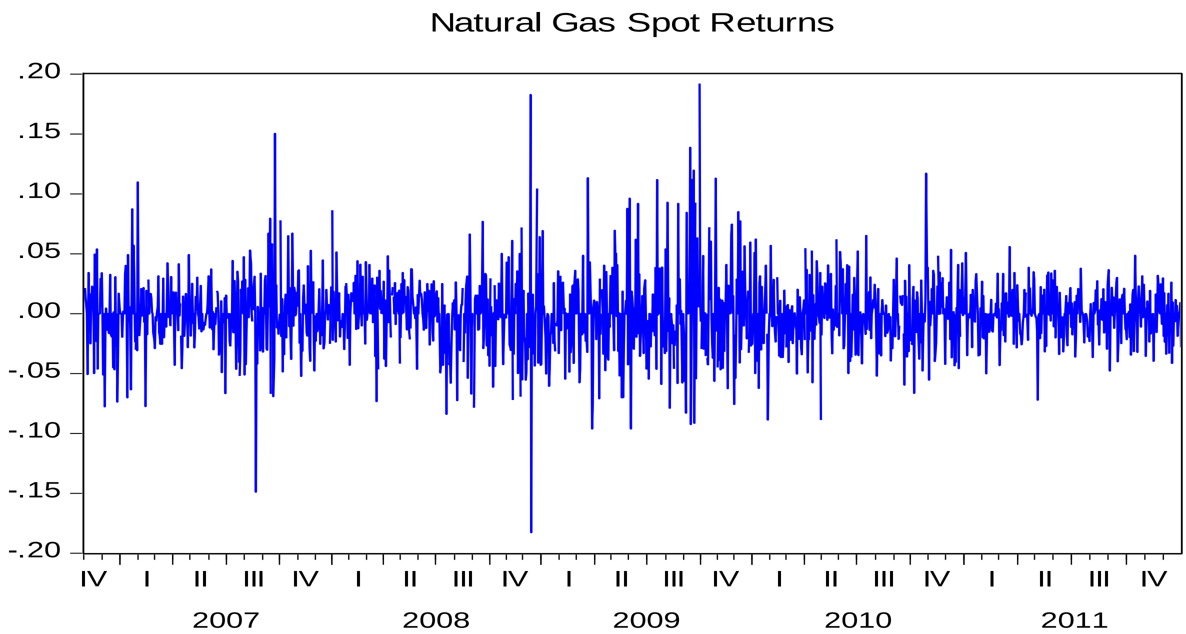


Figure 4.10 Natural Gas Spot Returns



4.4 Econometric Investigation

In examining macroeconomic dynamics of the commodity market, this study uses different time series techniques. For volatility clustering effect, ARCH and GARCH models are used. EGARCH and GJR-GARCH are applied to check asymmetric behaviour of the commodities. FIGARCH is used for the analysis of long memory. Finally, Multi-variate GARCH (BEKK[7] model) model is used to examine spillover effect between spot and futures market. The following sub section has delineated the examination of volatility clustering effect across the chosen commodity series.

4.4.1 Volatility Clustering Effect

Volatility clustering is a time series process where a high volatility is followed by another period of high volatility and low volatility is followed by another period of low volatility. In other words, if volatility increases, it will remain high and if it decreases it will remain low for a certain period (Engle, 2003). Volatility clustering effect can be examined by ARCH and GARCH models. Moreover, ARCH and GARCH also measure the impact on previous shocks on current price changes in the series.

There are diversified views on volatility clustering with different markets. Some of the important studies are reviewed as follows:

Yang and Brorsen (1993) find that estimated GARCH terms are significant at the one percent level which implies, variances of price changes are autocorrelated. Using BDS test, they find volatility clustering in price futures price changes. Moreover, the distribution is not normal. They are slightly skewed and have fat tails. Liew and Brooks fitting the GARCH model

[7] A model that can be viewed as a restricted version of the VEC model is the Baba-Engle-Kraft-Kroner (BEKK) defined in Engle and Kroner (1995).

(1998) find volatility clustering effects in crude palm oil futures market. Further, their result strongly supports the presence of seasonal effects in volatility.

Edwards (1988) finds no evidence that futures trading increases general market volatility. While there are some evidence of futures trading induces short-run volatility, such as that which occurs on (futures) contract expiration days, this does not carry over to longer periods of time. Thus, it seems unlikely that the recent volatility of stock and bond prices is attributable to anything associated with futures trading. The more likely explanation for such volatility is the increasing uncertainty generated by the existence of widely recognized macroeconomic disequilibrium.

Brajesh Kumar (2010) investigates the relationship between futures trading activity and spot market volatility for agricultural, metal, precious metals and energy commodities in Indian commodity derivative market. Using GARCH (1,1) model with trading activity as an explanatory variable, his study finds that both expected and unexpected futures trading volume affect contemporaneous spot volatility positively. However, only unexpected futures trading volume affects contemporaneous spot volatility.

Ahmad, Ali Shah and Shah (2010) investigate an impact of futures trading on spot price volatility. Using GARCH model, they find volatility clustering among commodities. They find futures markets highly volatile. Their study also finds that introduction of futures market increases the volatility of underlying spot market. On the contrary, Chong and Miffre (2009) find commodity futures market reduces risk in the spot market. Their results suggest that adding commodity futures to Treasury-bill portfolios reduce risk further in volatile interest rate environment.

Reading through above literature about volatility clustering effect can't be understood properly. Therefore, this study makes an attempt to examine volatility clustering effect in the Indian context.

a) Autoregressive Conditional Heteroskedasticity (ARCH)

The ARCH model was developed by R. F. Engle in 1982. He developed two equations i.e. mean equation and variance equation. The mean equation as follows:

$$R_t = \alpha + \beta R_{t-1} + \varepsilon_t \qquad (4.4.1)$$

In equation (4.4.1), R_t is a return of asset at period t and ε_t is an error term at period t, α and β are the intercept and coefficient respectively.

$$\varepsilon_t \sim iid\ N(0, h_t)$$

Here error term, ε_t, is independent and identically distributed with zero mean and conditional variance.

The simplest and very useful ARCH model is the first order model. Let $\{\varepsilon_t\}$ be real valued discrete time stochastic process akin to a Gaussian white noise process with unit variance and Ψ_t the set of all information available at time t. The process $\{\varepsilon_t\}$ is the linear ARCH (1) such that

$$\varepsilon_t = \alpha_t h_t^{1/2}$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 \qquad (4.4.2)$$

Equation (4.4.2) says conditional variance h_t is the function of lagged squared error term.

To ensure conditional variance h_t is positive, $\alpha_0 > 0$, $\alpha_1 \geq 0$, where h_t is the conditional variance of ε_t, that is $h_t = var(\varepsilon_t|\psi_{t-1})$.

By making normality it can be more directly expressed in terms ψ_t

$$h_t = var(\varepsilon_t|\psi_{t-1}) = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 \qquad (4.4.3)$$

$$\alpha_0 > 0, \qquad \alpha_1 \geq 0$$

The equation of h_t shows that if ε_{t-1} is large then the conditional variance of ε_t is also large, therefore ε_t tend to be large. This behaviour will spread throughout the process and unusual variable tends to persist, but not always. The conditional variance will revert to unconditional variance provided $0 < \alpha_1 < 1$ so that the process will be stationary and finite variance.

So the ARCH (q) model is commonly written with conditional variance function;

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i\, \varepsilon_{t-i}^2 \qquad (4.4.4)$$

However, it is very difficult to decide number of lags (q) of the squared residual in the model. The number of lags of squared error that are required to capture all of the dependence in the conditional variance might be varying large. This would result in a large conditional variance model that was not parsimonious. Engle (1982) circumvented this problem by specifying an arbitrary linearly declining lag length or an ARCH (4). Other things being equal, the more parameters, there are in the conditional variance equation, the more likely it is that one or more of them will have negative estimated values. Moreover, non negative constraints might be violated. Therefore, to overcome some of the above mentioned limitations of ARCH, Bollerslev developed a model is called GARCH.

b) Generalized Autoregressive Conditional Heteroskedasticity (GARCH)

One of the limitations of the ARCH specification was that it looked more like a moving average specification than an auto-regression. Generalized Autoregressive Conditional Heteroskedasticity model was developed by Tim Bollerslev in 1986. This model 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 modeled 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 about volatility from squared residual from the mean equation and second one is 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 observe shocks. 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. A large sum of these coefficients will imply that a large positive or a large negative return will lead future forecast of variance to be high for a protracted period. The variance intercept term α_0 is very small, while the coefficient on the lagged conditional variance GARCH is larger at 0.9. When the sum of the coefficient is equal to one, the unconditional variance does not exist and the asymptotic properties of the maximum likelihood estimates are not clear.

Let ε_t denote a real valued discrete time stochastic process and ψ_t the set of all information through time t. The GARCH (p, q) is given by:

$$R_t = \alpha + \beta R_{t-1} + \varepsilon_t \qquad (4.4.5)$$

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

$$h_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i\, \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j} \qquad (4.4.6)$$

$$p \geq 0, q \geq 0$$

$$\alpha_0 > 0, \alpha_i \geq 0, i = 1,2, \dots \dots p$$

$$\beta_j \geq 0, j = 1,2, \dots \dots q$$

If p=0, the process reduces to the ARCH (q) process and for p=q=0, ε_t is simply white noise. In the ARCH (q) process the conditional variance is specified only, where as the GARCH (p, q) process allows lagged conditional variances to enter as well.

The simplest but often very useful GARCH process is of course the GARCH (1, 1) process given by:

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

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \qquad (4.4.7)$$

$$\alpha_0 > 0, \qquad \alpha_1 \geq 0, \qquad \beta_1 \geq 0$$

The stationary condition for GARCH (1, 1) $\alpha_1 + \beta_1 < 1$ is

The advantages of the GARCH speciation is that very convenient assumptions about the conditional density of commodity price changes, such as the normal or t distribution, can lead model that allows for time-dependent conditional variance and leptokurtosis in the unconditional distribution of price changes. This is achieved through relaxing the assumption that successive price changes are independent. Price changes may still be higher moments (Baillie and Mayers, 1991).

c) Empirical Examination of Volatility Clustering

The study uses descriptive statistic test on the metal and energy commodities. Descriptive statistics results for gold, silver and copper are reported in the table 4.1. The results indicate that the daily mean return for gold spot and futures are positive and minimum during the sample period. We generally measure volatility through standard deviation as it catches dispersion parts of the data. Standard deviation results for gold, silver and copper are reported in the table. We find that volatility of gold spot returns is comparatively more volatile than gold futures. Possible reasons may be the different seasonal and economic factors such as exchange rate changes, global financial crisis, sovereign crisis etc. The skewness of the gold futures and spot return are negative, which means both variables are negatively skewed or lack of symmetry. Kurtosis results indicate that both the variables are leptokurtic or fat tailed. Jarque-Bera statistics indicates gold futures and spot returns are not normal with one percent level of significance. On the other hand, daily mean returns for silver futures and spot are positive and minimum. Volatility in silver futures and spot return is similar during sample period. Kurtosis results indicate that both silver futures and spot returns are leptokurtic or fat tailed. Silver futures and spot returns are not normal according to Jarque-Bera results with one percent level of significance. In case of copper, daily mean returns for copper futures and spot are positive and minimum. Copper spot is more volatile than the copper futures. Copper futures return is negatively skewed but copper spot return is positively skewed and hence lack of symmetry in the series, and both the variables returns are leptokurtic or fat tailed. Copper spot and futures returns are not normal according to Jarque-Bera results with one percent level of significance. However, this descriptive statistics results are not free from limitations. For example, firstly, volatility is measured through standard deviation over the short period. The question remains unclear about the short period; whether one year, seven years or seven days etc. Finally, it is widely believed that recent past information has greater impact on current prices that the distant past information. Therefore, weightage should be given more to recent past information than the distant past information which standard deviation fails to do so. Therefore, this study uses ARCH and GARCH techniques to overcome above mentioned limitations.

Table 4.1 Descriptive Statistics Results for Gold, Silver and Copper

Statistics	Gold Futures	Gold Spot	Silver Futures	Silver Spot	Copper Futures	Copper Spot
Mean	0.00	0.00	0.00	0.00	0.00	0.00
Median	0.00	0.00	0.000	0.000	0.000	0.00
Max. Return	0.03	0.10	0.09	0.11	0.10	1.11
Mini. Return	-0.06	-0.07	-0.18	-0.16	-0.10	-1.10
Stand. Dev.	0.004	0.01	0.01	0.01	0.01	0.05
Skewness	-2.27	-0.06	-1.56	-0.84	-0.13	0.04
Kurtosis	48.35	10.22	16.71	11.71	6.71	341.46
Jarque-Bera	162014.2	4069.53	15457.06	6149.02	1092.47	9031.27
probability	0.00	0.00	0.00	0.00	0.00	0.00
Sum	1.43	1.45	1.59	1.57	0.93	0.87
SumSq. Dev.	0.03	0.23	0.72	0.63	0.62	5.64
Observations	1871	1871	1875	1875	1892	1892

The descriptive statistics results for crude oil and natural gas are reported in table 4.2. It is observed that daily mean returns for crude oil futures and spot are very low but positive over study period, while natural gas futures and spot daily mean returns are low but negative. As the study has already mentioned that volatility can be measure by standard deviation, we find that volatility of crude oil spot is similar with crude oil futures returns during sample period. Similarly, volatility of natural gas futures returns is also similar with spot returns volatility. The skewness results for the crude oil futures and spot returns are positive, indicate both variables are positively skewed and hence series are lack of symmetry. Kurtosis results indicate crude oil futures and spot returns are leptokurtic or fat tailed. Jarque-Bera statistic indicates that crude oil futures and spot returns are not normal with one percent level of significance. Natural gas futures and spot returns also positively skewed as skewness is positive and hence lack of symmetry in the series. Kurtosis results show that both variables are fat tailed. Similarly, natural gas futures and spot returns are not normal with one percent level of significance according to Jarque-Bera test results. However, this descriptive statistics results are not free from limitations. Firstly, volatility is measured through standard deviation over the short period. The question remains unclear about the short period; whether one yea, five year, seven days etc. Finally, it is widely believed that recent past information has greater impact on current prices that the distant past information. Therefore, weightage should be given more to recent past information than the distant past information which standard deviation fails to do so. Therefore, this study uses ARCH and GARCH techniques to overcome above mentioned limitations.

Table 4.2 Descriptive Statistics Results of Crude Oil and Natural Gas				
Statistics	**Crude Oil Futures**	**Crude Oil Spot**	**Natural Gas Futures**	**Natural Gas Spot**
Mean	0.00	0.00	-0.00	-0.00
Median	0.00	0	-0.00	0
Max. Return	0.23	0.17	0.24	0.19
Mini. Return	-0.09	-0.14196	-0.12371	-0.18276
Stand. Dev.	0.02	0.02	0.02	0.02
Skewness	0.96	0.31	0.79	0.44
Kurtosis	16.60	9.70	9.29	7.81
Jarque-Bera	15040.57	3615.37	2728.33	1551.73
probability	0.0	0.0	0.0	0.0
Sum	0.56	0.56	-0.74	-0.74
SumSq. Dev.	0.79	0.96	1.17	1.39
Observations	1913	1913	1553	1553

Prior to ARCH analysis, the study tests for heteroskedasticity effect on the commodities under consideration. Deploying the ARCH-LM test for heteroskedasticity effect across the commodity futures and spot return series, the study affirms the presence of heteroskedasticity effect in gold, silver, copper and crude oil series. However, the corresponding F-statistics and observed R-squared for natural gas futures series under the ARCH LM test found to be statistically not significant, which therefore negates the presence of heteroskedasticity effect. But the ARCH LM test on natural gas spot series confirms that the series experiences the presence of heteroskedasticity effect over the time period. The absence of heteroskedasticity effect in natural gas futures could be due to the fact that the information shocks are not strong enough to destabilise the said series, which we have already noticed in the graphical analysis.

As compared to the natural gas spot return and futures series found to be less volatile as suggested by the graphical analysis. Therefore, ARCH family models are not applied to the natural gas futures as it fails in heteroskedasticity effect.

Table 4.3 Heteroskedasticity Test Results for Commodity			
Variables	**F-statistic**	**R Square**	**ARCH effect**
Gold Futures	100.51 (0.00)	95.47 (0.00)	Yes
Gold Spot	62.25 (0.00)	60.55 (0.00)	Yes
Silver Futures	64.01 (0.00)	61.95 (0.00)	Yes
Silver Spot	71.77 (0.00)	69.19 (0.00)	Yes
Copper Futures	105.38 (0.00)	99.92 (0.00)	Yes
Copper Spot	211.89 (0.00)	190.71 (0.00)	Yes
Crude Oil Futures	29.53 (0.00)	29.11 (0.00)	Yes
Crude Oil Spot	7.2 (0.00)	7.18 (0.00)	Yes
Natural Gas Futures	0.00 (0.99)	0.00 (0.99)	No
Natural Gas Spot	25.11 (0.00)	24.74 (0.00)	Yes

Note: Probability values are in parenthesis

ARCH and GARCH models are used for the analysis of volatility clustering effect. There are two equations i.e. mean and variance equation. Auto-regressive format is applied in the mean equation. E-views 7 econometric software is used for ARCH, GARCH, E-GARCH and GJR-GARCH Analysis. RATS econometric software is used for FIGARCH and Bi-variate GARCH (BEKK) analysis. Table 4.4 represents ARCH results for the commodities under study. The lag length one is selected on the basis of five different selection criteria i.e. AIC, SBC, FPE, Hanan-Quin criteria and LR statistics. For the diagnostic checking, the study has used Ljung-Box Q statistics at the lag (20). Ljung-Box Q (LB) test is applied with 20 lags considering it as the optimal lag length and LBQ test statistics results are reported in the table 4.4.

ARCH results are reported in table 4.4 for the commodities under the study. Coefficients values of mean and variance equations are statistically significant for gold futures and spot return series which indicate the fact that the series are experiencing volatility persistence. In other words, previous shocks/news has significant impact on current price changes in gold. In other words, we find volatility clustering effect on the gold futures and spot return. The coefficients values in mean equations are not statistically significant for silver (spot and futures), copper spot, crude oil (spot and futures), and natural gas spot. However, coefficients values of variance equation results are statistically significant for silver (futures and spot), copper (futures and spot), crude oil (futures and spot) and natural gas spot. Therefore, it is observed that volatility clustering effect exists on silver, copper, crude oil and natural gas spot returns. Volatility clustering in these commodities refers that if volatility in the return series increases then it will remain high for certain period of time and vice versa. Moreover, previous shocks/news has significant impact on the current return series of silver, copper, crude oil and natural gas spot. Certain limitations in ARCH model led the development of GARCH in 1986 by Bollerslev.

Table 4.4 ARCH Results for the Commodities						
Variable	**Mean Equation**		**Variance Equation**		**Ljung-Box**	
	Constant	**AR**	**Constant**	**ARCH**	**Q(20)**	**Q^2(20)**
Gold Futures	0.00 (70.06)	0.203 (150.55)	0.00 (70.06)	5.06 (45.92)	41.29	9.46
Gold Spot	0.00 (4.98)	0.001 (0.058)	0.00 (32.54)	0.381 (11.24)	34.29	9.64
Silver Futures	0.00 (4.73)	-0.06 (-3.72)	0.00 (38.47)	0.461 (17.84)	32.84	143.9
Silver Spot	0.00 (3.81)	-0.112 (-6.185)	0.00 (36.24)	0.38 (13.01)	21.91	113.4
Copper Futures	0.00 (1.59)	0.006 (0.28)	0.00 (37.53)	0.19 (8.16)	22.92	532.2
Copper Spot	0.00 (0.95)	-0.125 (-1.99)	0.00 (25.7)	0.07 (4.37)	19.24	0.33
Crude Oil Futures	0.00 (2.02)	0.062 (3.01)	0.00 (35.29)	0.33 (15.32)	25.13	363.9
Crude Oil Spot	0.00 (2.42)	0.057 (-3.56)	0.00 (39.26)	0.23 (12.45)	37.4	806.3
Natural Gas Spot	-0.00 (-0.46)	-0.093 (-3.02)	0.00 (44.63)	0.05 (3.69)	26.92	150.2

Note: t-statistics values are in parenthesis

The major difference between GARCH and ARCH models is lagged conditional variance. In the GARCH model, conditional variance is modelled as lagged error term plus lagged conditional variance. There are two coefficients in GARCH model i.e. reaction coefficient which says the reaction of previous shocks on current prices and persistent coefficient which says the volatility persistence over time. It is widely studied that GARCH (1,1) is the best fit for forecasting volatility. Mean and variance equation results for the commodities under the study are reported in table 4.5. 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_1 (ARCH 1) is the "news" coefficient, with a higher value implying that recent news has greater impact on price changes. Similarly, β_1 (GARCH 1) reflects persistence of volatility, It indicates that the level of persistence in information and its effect on volatility.

Table 4.5 GARCH Results for Commodities

Variable	Mean Equation		Variance Equation			Ljung-Box	
	Constant	AR	Constant	ARCH	GARCH	Q(20)	$Q^2(20)$
Gold Futures	0.00 (14.97)	-0.085 (-2.72)	0.00 (3.03)	0.519 (18.63)	0.82 (125.6)	24.28	0.23
Gold Spot	0.00 (2.89)	0.006 (0.301)	0.00 (6.04)	0.06 (10.94)	0.92 (130.1)	20.58	8.97
Silver Futures	0.00 (4.16)	-0.022 (-0.96)	0.00 (8.84	0.22 (17.03)	0.70 (36.74)	28.65	21.78
Silver Spot	0.00 (2.78)	-0.028 (-1.364)	0.00 (6.46)	0.06 (11.97)	0.91 (146.1)	13.19	18.30
Copper Futures	0.00 (2.36)	-0.008 (-0.03)	0.00 (4.52)	0.73 (10.66)	0.907 (95.58)	16.21	22.71
Copper Spot	0.00 (0.64)	-0.093 (-0.99)	0.00 (28.76)	0.09 (3.21)	-0.03 (-1.13)	27.93	0.73
Crude Oil Futures	0.00 (2.22)	0.16 (0.70)	0.00 (3.91)	0.043 (6.39)	0.94 (105.2)	13.52	12.05
Crude Oil Spot	0.00 (1.96)	-0.03 (-1.42)	0.00 (3.84)	0.036 (6.47)	0.95 (118.2)	13.2	16.32
Natural Gas Spot	-0.00 (-0.85)	-0.08 (-2.9)	0.00 (2.64)	0.046 (7.34)	0.94 (113.4)	17.77	0.72

Note: t-statistics values are in the parenthesis

Coefficients values in the mean equation are not statistically significant for gold (spot and futures). However, coefficients values in variance equation are statistically significant for gold (spot and futures). GARCH (1, 1) results for gold futures returns show α_1= 0.519 and β_1=0.82 which suggests that past conditional variance has a greater impact on current change in return than recent shocks or news announcements. High β_1 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. Gold spot return is explosive. Similarly, coefficient values of mean equation results are not statistically significant for silver (futures and spot), copper (futures and spot), crude oil (futures and spot) and natural gas spot. However, coefficients values of variance equation results are statistically significant for silver (futures and spot), crude oil (futures and spot), copper futures and natural gas spot, 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. Coefficients values of copper spot violate the non-negative constraint. A negative value in the conditional variance equation does not make any economic sense.

4.4.2 Asymmetric Behaviour

Asymmetric behaviour is one of the major features in the futures market. Despite the apparent success of the ARCH and GARCH models these models could not capture some important features of the data. The most interesting feature that could not be addressed by these models is the leverage or asymmetric effect discovered by Black (1976). Statistically this effect occurs when unexpected drop in price (Bad news) increases predictable volatility more than an unexpected increase in price (Good news) of similar magnitude.

In the GARCH models, one of primary restriction of the GARCH is that they enforce a symmetric response of volatility to positive and negative shocks. This arises since the conditional variance is a function of the magnitudes of lagged residuals and not their signs. In other words by squaring the lagged error the sign is lost. It has, however, been argued that a negative shock to financial time series is likely to cause volatility to rise by more than a positive shock of the same magnitude. Several studies have been conducted in different market with respect to asymmetric volatility. A Few important studies are reviewed here as follows:

Wu (2001) provides a formal explanation to the observed negative correlation between return and return volatility and to analyse economic significance. Black (1776) and Christie (1989) are among the first to document and explain the asymmetric volatility property of individual stock return in the US equity markets. The explanation they put forth is the leverage effect hypothesis. A drop in the value of the stock (negative return) increases financial leverage, which makes the stock riskier and increases its volatility. It is accepted that leverage effects are synonymous with asymmetric volatility. If volatility is priced, an anticipated increase in volatility raises the required return on equity, leading to an immediate stock price decline. This is often referred to as “volatility feedback effect”.

Beakaert and Wu (2000) examine asymmetric volatility in the Japanese equity market using general empirical framework based on multivariate GARCH-in-mean model. They also try to differentiate between the two main explanations for the asymmetry and conclude that volatility feedback is the dominant cause of the asymmetry for the Japanese stock market.

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

Xu (1999) examines the shanghai stock exchanges (SSE). Using and comparing GARCH, EGARCH, and GJR-GARCH model, he finds that unexpected negative returns causes volatility increase almost equal to that of an unexpected positive return of the same magnitude in Shanghai stock market. There is almost no so-called leverage effect or asymmetric behaviour in the Shanghai stock market and the reason was volatility was mainly caused by government policies on stock markets under the current financial system.

From the above reviews, it can be concluded that there is lack of conclusive evidence regarding asymmetric volatility specifically on Indian commodity futures market. This study tries to solve this issue empirically.

a) Exponential Generalize Autoregressive Conditional Heteroskedasticity (EGARCH)

There are two popular asymmetric models formulations may be explained here, they are (a) exponential GARCH (EGARCH) model proposed by Nelson (1991) and (b) GJR-GARCH model named after the authors Glosten. Jagnnathan, and Runkle (1993). One method proposed to capture such asymmetric effects is Nelson’s exponential GARCH or EGARCH model (1991).

$$R_t = \alpha + \beta R_{t-1} + \varepsilon_t \qquad (4.4.8)$$

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

$$\log(h_t) = \omega + \beta \log(h_{t-1}) + \gamma \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \alpha \left[\frac{|\varepsilon_{t-1}|}{\sqrt{h_{t-1}}} - \sqrt{\frac{2}{\pi}} \right] \qquad (4.4.9)$$

Where $\omega, \beta\ and\ \gamma$ are parameters. The EGARCH model is asymmetric because the level of $\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}$ is include with a coefficient γ, since this coefficient is typically negative, positive return shocks generate less volatility than negative returns shocks, all else being equal.

A comparison between the GARCH (1, 1) model and the EGARCH (1, 1) suggests an interesting metric by which to analyze the effect of news on conditional heteroskedasticity. EGARCH model allows good news and bad news to have different impact on volatility, while the standard GARCH model does not. 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.

b) Glosten, Jagannathan and Runkle Generalized Autoregressive Conditional Heteroscedasticity (GJR-GARCH)

The GJR model is also extension of GARCH model with additional term added to account for possible asymmetries. The mean and conditional variance equations now given by:

$$R_t = \alpha + \beta R_{t-1} + \varepsilon_t \qquad (4.4.10)$$

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

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta \varepsilon_{t-1}^2 I_{t-1} + \lambda_1 \sigma_{t-1}^2 \quad (4.4.11)$$

Where $I_{t-1} = 1\ if\ \varepsilon_{t-1} < 0$

= 0 otherwise.

For the leverage effect, $\beta > 0$. The condition for non negativity will be $\alpha_0 > 0, \alpha_1 \geq 0, \beta \geq 0, \alpha_1 + \beta \geq 0$.

c) Empirical Analysis of E-GARCH and GJR-GARCH

Asymmetric volatility is one of the important features of commodity futures market which refers to bad news generates more volatility than good news of similar magnitude. The study uses two asymmetric models i.e. EGARCH and GJR-GARCH to analyse asymmetric behaviour of the commodities under study. EGARCH results are reported in the table 4.6. Results show that gold futures and spot returns do not have any asymmetric properties that means bad news and good news have similar impact on current changes in gold returns. Similarly, silver futures and spot, and copper spot do not have any asymmetric properties too. However, asymmetric property exists in the copper futures, crude oil futures and spot, and natural gas spot, which indicate bad news creates more volatility than good news of similar magnitude. For the diagnostic checking, the study has used Ljung-Box Q statistics at the lag (20). Ljung-Box Q (LB) test is applied with 20 lags considering it as the optimal lag length for taking into account all the commodity return series and LBQ test statistics results are shown in the table 4.6. Asymmetric behaviour of the commodities gives additional concern to investors as well policy makers as it indicates the market instability.

Table 4.6 EGARCH Results for Commodities								
Variable	**Mean Equation**		**Variance Equation**				**Ljung-Box**	
	Constant	AR	Constant	ARCH	GARCH	Asym.	Q(20)	$Q^2(20)$
Gold Futures	0.00 (21.84)	-0.088 (-3.58)	-0.345 (30.5)	0.34 (30.5)	0.98 (797.0)	0.17 (15.05)	29.8	0.33
Gold Spot	0.00 (4.32)	-0.007 (-0.92)	-0.181 (-7.06)	0.114 (10.69)	0.98 (442.6)	0.053 (8.07)	22.37	14.27
Silver Futures	0.00 (3.66)	-0.007 (-0.09)	-0.806 (9.90)	0.32 (20.93)	0.928 (102.3)	0.003 (0.35)	25.98	21.63
Silver Spot	0.00 (3.30)	-0.051 (-2.43)	-0.252 (-7.92)	0.147 (14.36)	0.017 (3.77)	0.98 (286.4)	15.46	21.28
Copper Futures	0.00 (1.65)	-0.017 (-0.74)	-0.309 (-7.35)	0.159 (12.50)	0.976 (212.8)	-0.041 (-5.22)	18.97	24.75
Copper Spot	0.00 (1.11)	-0.00 (-0.17)	-4.18 (-4.92)	-0.189 (-6.64)	0.33 (5.01)	0.382 (14.00)	20.93	0.12
Crude Oil Futures	0.00 (1.40)	0.007 (0.32)	-0.139 (-5.87)	0.086 (6.45)	0.99 (485.8)	-0.041 (-5.86)	17.12	15.22
Crude Oil Spot	0.00 (1.82)	-0.037 (-1.66)	-0.089 (-3.25)	0.08 (6.47)	0.98 (402.8)	-0.05 (-5.87)	11.15	19.42
Natural Gas Spot	-0.00 (1.12)	-0.08 (-3.25)	-0.11 (-4.01)	0.09 (7.97)	0.99 (307.03)	-0.018 (-2.28)	19.32	15.7

Note: t-statistics values are in the parenthesis

Another important model for asymmetric analysis is GJR-GARCH model. Its results are reported in the table 4.7 for the commodities under consideration. It is seen that, coefficients values for most of the commodities violate non-negative constraints. Negative values in the conditional variance equation do not make any economic sense. For sake of simplicity, the has not considered GJR-GARCH results for interpretation.

Table 4.7 GJR-GARCH Results for Commodities								
Variable	**Mean Equation**		**Variance Equation**				**Ljung-Box**	
	Constant	AR	Constant	ARCH	GARCH	Dummy	Q(20)	$Q^2(20)$
Gold Futures	0.00 (17.57)	-0.035 (-1.27)	0.00 (6.67)	0.62 (22.45)	0.82 (207.2)	-0.56 (-6.32)	20.74	0.24
Gold Spot	0.00 (3.82)	-0.008 (-0.37)	0.00 (5.14)	0.09 (10.54)	0.93 (144.1)	-0.06 (-6.08)	21.47	10.38
Silver Futures	0.00 (3.83)	-0.008 (-0.37)	0.00 (8.98)	0.21 (11.28)	0.66 (31.38)	0.044 (1.67)	29.35	23.47
Silver Spot	0.00 (2.98)	-0.033 (-1.59)	0.00 (5.97)	0.07 (11.51)	0.92 (164.5)	-0.02 (-4.54)	13.28	18.51
Copper Futures	0.00 (1.83)	-0.008 (-0.34)	0.00 (4.46)	0.05 (5.94)	0.907 (94.93)	0.04 (4.03)	17.83	22.71
Copper Spot	0.00 (1.05)	-0.06 (-1.32)	0.00 (2.99)	0.096 (8.32)	0.616 (4.73)	-0.161 (-12.79)	34.86	0.81
Crude Oil Futures	0.00 (1.32)	0.01 (0.59)	0.00 (4.21)	0.01 (2.05)	0.94 (116.31)	0.54 (6.04)	16.02	12.51
Crude Oil Spot	0.00 (1.08)	-0.04 (-1.72)	0.00 (4.42)	0.011 (5.12)	0.94 (109.54)	0.047 (4.39)	12.78	17.71
Natural Gas Spot	-0.00 (-1.04)	-0.083 (-3.087)	0.00 (2.20)	0.027 (4.66)	0.45 (138.48)	0.02 (2.98)	19.26	16.55

Note: t-statistics values are in the parenthesis

4.4.3 Long Memory

Long memory can be expressed in terms of volatility persistence; a GARCH model features an exponential decay in the autocorrelation of conditional variances. However, a shock in the volatility series seems to have very "long memory" and impacts on futures volatility over a long horizon. Baillie et al. (2007) explained that the long memory refers to the presence of very slow hyperbolic decay in the autocorrelations and impulse response weights. In other words, Long memory process means a spell of high volatility is followed by another spell of high volatility. Moreover, if a period of high volatility persists over time it is said that the process governing the behaviour of the underlying variable has long-memory. On the contrary, if high volatility occurs only for a short period, the process exhibits short memory.

Long memory processes can be modelled by Integration-GARCH (IGARCH) and Fractional Integration-GARCH (FIGARCH) specifications but not by the most popular GARCH ones. This is because in the GARCH specification it is assume that the process is stationary and thus exhibits short memory. However, this may not be the case for some volatility time series. IGARCH estimates a model where the integration coefficient is equal to 1 (this usually happens when the sum of the alpha and beta coefficients is close to one). FIGARCH, on the other hand, assumes no previous fixed value for the integration coefficient and estimates this coefficient along with the other parameters of the model. This coefficient is usually termed as "d". If $0 < d < 1$, the process is said to be mean reverting and possesses long memory. The implications for this are important for commodity futures markets since during periods of high volatility the risk of an investment increases dramatically – the investor can win but also can lose large amounts of money if he/she trades on commodities over that period.

Few important studies are reviewed as follows:

Baillie, Bollerslev and Mikkelsen (1996) propose new class fractional integrated generalized autoregressive conditional hetroskedasticity (FIGARCH) to capture long memory process. They find the existence of long memory in financial market volatility which refers shocks to conditional variance will die out slow hyperbolic rate of decay determined by a fractional differencing parameter. Bollerslev and Mikkelsen (1996) also develop fractional integrated GARCH and EGARCH models for characterizing financial market volatility. Using daily prices on the Standard and Poor's 500 composite index from January 2, 1953 to December 31, 1990. They find that long memory process exists in that market.

Tanscuhat, Chang and Mcaleer (2009) estimate the long memory models for agricultural commodity futures returns from different futures markets. Using FIGARCH model, they find existence of long memory in almost all the commodities under study. On the contrary, Crato and Ray (2000) find that no evidence of long memory on the returns.

Ferretti and Gilbert (2008) consider the dynamic representation of spot and three month aluminum and copper volatilities. Using bi-variate FIGARCH model, which allows parsimonious representation of long memory volatility processes, they find that spot and three month aluminum and copper volatilities follow long memory processes are symmetric. However, there is no evidence that the process is fractionally cointegrated.

Wang, Wu and Yang (2008) use high frequency returns, realized volatility and correlation of NYMEX light, sweet crude oil, and Henery-Hub natural gas futures contracts to study long memory and asymmetry. They find long memory and asymmetric volatility for natural gas but not for crude oil futures.

a) Factional Integration GARCH Model

Fractional integration generalized autoregressive conditional hetroskedasticity (FIGARCH) developed by Baillie, Bollerslev and Mikkelsen (1996). The model can be described as follows:

$$R_t = \alpha + \delta R_{t-1} + \varepsilon_t \qquad (4.4.12)$$

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

$$h_t = \omega + \{1 - [1 - \beta_1 L]^{-1}(1 - \theta_1 L)^d\}\varepsilon_t^2 \quad (4.4.13)$$

There are two equations for the FIGARCH model. Equation (4.4.12) is the mean equation and equation (4.4.13) is the conditional variance equation. Error term, ε_t, condition upon information φ_{t-1} is normally distributed to zero mean and conditional variance. α, δ, ω, β, θ and d are the parameters to be estimated with d being the fractional integration parameter which catches the long memory behaviour. L is the lag operator. Interestingly, the FIGARCH(1,d,1) models nests the GARCH(1,1) model (Bollerslev, 1986) for d=0 and the IGARCH (Engle and Bollerslev, 1986) for d=1. As advocated by Baillie et al. (1996), the IGARCH process may be seen as too restrictive as it implies infinite persistence of a volatility stock. Such a dynamic is contrary to the observed behaviour of agents and does not match the persistence observed after important events (Baillie et al., 1996, Bollerslev and Engle, 1993). By contrast, for 0<d<1, the FIGARCH model implies long memory behaviour and a slow decay of impact of volatility shock.

b) Empirical Analysis of FIGARCH

Long memory is one of the major features of any commodity futures market. The study uses FIGARCH models to test long memory in all the commodities under the study. For the diagnostic checking, the study has used Ljung-Box Q statistics at the lag (20). Ljung-Box Q (LB) test is applied with 20 lags considering it as the optimal lag length and LBQ test statistics results are shown in the table 4.8. FIGARCH results are reported in the table 4.8. The fractional coefficient values for the gold spot and futures are less than one and statistically significant which suggests that both the series have shown long memory properties. Similarly, fractional coefficient values for silver spot and futures, copper futures, crude oil spot and futures, and natural gas spot are less than one and statistically significant and hence long memory features do exist in the commodities. However, fractional coefficient value of copper spot is equal to one and statistically significant. Therefore, for copper spot, IGARCH model is best fit for the long memory.

Table 4.8 FIGARCH Results for Commodity						
Variable	**Variance Equation**				**Ljung-Box**	
	Constant	ARCH	GARCH	Fraction (d)	Q(20)	$Q^2(20)$
Gold Futures	0.00 (9.8)	0.00 (9.32)	0.82 (51.16)	0.97 (37.71)	61.5	35.12
Gold Spot	0.00 (0.36)	0.00 (0.39)	0.27 (4.28)	0.36 (7.50)	23.29	12.63
Silver Futures	0.00 (4.33)	0.00 (0.65)	-0.02 (-0.43)	0.29 (6.65)	25.99	19.95
Silver Spot	0.00 (3.12)	0.00 (0.48)	0.37 (3.37)	0.28 (6.76)	12.29	21.34
Copper Futures	0.00 (2.44)	-0.00 (-.44)	0.26 (4.56)	0.32 (6.70)	17.34	34.96
Copper Spot	0.00 (247.1)	0.00 (29.93)	0.56 (526.5)	1.00 (3330.7)	20.73	0.108
Crude Oil Futures	0.00 (2.63)	-0.00 (-1.02)	0.164 (2.65)	0.24 (5.89)	15.63	16.5
Crude Oil Spot	0.00 (2.23)	-0.00 (-0.64)	0.25 (5.32)	0.27 (6.27)	13.54	19.93
Natural Gas Spot	-0.00 (-0.83)	0.00 (0.032)	0.21 (4.72)	0.25 (5.98)	28.26	24.76

Note: t-statistics values are in the parenthesis

4.4.4 Spillover effect

Until now, the study has discussed the univariate models and its application to the commodities under study. However, there are evidences that spot and futures tend together over the period, and any changes in the futures market affects spot and any changes in spot market affects futures. Therefore, the study uses multi-variate GARCH (BEKK) model to check futures and spot trend as well as spillover impact.

It is widely accepted that volatilities move together more or less closely over time across the assets or markets. To show the spillover impact between futures and spot, multivariate generalized autoregressive conditional heteroskedasticity (MGARCH) model in vector autoregressive (VAR) is employed where the conditional mean and variance are estimated simultaneously. The MGARCH model is used to study the mean and volatility spillover between futures and spot market is the BEKK parameterization of MGARCH developed by Engle and Kroner (1995). The BEKK model doesn't impose restriction of constant correlation among variables over time. Furthermore, the model incorporates quadratic forms in such a way that ensures the positive semi-definite of the covariance matrix. Bi-variate GARCH model is used to study the volatility transmission among two markets simultaneously.

Few important studies are reviewed as follows:

Tse (1999) examines volatility spillovers between the DJIA index and the index futures. Using bi-variate EGARCH model, he finds a significant bi-directional information flow i.e., innovations in one market can predict the future volatility in another market, but the futures market volatility spillovers to the stock market is more and vice versa. Both markets also exhibit asymmetric volatility effects, with bad news having a greater impact on volatility than good news of similar magnitude.

Baillie and Mayers (1991) examine six different commodities using daily data over two futures contract. They use Bi-variate GARCH models of spot and futures prices of commodities. The optimal hedge ratio (OHR) is then calculated as ratio of the conditional covariance between spot and futures to the conditional variance of futures. From OHR results, they find that standard assumption of time invariant OHR is inappropriate. For each commodity the estimated OHR path appears non-stationary, which has important implications for hedging strategies.

a) Multivariate GARCH model (BEKK Model):

There are two major equations i.e. mean equation and variance equation. The mean equation in the VAR-MGARCH model can be specified as;

$$R_{i,t} = \mu_i + \alpha R_{i,t-1} + \varepsilon_{it} \qquad (4.4.14)$$

can also be stated as:

$$\begin{bmatrix} R_{1,t} \\ R_{2,t} \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} R_{1,t-1} \\ R_{2,t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} \quad (4.4.15)$$

Where $R_{i,t}$ is returns at time t; μ_i is the drift coefficient; and ε_{it} is the error term for the return for the return of ith market,

Let $\varepsilon_t | \varphi_{t-1} \sim N(0, H_t)$; H_t is a 2×2 corresponding variance covariance matrix, $\varphi_{t-1}$is a information set at time t-1. The parameter a_{ij} represents the mean spillover effects from market j to market i whereas the a_{ii} measure their own lagged response.

The BEKK parameterization for variance equation can be given as:

$$H_t = C'C + A'\varepsilon_t\varepsilon'_{t-1}A + B'H_{t-1}B \quad (4.4.16)$$

The individual elements for

$$A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$$

$$B = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}$$

$$C = \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix}$$

A is a 2×2 matrix of parameters and shows how conditional variance are correlated with past squared errors. The elements a_{ij} measure the effects of shocks spillover from the market j to volatility in market i and a_{ii} measure the magnitude of impacts of shocks in market on its own volatility. B is 2×2 square matrix of parameter and show how past conditional variances affect current levels of conditional variances. Thus, b_{ij} implies the volatility spillover from market j to market i and b_{ii} indicates persistence of volatility within the same market.

To have better understanding about the effect of shocks and volatility on the conditional variance equation can be expanded for the bi-variate GARCH(1,1) as :

$$h_{11} = c_{11} + a_{11}^2 \varepsilon_1^2 + 2a_{11} a_{21} \varepsilon_1 \varepsilon_2 + a_{21}^2 \varepsilon_2^2 \quad (4.4.17)$$

$$h_{12} = c_{12} + a_{11} a_{12} \varepsilon_1^2 + a_{21} a_{12} \varepsilon_1 \varepsilon_2 + a_{11} a_{22} \varepsilon_1 \varepsilon_2 + a_{21} a_{22} \varepsilon_2^2 \quad (4.4.18)$$

$$h_{22} = c_{13} + a_{11}^2 \varepsilon_1^2 + 2a_{12} a_{22} \varepsilon_1 \varepsilon_2 + a_{22}^2 \varepsilon_2^2 \quad (4.4.19)$$

Equation (4.4.17), (4.4.18) and (4.4.19) show how shocks and volatility are transmitted across markets and over time. Since two futures and spot markets are used, the transmission mechanism is examined by estimating bi-variate GARCH models.

The BEKK-MGARCH model is estimated using the maximum likelihood method is which the log-likehood can be written as:

$$l(\theta) = -T ln(2\pi) - \frac{1}{2}\sum \ln |H_t| + \varepsilon_t' H_t^{-1} \varepsilon_t$$

Where T is the number of observations and θ represents the parameter vector to be estimates. To obtain the estimates of the parameters, a combination of the standard gradient search algorithm Broyden-Fletcher-Goldfarb-Shanno (BFGS) and simplex algorithm are used.

b) Empirical analysis of Spillover Effect

Multivariate GARCH (BEKK Model) results on commodity series are reported in the table 4.9. The covariance GARCH parameters $a_{11}$and b_{11}, which account for the conditional covariance between spot and futures returns, are all positive and statistically significant, implying strong interactions between spot and futures prices. It seems important to let the conditional covariance be time-dependent rather than restricting it to be a constant. In addition to, there appears to be substantial efficiency gains in modelling the spot and futures prices jointly as opposed to a univariate analysis (Baillie, 2001). As the coefficients $\hat{a}_{11}$ and $\hat{b}_{11}$ are statistically significant indicating that future volatility in all spot and futures are influenced by the shocks and volatilities in their own market for gold, silver and copper. Bi-directional shocks transmission as can be observed from significant coefficient a_{12} and a_{21} for the aforesaid series. The coefficient a_{12} is significant for the commodities like gold, silver and crude oil which mean shocks in the futures market do have impact on spot market volatility. On the other hand, coefficient a_{21} is statistically significant for gold and silver that means shocks in the spot market do affect futures market volatility. However, coefficient a_{21} is statistical insignificant for copper, indicates shocks in the copper spot market do not have any impact on copper futures market volatility. Coefficients b_{12} and b_{21} are statistically significant in case of gold and silver, indicate that the volatility spillover from futures market to spot market and vice versa. For the diagnostic checking, the study has used Ljung-Box Q statistics at the lag (10). Ljung-Box Q (LB) test is applied with 10 lags considering it as the optimal lag length and LBQ test statistics results are reported in the table 4.9.

Table 4.9 Multivariate GARCH Results for Commodity

		Gold	Copper	Silver	Crude Oil
$VAR1$	C	0.024 (15.84)	0.23 (6.69)	0.11 (4.39)	0.094 (2.73)
	AR	-0.17 (-5.01)	-0.43 (-15.46)	-0.79 (-55.16)	-0.23 (-10.01)
$VAR2$	C	0.04 (1.90)	0.205 (6.72)	0.05 (2.24)	0.075 (2.14)
	AR	-0.035 (-1.36)	-0.16 (-9.01)	-0.84 (-8.18)	-0.11 (-5.76)
$\hat{c}_{11}$		-0.00 (-4.04)	1.19 (14.39)	0.357 (9.44)	0.108 (-2.23)
$\hat{c}_{21}$		0.03 (1.08)	0.57 (8.45)	0.353 (14.61)	-0.66 (-10.46)
$\hat{c}_{22}$		0.099 (5.19)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
$\hat{a}_{11}$		0.706 (31.05)	-6.609 (-12.87)	-0.324 (-11.54)	-0.22 (-6.18)
$\hat{a}_{12}$		0.212 (4.45)	-0.906 (-27.11)	-2.42 (-48.92)	-0.87 (-22.16)
$\hat{a}_{21}$		0.002 (1.88)	0.22 (6.22)	0.011 (0.64)	0.13 (6.01)
$\hat{a}_{22}$		0.237 (13.36)	0.33 (10.36)	1.71 (51.05)	0.33 (8.36)
$\hat{b}_{11}$		0.907 (194.1)	0.32 (2.12)	0.44 (134.2)	1.06 (172.9)
$\hat{b}_{12}$		-0.018	-0.46	-0.04	0.193

	(-2.19)	(-6.95)	(-3.5)	(10.73)
$\widehat{b}_{21}$	-0.00 (-0.08)	-0.92 (-9.33)	-0.02 (-1.62)	-0.20 (-8.45)
$\widehat{b}_{22}$	0.96 (216.3)	0.101 (0.74)	-0.068 (-8.39)	0.55 (15.51)
Log-Liklihood	-1849.23	-6833.66	-8088.31	-7340.63
Q(10)	62	520.27	544	481.44
Q^2(10)	15	130.07	69	67.03

Note: t –statistics values are in parentheses

4.9 Conclusion

Examination of macroeconomic dynamics of commodity futures market has focused on issues around volatility clustering, volatility asymmetry, long memory and spillover effects relating to the commodities chosen under the study. By making use of the advanced econometric techniques the findings of the study reported as follows;

Volatility is persistence both in spot and futures market across all the commodities but the degree of persistence differs across the time period for the commodities. Gold spot and futures, Silver futures and spot, and copper spot do not have any asymmetric behaviour properties too. However, asymmetric property exists in the copper futures, crude oil futures and spot, and natural gas spot, which indicates bad news creates more volatility in the above mentioned commodities than good news of similar magnitude. It is observed that the spot and futures series of gold, silver, crude oil, copper futures and natural gas spot have shown long memory properties. Volatility spillover impact is observed to be statistically significant in all the respective spot and futures commodities under the study. Bi-directional shocks transmission as can be observed across the commodities like gold, silver and crude oil which means shocks in the futures market do have impact on spot market volatility for gold, silver and crude oil. As the fractional coefficient value of copper spot is equal to one IGARCH model may perhaps fit the best for examining the long memory process in the series.

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CHAPTER 5

Impact of Futures Trading on Inflation

5.1 Introduction

Inflation in India is a major concern not only for investors and policy makers but also for consumers since it reduces the real purchasing power. Economists around the world have been suggesting different policies to tame inflation. Though these policy measures work in the short run for softening inflation, yet in the long run high inflation restores due to uncertainty in the economy. However, question remains unresolved about the root cause of inflation. It has been argued that futures market is one of the reasons which causes inflation to rise. Possible reason might be speculation activities. Speculator infuses money into the futures market, which can be felt in increasing prices of commodities. There are also several other factors which affect inflation such as seasonal and cyclical variations etc. previous studies have given differential views on futures market and inflation. A few studies claim futures market causes inflation (IMF, 2008[44], Nath and Lingaredy, 2008[45]). Some other studies are inconclusive on futures market and inflation (RBI, 2010[46], Sen, 2008[47]). Therefore, looking at dearth of conclusive evidence on impact of futures trading on inflation, this study makes an attempt to solve this issue empirically.

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[44] IMF (2008): 'Is Inflation Back? Commodity Prices and Inflation', *World Economic Outlook,* Chapter 3, pp.-83-18.

[45] Nath, G. C. and Lingareddy, T. (2008): 'Impact of Futures Trading on Commodity Prices', *Economic & Political Weekly,* Vol. XLIII, pp. 18-23.

[46] RBI (2010): 'Reserve Bank of India Annual Report 2009-2010', Page no. 32

[47] Sen, A. (2008): ' Report of the Expert Committee to Study the Impact of Futures Trading on Agricultural Commodity Prices', *Ministry of Consumer Affairs, Food & Public Distribution*, Government of India

Futures market has been growing significantly in recent years where commodity becomes more investment asset than consumption asset class. This financialisation of commodity markets usually affects commodity price behaviour in general, although views about the extent of influence vary widely among analysts. One perspective is that financialisation of commodities is largely beneficial and improves market efficiency and price discovery. Another view is that recent commodity price surges are largely driven by speculators and herd behaviour among investors looking for alternative asset classes. Increase in food and essential commodity prices in India in 2010-2011 brought to the fore the debate on the commodity futures market is influencing price trends. UNCTAD (2010)[48] argues that commodity futures market is the major cause of price rise as there are extra ordinary increases in the volume of commodity derivatives as asset classes, which attracts swings of short term portfolio investments, causing prices to deviate further from their trend levels. This increasing interest in commodities as an asset class has been termed as “financialization of commodity markets” which is a relatively new factor in price formation in commodity futures market.

Some studies disagree the fact that futures trading causes inflation. Sen (2008) finds that no strong conclusion can be drawn on whether introduction of futures trading is associated with increase or decrease in spot price volatility. RBI annual report, 2010, also finds inconclusive result that futures market causes inflation. Moreover, it suggests that commodity prices in India seem to be influenced more by other drivers of price changes, particularly demand-supply gap in specific commodities, the degree of dependence on imports and international price movements in these commodities. On the contrary, forward market commission says

[48] United Nations Conference on Trade and Development (2010): ‘Recent Developments in Key Commodity Markets: Trends and Challenges. *Multi-year Meeting on Commodities and Development*, Geneva 24-25 March 2010

that future trading does not have any impact on inflation. The price of any commodity is determined by the actual demand and supply position in the market. In an open market situation, prices are bound to fluctuate either way, depending on the additional information which influences expectations of market participants, relating to future demand and supply conditions. The futures market does not alter the basic condition of demand and supply but merely estimates the prices based on the actual and expected demand and supply factors. The demand and supply conditions also influence prices of commodities in which there is no futures trading. The demand-supply gap causes price rise in such commodities too. Therefore, futures trading is not responsible for increase in the prices of commodities. Moreover, it is important to understand that if a rise in spot prices after the introduction of futures trading is seen as an adverse impact, then a fall in spot prices after futures trade without support from fundamental factors to that extent is equally bad for the famers/producers. Hence, the impact of futures trade on spot prices can be best evaluated in terms of their effectiveness in decreasing seasonality. The uni-directional rise in prices can be identified with futures trade only under specific market (scarce/market) condition of the underlying commodity.

Futures market is considered as inflation hedge as investors ultimately care for the real purchasing power of their returns, which means that the threat of inflation is a concern for investors. For them, commodity futures might be a better inflation hedge than stocks or bonds. Firstly, because commodity futures represent a bet on commodity prices, they are directly linked to the components of inflation. Secondly, because futures prices include information about foreseeable trends in commodity prices, they rise and fall with unexpected deviations from components of inflation. On the other hand, many traditional asset classes such as bond and equities are a poor hedge against inflation. Bonds are nominally denominated assets, and their yields are set to compensate investors for expected inflation over the life of the bond. When inflation is unexpectedly higher than the level investors contracted for, the real purchasing power of the cash flows will fall short of expectations. To the extent that unexpected inflation leads to revisions of future expected inflation, this loss of real purchasing power can be significant. Similarly, there are reasons to expect equities to provide a better hedge than bonds against inflation. After all, stocks represent claims against real assets, such as factories, equipment, and inventories, whose value can be expected to hold pace with the general price level. However, firms also have contracts with suppliers of inputs, labour and capital, that are fixed in nominal terms and hence act very much like nominal bonds. In addition, (unexpected) inflation is often not neutral for the real economy. Unexpected inflation is associated with negative shocks to aggregate output, which is generally bad news for equities (Gorton and Rouwenhorst, 2005)[49]. In a nutshell, the opposite exposure to (unexpected) inflation may help to explain why futures do well when stocks and bonds perform badly.

Sen (2008) says that it is difficult to distinguish whether futures markets cause increases (or decreases) in spot prices as both markets reflect the same fundamental supply-demand conditions almost simultaneously. Information based trades can occur in either of the markets depending upon relative transaction costs. The other market then adjusts to maintain the no-arbitrage relationship. In well functioning markets this adjustment is instantaneous so that it may be difficult to identify the sequence of market reactions. Therefore, hardly any conclusive evidence can be drawn that futures market increases spot price.

Speculative activity in futures market is one of the major reasons that cause rise in prices of commodity. For example, if everyone is expecting a price rise of commodity, then it may be thought that there are no dissenting opinions on price rise. All opinions would seem to

[49] Gorton, G. and Rouwenhorst, K. G. (February 2005): 'Facts and Fantasies about Commodity Futures', *Yale ICF Working Paper* No. 04-20 pp. 1-40.

converse over a price rise. It is thought that under these circumstances, if speculators enter the futures market, they would also be buyer rather than sellers and their buying activity may further aggravate the price rise of the commodity and hence inflation. There is a study which says increased investor interest has led to some private analysts to suggest that speculative activity has been a major contributor to the recent surge in commodity prices. It is argued that speculation has magnified the impact of changes in the fundamental determinants of supply and demand, which have been supportive of higher prices, to an extent that in some cases prices have risen far in excess of levels justified by fundamentals. Excessive speculation in the commodity futures market could, in principle, push up futures prices (through arbitrage) and spot prices above levels justified by fundamentals. It is also widely believed that manipulative activity is creating distortion in the futures market and causing inflation. However, an alternative view is that increased investor activity, by providing the necessary liquidity, is simply a vehicle to translate changing views about fundamentals into changing prices. In this case, higher prices would be the cause (rather than the effect) of increased investor participation. In the intermediate case, there could be a two way causality between prices and speculation, so that higher prices induce an increase in speculation, which in turn pushes prices up further until a new equilibrium is achieved.

During financial crisis in 2008, commodity futures markets were heavily influenced by the reactions of institutional investors to growing economic and financial uncertainties. The rise in the notional value of commodity derivative was one of the underlying causes of the increase in prices, and the crisis unfolded; the rapid unwinding of commodity futures positions aggravated the bust and amplified the price shocks. There are also several other factors which causes price rise of commodities apart from futures trading. For example, global food price pressures reflect the combined impact of growing demand and weak supply response. On the supply side, the availability of arable land is shrinking due to increasing urbanization as well as diversion of land for bio-fuels production. Recent spikes in oil prices have also raised the input costs for farms, including transportation and fertilizer costs. Climatic changes and weather related disturbances also impact global commodity prices. Import barriers and large farm subsidies in advanced economies are influencing the supply response through price distortions.

Inflation in India has been increasing significantly in recent years. Analysts believe that futures market is one of the reasons which causes inflation. However, other factors such as implementation of sixth pay commission’s recommendations, government’s welfare scheme like MGNREGA, increment of MSP etc. also cause inflation to rise. These factors contribute to increase in purchasing power of the rural as well as urban people and hence cause inflation. On the other hand, Low energy efficiency and policies on oil subsidies have also contributed to the growth of demand. The demand for metals and minerals, particularly steel, copper, aluminium, oil and coal have increased. In the case of oil, the peak oil hypothesis seems to suggest that global production may be rising. Financialisation of commodities has added a new dimension to the commodity price cycle. Geo-political factors continue to be an important factor behind sudden and sharp increases in oil prices, as has been the case since the beginning of 2011. The spillover effects to domestic prices depend on the degree of import dependence in a commodity, domestic supply demand trends, administered price interventions and pricing power at the wholesale level. The impact ultimately depends on the weight of respective commodities in the WPI and the linkages with other commodities that determine the second round effects. The second round effect reflects response of wages and prices aimed at protecting real wages and profit margins as input costs rise, RBI (2011).

5.3 Literature Review

Some studies argue that futures market causes inflations while others disagree on that. The study reviews some of the important literature, statement of economists and view of the policy makers as follows:

Nath and Lingareddy (2008) attempt to explore the effect of the introduction of futures trading on spot prices of pulses. They find that volatility in urad as well as pulses prices was higher during the period of futures trading than in the period prior to its introduction as well as after the ban of futures contracts.

RBI (2010) studies the impact of futures trading in commodities on their spot prices is through Granger causality tests. The test relating to the sample period for which data are available indicates that futures prices have casual impact on spot prices in the case of sugar and urad. It is also observed that spot prices Granger causes futures prices in case of urad, chana, wheat and sugar. Sugar and urad seem to exhibit two-way causality between spot and futures. The test relates to a monthly data for the period of 2004 to 2009. For commodities on which ban was imposed, data for the period of 2004 to 2007 the empirical analysis, thus, does not provide any conclusive evidence in support of the relationship between spot and futures prices. Commodity prices in India seem to be influenced more by other drivers of price changes, particularly demand-supply gap in specific commodities, the degree of dependence on imports and international price movements in these commodities.

IMF (2008) finds that the short-run causality generally runs from spot and futures prices to speculation, and not vice versa. For crude oil, speculation appears to have had a significant but very small effect on futures prices. However, this has not been translated into a causal impact on spot prices. On the contrary, Gorham (1981) says high and variable rates of inflation have been partly responsible for the tremendous growth in the use of futures markets since many years. Generally, inflation affects the rules which govern the operations of these markets. Periods of rapid inflation also tend to be periods of highly variable differences in the price increases of individual items or commodities. On the positive side, this price uncertainty increases the demand for both the hedging and speculative opportunities afforded by futures markets. On the negative side, this price uncertainty makes it much more difficult for the exchanges to project their own operating costs (Gorham, 1981).

Sen Committee was constituted in 2007 to study whether effects of the futures trading on prices of agricultural commodities. Although in certain sensitive commodities, prices of the commodities did accelerate after introduction of futures trading but it does not necessarily follow that introduction futures trading was the causative factor.

Raizada and Sahi (2006) study the commodity futures market efficiency in India and analyse its effect on social welfare and inflation in the economy. Applying Johansen's cointegration approach on wheat futures market from different futures forecasting horizons ranging from one week to three months, they find that commodity futures market is not efficient even in the short run and the growth in commodity futures markets volumes also has significant impact on the inflation.

Bose (2009) disagrees that futures market causes the price rise of the commodity. She put emphasiss on the role participants can possibly play in the market rather than supply-demand side factor leading to the inflation. On the contrary, Working group on consumer affairs (2011), headed by Modi, suggests that futures trading on essential commodities should be kept, for the time being, out of the futures market as there is lack of strong linkages between spot and futures market.

National Commodity and Derivative Exchange (NCDEX) dismisses allegations that futures trading was causing high inflation in the country and says commodities not being traded contributed almost three times more to the wholesale price index than those traded. NCDEX managing director PH Ravikumar says "Pricing of commodities have gone up due to stagnant productivity and supply shortfalls and to blame commodity exchanges for inflation is misplaced accusation." Montek Singh Ahluwalia, deputy chairman of planning commission, says that commodity futures trading is not the main cause for price rise and inflation in the economy. "I don't support the notion that futures market creates inflation. We should not look at banning futures trading as this market plays an extremely important role in price discovery. Banning futures trading will be contrary to real economic rationale," Mr Ahluwalia avers.

B.C. Khatua, Chairman, Forward Markets Commission (FMC), has said, "futures trading has become a newfound scapegoat for price rise in commodities." Reacting to the manufacturers demand for a ban on steel futures trading to rein in spiralling prices, Mr Khatua said, "India produces about 60 million tonnes of steel per annum, while exchanges trade just about 10-15 lac tonnes. There is no point to say that futures exchange causes price rise of commodities.

The organization of the petroleum exporting countries (OPEC) have also suggested that while geopolitical uncertainties have been a major force behind higher prices, speculation has also been a significant factor, given the organization's accommodative supply policies and the historically high level of inventories in OECD countries. The lack of solid evidence partly reflects data and definitional problems associated with defining and measuring speculation. A price bubble is certainly a theoretical possibility and a periodic occurrence in commodity futures markets.

Due to shortage of conclusive evidence about the impact of futures market on inflation, this study makes an attempt to examine the impact of futures trading on commodity inflation.

5.3 Wholesale Price Index (WPI) in India

Prices do not remain constant in a dynamic market. Inflation rate calculated on the basis of the movement of the Wholesale Price Index (WPI) is an important measure to monitor the dynamic movement of prices. As WPI captures price movements in a most comprehensive way, it is widely used by Government, banks, industry and business circles. Important monetary and fiscal policy changes are often linked to WPI movements. Similarly, the movements of WPI serve as an important determinant, in formulation of trade, fiscal and other economic policies by the Government of India. The WPI indices are also used for the purpose of escalation clauses in the supply of raw materials, machinery and construction work.

Latest revision of WPI in India has been done by shifting base year from 1993- 94 to 2004-05. A representative commodity basket comprising 676 items has been selected and weighting diagram has been derived for the new series consistent with the structure of the economy. The number of quotations selected for collecting price data for the above items are 5482. Total weight to all commodities is 100, and all commodities are divided into three major groups, i.e., primary articles, fuel & power and manufactured products. Primary articles are assigned 20.12 weight, fuel & power is assigned 14.91 where as manufactured products are assigned 64.74 weight.

As it is evident from the aforesaid discussion that the linkage between futures trading and inflation in India is still to be understood which necessitates an empirical investigation. Against this backdrop, the following section has made an attempt to examine the nexus between futures trading and inflation.

5.4 Nature and Sources of Data

To show the impact of futures trading on inflation, the study uses monthly Wholesale Price Index (WPI) from November 2006 to December 2011. WPI has three sub-components, i.e. primary articles, fuel & power and manufacturing products. Sub-component of WPI i.e. fuel & energy data is collected from RBI database and MOSPI. The study has not considered gold, silver and copper for the analysis as the weight assigned to these commodities is very minimal in WPI. The study has considered fuel & power for the analysis where crude oil and natural gas are given maximum weight (i.e. 9.36439). The nearby futures price series of crude oil and natural gas are taken for the analysis. The series is constructed by taking into account the nearby futures contract, which is a contract with the nearest active trading delivery month to the day of trading. The nearby futures contract is used because it is highly liquid and the most active. The commodities are chosen based on MCX's world ranking in terms of number of futures contracts traded in 2011. The daily closing price of crude oil and natural gas futures data from November, 2006 to December, 2011 are collected from MCX website. Then, the study has converted daily data into the average monthly series. That data are transformed into log return form.

A subcomponent of WPI constituting fuel and power has been taken as WPI proxy for the analysis. The above subcomponent carries combined weight of 9.36. As this study concentrates on gold, copper, silver, crude oil and natural gas for studying futures commodity market in India. The study has not considered the whole WPI index for the studying nexus between futures trading and inflation. Therefore, the aforesaid subcomponent (crude oil & natural gas) have been chosen as the proxy futures trading in India. In the process, the study has attempted to examine the impact of futures trading proxy on inflation proxy.

5.6 Tools of Time Series

There has been lot of controversy in this area related to whether the recent commodity price boom has been underpinned by the rapid rise in investment in commodity futures by investors seeking to diversify their portfolios. Because the fair value of commodities is difficult to determine, the issue of whether such behaviour has driven prices away from fundamentals can be addressed through indirect approaches. One approach is to examine whether changes in commodity futures lead to changes in WPI using Granger causality test. Granger causality test has been used in examining the causal linkage between the futures trading and inflation.

The following Granger causality equations have been tested for the said explanation.

$$F_t = \sum_{i=1}^{n} \alpha_i \, WPI_{t-i} + \sum_{j=1}^{n} \beta_j \, F_{t-j} + \varepsilon_{1t} \qquad (5.5.1)$$

$$WPI_t = \sum_{i=1}^{n} \gamma_i \, F_{t-i} + \sum_{j=1}^{n} \sigma_j \, WPI_{t-j} + \varepsilon_{2t} \qquad (5.5.2)$$

Where F_t is the futures and WPI_t is the wholesale price index at period t and it assumed that disturbance terms ε_{1t} and ε_{2t} are uncorrelated. Equation (5.5.1) says futures is related to past values of itself as well as past values WPI. Similarly, equation (5.5.2) reveals WPI is related to past values of itself as well as past values of futures. There are four cases of causation. First, unidirectional causality from WPI to futures is indicated if estimated coefficients on the lagged in equation (5.5.1) are statistically different from zero as a group and the set of estimated coefficient on the lagged futures in equation (5.5.2) is not statistically different from zero. Secondly, unidirectional causality from futures to WPI exists if the set of lagged spot coefficients in (5.5.1) is not statistical significant from zero and set of lagged futures coefficients in (5.5.2) is statistically different from zero. Thirdly, feedback, or bilateral causality, is suggested when the sets of futures and WPI coefficients are statistically significantly different from zero in both regressions. Finally, independence is suggested when the sets of futures and WPI coefficients are not statistically significant in both the regressions.

5.7 Empirical Analysis

To analyze whether futures market causes inflation, the study uses Granger causality test to crude oil futures and natural gas futures. The test results are reported in the table 5.1 for commodities. Different Lag length is selected on the basis of five major selection criteria i.e. LR, FPE, AIC, SC and HQ. In case of crude oil and WPI, we find that uni-directional causality from crude oil futures to WPI that means crude oil futures is the one of the major reasons for causing commodity inflation in India. On the contrary, in the case of natural gas futures and WPI, it is observed that uni-directional causality from WPI to natural gas futures. Moreover, Inflation often increases as per weight given to the commodities in WPI basket. From the results, it is found mix response relation between futures and inflation. Therefore, it can not strongly concluded that futures trading is the only reason that causes inflation to rise.

5.1 Granger Causality Test Results

Variable	Lag	Null Hypothesis	F-statistic & Prob.	Direction
Crude Oil Futures & WPI	6	WPI does not Granger Cause Crude Oil Futures	1.25 (0.29)	Uni-direct.
		Crude Oil Futures does not Granger Cause WPI	4.49 (0.00)	
Natural Gas Futures & WPI	5	WPI does not Granger Cause Natural Gas Futures	4.18 (0.003)	Uni-direct.
		Natural Gas Futures does not Granger Cause WPI	1.90 (0.11)	

Note: Probability values in parenthesis

5.4 Conclusion

Analysing individual commodity, it is found crude oil futures causes inflation where natural gas futures does not cause inflation but natural gas futures can be used as inflation hedge. The study concludes that individual commodity futures trading can be blamed for causing inflation but not the whole futures market. Moreover, whether futures trading causes inflation depends on the weight assigned to the commodities in WPI basket. If a commodity is assigned more weight in WPI than the possibility of commodity futures trading causes inflation will be more. In addition, futures trading alone cannot be blamed for causing inflation in India. There are several other factors such as welfare schemes introduced by Government of India, supply shocks, economic and political instability in developed as well as developing countries could be the cause of inflation in India. The study suggests that there is need for further investigation to understand inflation dynamics in India.

Chapter 6

Summary, Conclusion and Policy recommendations

6.1 Background

Commodity futures market plays significant role for market participants in hedging risk, price discovery and efficiency and stabilisation of commodity prices over a longer period. Price discovery incorporates available information to get equilibrium price of an asset, while hedging risk helps in stabilizing earning flow. Apart from the commodity specific factors, political, economic, social and technological macroeconomic environments exert pressure on commodity prices. A coordinated policy effort that facilitates optimal level of production, distribution and consumption of commodities may stabilise the commodity market. However, the dynamism in internal and external macro environments adds up to the market uncertainties, and as a result, markets in general and commodity market in particular runs into price instability, price spillover and price asymmetry. To avoid the price instability, many a times responsive government resort to policy tools like rationing of the commodity prices, setting of price floor, price ceiling to achieve the socio-economic objectives. The changes in the real market, monetary market, bond market, credit market and stock market also are responsible for commodity market movement, instability and volatility.

6.2 Rationale

The role of commodity futures market is still not clearly understood and researchers even differ across their views. Some studies claims that futures market provides platforms for hedging risk and price discovery. On the contrary, some other literature allege that futures market is one of the major reasons that causes market volatility and inflation to rise.

Commodity price movements, price persistence, price instability and price spillover either in spot or futures commodity market are undoubtedly exposed to macroeconomic dynamics. The volatility clustering, asymmetric behaviour, long memory and spillover effect of the commodity prices have not been much understood in the Indian commodity market context. Furthermore, the futures market linkage with the futures trading has remained a puzzle in the Indian commodity market context. Above all, not much literature on above issues are available in the Indian commodity market context. A systematic empirical investigation for such issues in the context of the Indian commodity futures market necessitates the present study. Hence, the present study tries to fill the gaps in literature on price discovery, price volatility, macroeconomic dynamics of the commodity market and impact of futures trading on inflation in India.

6.3 Objectives of the Study

The broad objective of the study is to analyze macroeconomic dynamics of Indian commodity futures market. The specific objectives are as follows:

1. to examine the price discovery and price volatility in the commodity futures market,
2. to investigate macroeconomic dynamics of commodity futures market:
    a. presence of volatility and volatility clustering in the commodity futures market,
    b. prevalence of asymmetric behaviour in the commodity futures market,
    c. persistence of long memory in the commodity futures market and
    d. emergence of volatility spillover effect of futures commodity market on spot market

3. to examine the impact of futures market on commodity inflation.

6.4 Nature and Sources of Data

The study has resorted to the secondary sources of information, which has been drawn from Multi Commodity Exchange (MCX), Reserve Bank of India (RBI) and Ministry of Statistics and Programme Implementation (MOSPI), India. The study has made use of the data for different frequencies for empirical investigations. Due to non-availability of authentic information in certain cases, the study has used the data for different time periods and frequencies.

To examine price discovery, price volatility and macroeconomic dynamics, daily spot and futures closing prices of gold silver, copper, crude oil and natural gas are collected from MCX. Here we have considered closing price of commodities as it is believed that closing prices incorporate all the information during the trading day. The commodities are chosen based on MCX's world ranking in terms of number of futures contracts traded in 2011, where silver stood 1st followed by gold, copper, natural gas and crude oil.

The nearby futures price series of gold, silver, copper, crude oil and natural gas are taken for the analysis. The future series of the aforesaid commodities are constructed by taking into account the nearby futures contract (i.e. contract with the nearest active trading delivery month to the day of trading). The nearby futures contract is used because it is highly liquid and the most active. Daily futures and spot closing prices are taken from September 1, 2005 to December 30, 2011 for gold, silver, copper, and crude oil. Natural gas futures and spot closing prices are taken from November 1, 2006 to December 30, 2011 based on availability. Data period includes 38 gold futures contracts with 1872 observations, 32 silver futures contracts with 1876 observations, 31 copper futures contracts with 1893 observations, 76 crude oil futures contracts with 1894 observations and 62 natural gas futures contracts with 1554 observations. Futures contracts and observations differ from commodity to commodity as official allocation of contracts differs commodity wise, e.g., gold has six futures contracts per year where crude oil has 12 contracts per year. All the observations are reported excluding Sundays and holidays. Furthermore, we have created data series in such a manner that both spot and futures data are available in a given date.

To show the impact of futures trading on commodity inflation, the study uses monthly Wholesale Price Index (WPI) from Novembe,r 2006 to December, 2011. WPI data is collected from RBI database and MOSPI. Average monthly crude oil and natural gas futures prices data from November, 2006 to December, 2011 are collected from MCX.

6.5 Tools Used in the Study

Different time series techniques are applied to examine above objectives. Engle-Granger two-stage co-integration technique and error correction mechanism are used to examine price discovery in Indian commodity futures market. To examine macroeconomic dynamics of Indian commodity futures market, ARCH family models are used for different sub-objectives. For example, ARCH and GARCH models are used for volatility clustering effect. E-GARCH and GJR-GARCH models are used to examine asymmetric behaviour. FIGARCH is applied to test long memory. Multi-variate GARCH model is used to examine spillover effect. Granger causality test is used to show the impact of futures trading on commodity inflation. Econometric softwares like Eviews 7 and RATS 7.3 are used for the analysis of the above mentioned time series models.

6.6 Major Findings of the Study

In examining the price discovery and price volatility in the Indian commodities market the study has revealed the following results:

- The investigation of cointegration properties of all the futures and spot series under the study affirm long-run equilibrium relationship across all the series.
- Error correction models findings suggest information flows from the futures to the spot market and price discovery takes place in the futures market first and transgress into the spot market in Indian commodity market.
- In examining price volatility through ratio of standard deviation of futures to spot, the study finds that inefficient utilisation of information in the gold market while there is an efficient utilisation of information in silver, copper, crude oil and natural gas market.

Examination of macroeconomic dynamics of commodity futures market has focused on issues around volatility clustering, volatility asymmetry, long memory and spillover effects relating to the commodities chosen under the study. The summary of findings for the macroeconomic dynamics of the Indian commodity futures market is reported as follows:

- All series under the study show heteroskedasticity effect except the natural gas futures which suggests inapplicability of dynamic models to natural gas futures series.
- Volatility is observed to be persistent both in spot and futures market across all the commodities but the degree of persistence differs across the time period for the commodities under the study.

- Volatility is persistence both in spot and futures market across all the commodities but the degree of persistence differs across the time period for the commodities.

- Volatility is observed to be persistently high around the global financial crisis for all the commodity series. Gold futures and spot returns do not have any asymmetric behaviour that means bad news and good news has similar impact on current changes in gold returns.
- Silver futures and spot, and copper spot do not have any asymmetric behaviour properties too. However, asymmetric property exists in the copper futures, crude oil futures and spot, and natural gas spot, which indicates bad news, creates more volatility in the mentioned commodities than good news of similar magnitude.
- In examining long memory process model reveals that all the commodity series contain long memory properties.
- The study reveals the prevalence of spillover effect between spot and futures market in gold, silver and crude oil. However, copper spot and futures market do not show any spillover effect.
- Bi-directional shocks transmission as can be observed across the commodities like gold, silver and crude oil which means shocks in the futures market do have impact on spot market volatility for gold, silver and crude oil.
- As the fractional coefficient value of copper spot is equal to one IGARCH model may perhaps fit the best for examining the long memory process in the series.

In examining the impact of futures trading on commodity inflation the following results are obtained:

- Using the Granger causality test between a sub-component of wholesale price index of fuel and power, and futures prices of crude oil and natural gas the study suggests the presence of uni-directional causality between crude oil futures and inflation.
- Using the Granger causality test between a sub-component of wholesale price index of fuel and power the study suggests that the inflation granger causes the natural gas future price otherwise.

6.7 Conclusion

In conclusion, the study finds that price discovery takes place in the futures market first and transfers into the spot market in the Indian commodities market. Secondly, in examining the volatility clustering effects, the study affirmed that previous period news/shocks impact current price changes for all the commodities under consideration. Further volatility persistence is observed to be felt across all the commodities but the degree of persistence differs across the time period for all the commodities. It is inferred from the graphical analysis that the volatility is observed be persistently high during global financial crisis. Thirdly, in examining the asymmetric behaviour, the study finds that gold and copper futures and spot returns do not have any asymmetric behaviour which suggests that good news has similar impact on current changes in return series. However, asymmetric property exists in the copper futures, crude oil futures and spot, and natural gas spot, which indicate that bad news creates more volatility for said commodities than good news of similar magnitude. Fourthly, the study reveals the presence of long memory properties in gold, silver and crude oil spot and futures series. However, the natural gas spot price series contains the long memory process as well. In examining the fractional coefficient value of copper spot, it is observed to be equal to one and statistically significant that may suggest the presence of long memory. Fifthly, the study also concluded that the realisation of spillover effect between spot and futures market in gold, silver and crude oil but not in the context of copper spot and futures market. Finally, the Granger causality test between a sub-component of wholesale price index of fuel and power suggests that futures prices of crude oil granger cause inflation.

6.8 Policy recommendations

The following policy recommendations emanate from the present study:

- As the price discovery takes place in the commodity futures market and transfers into the spot market in India, in a policy stance it is suggested that policy makers may allow the commodity futures market to behave freely with least regulation in its functioning.
- In case of gold, inefficient utilization of information might lead inefficient price discovery. Therefore, policy makers should make the policies in such way that market will incorporate all the information efficiently.
- Futures trading on crude oil should be banned as it causes inflation.
- Policy makers should design liberalized macro policy tools that would facilitate commodity futures market functioning with a continuous watch into national and international macroeconomic dynamics in a regular basis.

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Appendix A

Glossary

Arbitrage: Buying commodities in market where it is cheaper and selling it in the market where it is dearer.

Backwardation: A situation where, and the amount by which, the price of a commodity for future delivery is lower than the spot price, or a far future delivery price is lower than a near futures delivery.

Basis: The difference between spot price and futures price of a given commodities.

Basis Risk: The risk to a hedger that arises from the uncertainty about the basis at a future time.

Clearing House: A body corporate, an association, or an organization forming part of commodity futures exchange that clears and settles commodity futures contracts and makes adjustments to the contractual obligations arising out of those commodity futures contract.

Commodity: A commodity is an article or product that is used for commerce, is movable, has a value, can be bought and sold, that is produced or used as a subject in a barter or sale.

Contango: when the futures price is above the expected future spot price. Consequently, the price will decline to the spot price before the delivery date.

Convergence: A movement in the price of a futures contract towards the price of the underlying product or physical good, rather than the contract or derivative product.

Cost of Carry: For physical commodities such as grains and metals, the cost of storage space, insurance, and finance charges incurred by holding a physical commodity. In interest rate futures markets, it refers to the differential between the yield on a cash instrument and the cost necessary to buy that instrument.

Delivery: The tender and receipt of the actual commodity, or of a delivery instrument covering the commodity (e.g., warehouse receipts or shipping certificates), used to settle a futures contract.

Derivatives: The generic term used to categorize a wide variety of financial instruments whose value is 'derived from' or 'depends on' the value of the underlying instrument, reference rate or index.

Exchange: A safe environment in which market participants can trade. Regulated exchanges are like club members' behaviour. These are marketplaces where buyers and suppliers negotiate prices, usually with a bid and ask system, and where prices move up and down.

Forward Contract: A contract between two counterparties where one person agrees to buy from the other person, who agrees to sell, a certain quantity of a financial instrument or commodity at a pre-determined price but for delivery at an agreed future date.

Fundamental Analysis: Fundamental analysis essentially involves the study of the underlying economic factors of supply and demand for individual commodities, or even an entire sector, for the purpose of predicting the future.

Futures Contract: A contractual agreement, generally made on the trading floor of a futures exchange, to buy or sell a particular commodity or financial instrument at a pre-determined price on a future date.

Hedging: The practice of offsetting the price risk inherent in any spot market position by taking an equal but opposite position in the futures market.

Long Position: The buying side of an open futures contract or futures option;(2) a trader whose net position in the futures or options market shows an excess of open purchases over open sales.

Margin: Cash or equivalent deposited as guarantee of fulfilment of a futures contract.

Marking to Market: The process by which the changes in the value of futures contracts are settled daily.

Open Interest: Open interest is the total number of outstanding contracts in futures market yet to be settled at the end of each trading period.

Payoff: A pay off is the profit or loss that is likely to be faced by the market participants with changes in the price of the underlying asset. Payoff diagrams are used to graphically represent these, with the price of the underlying being plotted of the X axis and the profit or loss on the Y axis.

Appendix B

MCX

Contract Specifications of Gold

Table B.1 Contract Specifications of Gold **Annexure 1**

Symbol	GOLD
Description	GOLDMMMYY
Contract Listing	Contracts are available for February, April, June, August, October and December calendar months of the year, as per the contract Launch Calendar.
Contact Start Day Last Trading Day	16th day of contract launch month. If 16th day is a holiday then following working day 5th day of contract expiry month. If 16the day is 5th is a holiday then preceding working day.
Trading Period	Mondays through Saturdays
Trading Session	Mondays to Friday: 10.00 a.m. to 11.30 p.m. Saturday: 10.00 a.m. to 2.00 p.m.
Trading Unit	1 kg
Quotation/Base Value	10 grams
Price Quote	Ex-Ahmedabad (inclusive of all takes and levies relating to import duty, customs but excluding sales tax and VAT, any other additional tax or surcharge on sales tax, local taxes and octroi)
Maximum Order Size	10kg

Tick Size (Minimum Price Movement)	Re. 1 per 10 grams
Daily Price Limit	The bas 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% with the approval of FMC*
Initial Margin	4%
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: 2.5 MT for all Gold contracts combined together For a member collectively for all clients: 12.5 MT or 15% of the market wide open position whichever is higher, for all Gold contracts combined together.
Delivery	
Delivery Unit	1 kg
Delivery Period Margin	25% of the value of the open position during delivery period
Delivery Center(s)	Ahmedabad and Mumbai at designated Clearing House facilities of Group Securicor at these centers and at additional delivery centers at Chennai, New Delhi and Hyderabad (for procedure please refer circular no. MCX/198/2005)
Quality	995 purity

Specifications	It should be serially numbered Gold bars supplied by LBMA approved suppliers or other suppliers as may be approved by MCX to be submitted along with supplier's quality certificate.
If the Seller offers delivery of 999 purity	Seller will get a proportionate premimum and sale proceeds will be calculated in the manner of Rate of delivery* 999/995 If the quality is less than 995, it is rejected.
Due Date Rate Delivery Logic	DDR is calculated on the expiry day of the contract. This calculated by way of taking simple average of last 3 days spot market prices of Ahmedabad. Compulsory

Contract Launch Calendar of Gold

Contract Launch Months	Contract Expiry Months
After approval of the Commission	February 2012
April 2011	April 2012
June 2011	June 2012
August 2011	August 2012
October 2011	October 2012
December 2011	December 2012

Delivery and Settlement Procedure of Gold Contracts **Annexure 2**

Delivery Logic	Compulsory Delivery
Last Day of Trading	5th day of contract expiry month
Tender Period	1st to 6th day of the contract expiry month
Delivery Period Buyer's Intention	1st day 6th day of the contract expiry month On 1st, 2nd , 3rd , and 4th of the contract expiry month
Tender notice by seller	The seller will issue tender notice along with evidence of delivery (Vault Receipt, Packing List, Certificate etc) to the Exchange in a specified format by 6:00 p.m. during weekdays and on Saturdays by 12:00 noon.
Dissemination of information on tendered delivery and buyers interest	The exchange will inform members through TWS regarding tender notice and delivery intentions of the seller's members and the buyers respectively by 7.00 p.m. on the respective tender days and on Saturdays by 1:00 p.m.
Tender Period Margin	5% incremental margin for last 5 days on all outstanding positions. Such margin will be addition to initial, additional and special margin as applicable.
Delivery Period Margin	25% on the market quantity
Exemption from Tender and Delivery Period Margin	Tender & Delivery Period Margin is exempted if goods tendered on designated tender days of the contract month and seller submits all the documentary evidence.
Delivery Pay-in	On Tender Days: On any tender days by 6.00 p.m. during week days and by 12.00 noon on Saturdays except Sundays and Trading Holidays. Marking

	of delivery will be done on the tender days based on the intention received from the sellers after the trading hours. On Expiry: On expiry all the open positions shall be marked for delivery Delivery Pay-in will be on E+1 basis by 11.00 a.m. except Saturdays, Sundays and Trading Holidays.
Funds Pay-in	T+1 working day by 11.00 a.m.(“T “ stands for tender day)
Funds Pay-out	T+1 working by 05.00 p.m.
Delivery Pay-out	T+1 working day after completion of Funds pay-in
Mode of communication	Fax or courier
Penal Provision	A penalty of 2.50% or DOR will be imposed on defaulting buyer/seller out of which 2.00% will be credited to IPF and 0.50% will be credited to the counter party. And 4.00% of DOR as a replacement cost will be charged from defaulting buyer / seller out of which 90% will be given to the counter party and 10% will be retained by the Exchange as administrative expenses. Additionally, On the date of default by the seller, if spot price is higher by 6.5% or more than the DOR (Delivery Order Rate), then the difference amount between spot price on default date minus (DOR+6.5% of DOR) e.g. DOR Rs 100 and spot price is Rs. 110, then the difference amount would be Rs. 3.5 i.e. Rs 110-Rs 110 (100+6.50). Such

	difference will be charged to the seller. On the date of default by the Buyer, if spot price is lower by 6.5% or more than the DOR, then the difference amount between DOR minus is (DOR is Rs 100 and Spot price is Rs 90 on default date e.g., then different amount would be Rs 3.5 i.e.Rs100-(90.6.50). such difference will be charged to the buyer
Allocation of delivery	On the respective tender days after the end of the day
Delivery order rate (DOR)	Settlement/ closing price on the respective tender days except on expiry date. On expiry date the delivery order rate shall be the Due Date Rate (Due Date Rate) and not the closing price.
Buyer's obligation	The buyer shall not refuse taking delivery and such refusal will entertain penalty as per the penal provision
Close out of outstanding positions	All outstanding positions on the expiry of contract, not settled by way of delivery in the aforesaid manner, will be settled as per the due date rate with penalty as per penal provisions.
Verification by the buyer at the time of release of delivery	At the time of taking delivery, the buyer can check his delivery in front of G4S personnel. If he is satisfied with the quantity, weight and quality of material, then he will issue receipt instantly. If he is not satisfied with the quality of material, then he will issue receipt instantly. If he is not satisfied with the quality, he can insist for assaying by any of the approved assayers available at the center. If the buyer chooses for assaying, G4S person will carry the good to the assayer facilities, get it assayed and bring it back to G4S facilities along with assayer's certificate. If the assayer's certificate differs from the certificate submitted by the seller have to mutually negotiate the final settlement proceeds within 1 day from receipt of assayer's report, however if they do not agree on any mutually acceptable amount within 1 day, then the exchanged will send the goods to a second assayer and in that case , the report received from

	such as assayer will be final and binding on both buyer and seller. The cost of first assaying as well as cost of transportation from G4S to assayer's facilities to and fro will be borne by the buyer, while the cost of second assaying, if any, will be equally divided between the buyer and seller. The vault charges during such period of first and second assaying, if any, will be borne by both the buyers and sellers equally. If the buyer does not opt for assaying at the time of lifting delivery, then he will not have any future recourse to challenge the quantity or quality subsequently and it will be assumed that he has received the quantity and quality as per the bill made by the seller.
Delivery Centers	Ahmedabad and Mumbain at designated clearing House facilities of G4S at theses centers and at additional delivery centers at Chennai, New Delhi and Hyderabad (for procedure please refer circular no. MCX/198/2005).
Legal Obligation	The members will provide appropriate tax forms wherever required as per law and as customary and neither of the parties will unreasonably refuse to do so.
Takes, duties, cess and levies	Ex-Ahmedabad Inclusive of all takes/ levies relating to import duty, customs but excluding sales tax/ VAT, any other additional tax or surcharge on sales tax, local taxes and Octori.
Vault, Insurance and Transportation charges	Borne by the seller up to commodity pay-out date Borne by the buyer after commodity pay-out date
Evidence of stock in possession	At the time of issuing delivery order, the member must satisfy the exchange that he holds stocks of the quantity and quality specified in the Delivery order at the declared delivery center by productig vault receipt.

Validation Process	On receipt of delivery, the G4S personnel will do the following validations. a. Whether the person carrying gold is the designated clearing agent of the member. b. Whether the selling member is the bonfide member of the exchange. c. Whether the quantity being delivered is from exchange approved refinery. d. Whether the serial numbers of all the bars is mentioned in the packing list provide. e. Whether the original certificates are accompanied with the Gold bars Any other validation checks, as they may desire
Delivery Process	In case any of the above validation fails, the G4S will contact the exchange office and take any further action only as per instructions received from the exchange in writing. If all validations are through, then the G4S personnel will put the Gold in the Vault. Then the custodian of G4S will cut a serially numbered G4S receipt (in triplicate consisting of white, pink and Yellow slips), get the signature of the seller's clearing agent and sigh the same for authorization, hand over the Yellow colour slip to seller's clearing agent, send by courier the third copy (pink colour slips), while retaining the white for the record of G4S. G4S in front of the selling member's clearing agent will deposit the said metal into their vault
Quality Adjustment	The price of gold is on the basis of 995 purity. In case a seller delivers 999 purity, he would get a premium. In such case, the sale proceeds will be calculated by way of delivery order rate *999/995
Procedure of taking	For the purpose of taking delivery of goods fully or partially, the

delivery from the Vault	Member shall send to the Exchange an Authority letter on his Letter head, authorising a representative on his behalf to take delivery. The Authority letter sent by the Member shall consist of the following details: a. Name of the authorised representative b. Name of the commodity along with quantity c. Name of the Vault along with the location d. Signature of the authorised representative e. Proof of Identity viz. PAN card, driving license, Election ID. f. Photo identity proof duly attested by the Member. The above mentioned details are required to be sent to the Exchange. Once the exchange receives the above mentioned details, the exchange will send delivery order to the Vault authorities. Based on the Delivery order received, the Vault will issue the requested quantity to the authorised representative who has to present himself personally at the Vault along with the requisite photo identity proof in original, the copy of which was sent/ communicated to the Exchange by its Member. The Vault official will, upon final scrutiny/checking of the identity, deliver goods to the representative of the Member. The vault official in case of any discrepancy or doubt or any other reason my refuse to issue the goods to the representative under the intimation to the Exchange. The delivery given to the representative shall be final & binding to the member and their constituents at all times.
	Deliverable grade of Underlying commodity the selling members

	tendering delivery will have the option of delivering such grades as per the contract specifications. The buyers has no option to select a particular grade and delivery offered by the seller and allocation by the Exchange shall be binding on him.
Endorsement of delivery order	The buyer member can endorse delivery order to a client or any third party with full disclosure given to the exchange. Responsibility for contractual liability would be with the original assignee.
Extension of delivery Period	As per exchange decision due to a force measure or otherwise.
Due date rate(DDR)	DDR is calculated on the expiry day of the contract. This is calculated by way of simple average of last 3 days spot market prices of Ahmedabad
Applicability of Business Rules	The general provisions of Byelaws, rules and business Rules of the exchange and decisions taken by forward markets commission, Board of Directors and Executive Committee of the Exchange in respect of matters specified above will form and integral part of this contract. The Exchange of FMC as the case may be further prescribe additional measures relating to delivery procedures warehousing, quality certification, margining, risk management from time to time. The buyer shall have to lodge their claim against quality and/or quantity disputed goods in the warehouse itself(without lifting them out of the warehouse), if any, within 48 hours from the date of scheduled pay out of the exchange thereafter. (The interpretation or clarification given by the Exchange of any terms of this contract shall be final and binding on the members and others.)

Source: Multi Commodity Exchange Ltd. India

MCX

Annexure 1

Contract Specifications of Crude Oil

Symbol	Crude oil
Description	CRUDEOILMMMYY
Contract Listing	Contract are available for all 12 calendar months in a year, as per the contract launch calendar.
Contract Start Day Contract Trading Day	As per the contract Launch Calendar As per the Contract Launch Calendar
Trading Period	Mondays through Saturdays
Trading Period	Mondays through Saturdays
Trading Session	Monday to Friday: 10:00 a.m. to 11.30 p.m Saturday: 10.00 a.m. to 2.00 p.m.
Trading Unit	100 barrels
Quotation/Base Value	Rs. Per barrel
Maximum Order Size	10,000
Tick Size (Minimum Price Movement) Price Quote	Re. 1 Ex- Mumbai excluding all takes, levies and other expenses
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 is more than the maximum daily price limit (currently 9%), the same may be further relaxed in steps of 3% with the approval of FMC
Initial Margin	5%
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 position.
Maximum allowable Open position	For individual clients: 4,80,000 barrels For a member collectively for all clients: 24,00,000 barrels or 15% of the market wide open position, whichever is higher
Delivery Unit	50,000 barrels with +/- 2% tolerance limit
Delivery Margin	25%
Delivery Centre	Port installation at Mumbai/ JNPT Port
Quality Sepcification	Light sweet crude Oil confirming to the following quality specification is deliverable Sulfur 0.42% by weight or less. API gravity: Between 37 degree – 42 degree All volumes are defined at 60 degree Fahrenheit
Due Date Rate	Due date rate is calculated on the last trading day of the contract on the basis of the market price of crude, ex-Mumbai, excluding all taxes, levies and freight, as available for this variety from various market sources and converted at the Rupee- US Dollar rate prevailing on expiry
Delivery Logic	Both option

Synopsis of the thesis submitted in partial fulfilment of the award of Ph.D. degree in Department of Economics

Macroeconomic Dynamics of Indian Commodity Market: An Econometric Investigation into Metal and Energy Futures

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I. Introduction

The role of commodity futures market is still sceptical as researchers differ in their views. It is widely claimed that futures market provides platform for hedging risk and price discovery (Garbade and Silber, 1983[1]; Moosa, 2002[2]). On the contrary, a few others allege that futures market causes market volatility and increases inflation (Nath and Lingareddy, 2008[3] and Ahamad, Shah, and Saha, 2010[4]). Price discovery, price volatility, market dynamics and inflation have been prime concern for market participants including policy makers over a period of time. These features play a key role in the investment and policy decisions. Due to inconclusive evidence of previous studies on the role of futures market, this study makes an attempt to examine price discovery, price volatility, market dynamics and impact of futures trading on inflation empirically.

Hedging risk and price discovery are considered as two major economic objectives of commodity futures market. Hedging risk controls risk exposure due to adverse seasonal and cyclical price fluctuations of the commodities. While price discovery reveals information about future spot market price through futures market price. The price discovery function depends on whether new information is reflected first on futures or spot prices. If information is reflected first in futures prices and subsequently on spot prices, futures prices should lead the spot prices, indicating that the futures market performs the price discovery function well. If, on the other hand, spot prices lead futures prices then the spot market is said to dominate the futures market, in which case the spot price is merely a satellite of the futures price

[1] Garbade, K. D. and Silber, W. L. (1983): 'Price Movements and Price Discovery in Futures and Cash Markets', *The Review of Financial and Economic Studies*, Vol. 65, pp. 421-440.
[2] Moossa, I. M. (2002): Economic Note by Banca Monte dei Paschi di Siena SpA, Vol.31, pp.155-165.
[3] Nath, G. C. and Linagareddy, T (2008): 'Impact of Futures Trading on Commodity Prices, Economic & Political Weekly, Vol. XLIII, pp. 18-23.
[4] Ahmad, H., Shah, A. Z. S. and Shah, I. A. (2010): 'Impact of Futures Trading on Spot Price Volatility: Evidence from Pakistan', *International Research Journal of Finance and Econometrics*, Vol.59, pp.145-165.

(Moosa, 2002)[5]. Moreover, spot and futures together play a major role in an efficient price discovery process in commodity futures market.

Commodity futures market is said to be efficient if it utilises all of the available information in setting the prices (Fama, 1970)[6]. The intuitive idea behind this concept of efficiency is that producers and investors process the information that is available to them and take positions according to that information. In an efficient market, there is perfect and instantaneous flow of information that helps in determining market price. In this scenario, futures price should move concurrently with its corresponding spot price without lead or lag in price movement from one market to other. However, if one market processes information faster than the other, a lead-lag relation will exist. There are many reasons why one market will react more rapidly to the arrival of new information. Possible reasons include ease of short sale, lower transaction cost, institutional arrangements and market microstructure effect (Foster, 1996)[7]. The lead-lag characteristics of futures and spot market illustrate how rapidly one market incorporates information relatively to the other. These characteristics also indicate the efficiency of their functioning as well as degree of integration between the two markets. Furthermore, futures market is linked to the underlying spot market by arbitrage which stabilises price and thus decreases the spot market volatility.

Volatility is as similar as but not exactly the same as risk. Risk is associated with undesirable outcome, whereas volatility measure strictly for uncertainty could be due to positive outcome (Poon, 2005)[8]. Some study affirms that the cause of volatility is the arrival of unanticipated information that alters expected returns on commodities. Thus, changes in market volatility would merely reflect changes in the local or global economic environment (Engle and Ng. 1993)[9]. Others claim that volatility is caused mainly by changes in trading practices or patterns, which in turn are driven by factors such as modifications in macroeconomic policies, shifts in investor tolerance of risk and increased uncertainty. The measurement and forecasting of volatility is essential for the characterization of dynamics of market, valuation of assets, pricing of derivative instruments, and choices that affect portfolio allocation

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[5] Moossa, I. M. (2002): Economic Note by Banca Monte dei Paschi di Siena SpA, Vol.31, pp.155-165.
[6] Fama, E. (1970): 'Efficient Capital Markets: A review of Theory and Empirical Works', *The Journal of Finance*, Vol. 25, pp. 383-417.
[7] Foster, J. A. (1996): 'Price Discovery in Oil Markets: A Time Varying Analysis of the 1990-91 Gulf Conflict', *Energy Economics*, Vol.18, pp.231-246.
[8] Poon, S. H. (2005): 'A Practical Guide to Forecasting Financial Market Volatility, (ed) book, John Wile & Sons. Ltd.
[9] Engle, R. F. and Ng V. (1993): 'Measuring and Testing the Impact of News on volatility', *Journal of Finance*, Vol.43, pp.1949-77.

decisions. Furthermore, policy makers, including central banks often rely on volatility estimates to assess the vulnerability of markets and the economy (Khalifa, Miao and Ramchander, 2011)[10].

It is widely believed that speculative activity in the futures market is the major cause of inflation. Liquidation to the futures market, through speculation, can create discrepancies in the commodity prices that can lead to unwarranted inflation or depressions driven by supply shocks. It can distort the equilibrium between demand and supply in specific commodities on prices, weakening thereby the role of fundamentals in the price discovery process. Speculation in the futures prices of commodities has been argued to affect the spot price through the channel of arbitrage. There is also an alternative view that in increased investor activity, by providing the necessary liquidity, is simply a vehicle to translate changing views about fundamental in changing prices. In this case higher prices would be the cause (rather than effect) of increased investor participation. On the contrary, few studies (RBI, 2010[11]; Sen, 2008[12]) did not find any strong conclusion that futures trading causes inflation. Furthermore, there could be a two-way causality between prices and speculation, so that higher price induces an increase in speculation, which in turn pushes prices up further until a new equilibrium is achieved. Due to inconclusive evidence, this study attempts to focus on the impact of futures trading on inflation.

Aforesaid discussion has helped us to understand the importance of futures market and its association with the spot market in general. However, it is not conclusively understood in the Indian context. As a result of which, Government of India has continually remained sceptical about the functioning of the commodity futures market and its outcome. Without understanding proper nature and dynamics of the commodity futures market functioning, government has resorted to continual ban of futures trading in some commodities and engaged actively in regulating futures market functioning in India. Control and active regulations of the futures commodity market has drawn wide attention of policy makers, analysts and academicians so as to examine its impact on the economy in general and different market participants in particular. A group of intellectuals still argue that our policy

[10] Khalia A. A. A., Miao, H. and Ramchandar, S. (2011): ‘ Measuring and Forecasting Volatility in the Metal Futures Markets’, *The Journal of Futures Market*, Vol. 48, pp, 27-77.
[11] Reserve Bank of India Annual Report 2009-10: ‘Impact of Futures Trading on Inflation’ (pp.32).
[12] Abhijit Sen (2008): ‘ Report of the Expert Committee to Study the Impact of Futures Trading on Agricultural Commodity Prices’, *Ministry of Consumer Affairs, Food & Public Distribution*, Government of India.

makers have not understood fully the functioning of the futures market in India. Further, the benefits and drawbacks of such markets need to be understood in proper perspectives.

Some studies even claim that futures market does not cause inflation rather helps hedging risks, enables price discovery and fair pricing of the commodities, but to many others it is just not convincing. It is also understood that futures market is largely influenced by the national and international macroenviroments. The macroeconomic dynamics play major roles in futures markets' demand supply scenario, price stabilisation, pricing volatilities, volume of spread, price discovery including market efficiency. Drawing the insights from some of the existing literature, policy makers attempt to ban and regulate the futures trading owing to its potential pressure in increasing general level of prices in the economy.

II. Justification of Study

Producers, investors and policy makers use price discovery as barometer for their decision making process in the commodity market. Existing literature is quite diversified with its views on price discovery process and occurrences in the commodity market. A wide array of literature suggests that price discovery takes place in futures market and then transgress to spot market. On the contrary, a few studies affirm that spot is the satellite for the price discovery and futures market realises the price changes afterwards. Some studies also suggest that there is simultaneity in the price discovery process both in spot and futures commodity market. Hence, the literature on price discovery is widely divided in the commodity market context. Furthermore, not much literature on price discovery process is available in the Indian commodity market context. There is a need for an empirical investigation for price discovery process in the Indian commodity market. Efficiency of market depends on the way the market incorporates the information to discover a competitive reference price. If futures market is less volatile than the spot market then there is a chance of inefficient use of information. On the other hand, if futures market is more volatile than spot market then there is chance of excess speculative activities. A few studies are available on price volatility specifically Indian commodity futures market. Therefore, this study makes an attempt to analyse the price volatility empirically.

Commodity price movements, price persistence, price instability and price spillover either in spot or futures commodity market are undoubtedly exposed to macroeconomic dynamics. The volatility clustering, asymmetric behaviour, long memory and spillover effect of the commodity prices have not been much understood in the Indian commodity market context that necessitates a formal study.

There is a notion that futures trading causes inflation through speculation. Speculators infuse money into futures market, expecting that price of the commodities will rise in future. This speculative behaviour perhaps increases the commodity prices that exerts price pressure on general basket of commodities thereby economy experiences commodity inflation. Policy makers and researchers are not under consensus whether futures trading causes inflation. Therefore, this study has made an attempt to resolve the confusion whether futures trading causes commodity inflation in India. Hence, the study tries to fill the gap in the literature on price discovery, macroeconomic dynamics of the commodity market and futures trading causing inflation in India.

III. Objectives of Study

The broad objective of the study is to analyse macroeconomic dynamics of Indian commodity futures market. The specific objectives are as follows;

a) to examine price discovery and price volatility in the commodity futures market,
b) to investigate macroeconomic dynamics of commodity futures market and,
c) to examine the impact of futures market on commodity inflation.

IV. Literature Review

Garbade and Silber (1983) use their model to seven commodities i.e. wheat, corn, oats, orange juice, gold and silver. They find that, in general, futures markets dominate spot market. Their evidence suggests that the spot markets in wheat, corn, and orange juice are largely satellites of the futures markets for those commodities, with about 75% of new information incorporated first in futures prices and then flowing to cash prices. The pricing of silver and especially oats and copper are more evenly divided between the cash and futures markets. However, the spot market also plays a role in the price discovery. Silvapulle and Moosa (1999) find more evidence for causality from futures prices to spot prices than otherwise. They also claim that although the futures market may play a major role in the price discovery process, the spot market also plays a role in this respect

Yang and Brorsen (1993) find that estimated GARCH terms are significant at the one percent level which implies, variances of price changes are autocorrelated. Using BDS test, they find volatility clustering in price futures price changes. Moreover, the distribution is not normal. They are slightly skewed and have fat tails. Liew and Brooks fitting the GARCH model (1998) find volatility clustering effects in crude palm oil futures market. Further, their result strongly supports the presence of seasonal effects in volatility.

Beakaert and Wu (2000) examine asymmetric volatility in the Japanese equity market using general empirical framework based on multivariate GARCH-in-mean model. They also try to differentiate between the two main explanations for the asymmetry and conclude that volatility feedback is the dominant cause of the asymmetry for the Japanese stock market.

Tanscuhat, Chang and Mcaleer (2009) estimate the long memory models for agricultural commodity futures returns from different futures markets. Using FIGARCH model, they find existence of long memory in almost all the commodities under study. On the contrary, Crato and Ray (2000) find that no evidence of long memory on the returns.

Tse (1999) examines volatility spillovers between the DJIA index and the index futures. Using bi-variate EGARCH model, he finds a significant bi-directional information flow i.e., innovations in one market can predict the future volatility in another market, but the futures market volatility spillovers to the stock market is more and vice versa. Both markets also exhibit asymmetric volatility effects, with bad news having a greater impact on volatility than good news of similar magnitude.

Nath and Lingareddy (2008) attempt to explore the effect of the introduction of futures trading on spot prices of pulses. They find that volatility in urad as well as pulses prices was higher during the period of futures trading than in the period prior to its introduction as well as after the ban of futures contracts.

V. Nature and Sources of Data

The study has resorted to the secondary sources of information, which have been drawn from Multi Commodity Exchange (MCX), Reserve Bank of India (RBI) and Ministry of Statistics and Programme Implementation (MOSPI), India. The study has made use of the data for different frequencies for empirical investigations. Due to non-availability of authentic information in certain cases the study has used the data for different time periods and frequencies.

In examining price discovery, price volatility and macroeconomic dynamics, daily spot and futures closing prices of gold, silver, copper, crude oil and natural gas are collected from MCX. Here we have considered closing price of commodities as it is believed that closing price incorporates all the information during the trading day. The commodities are chosen based on MCX's world ranking in terms of number of futures contracts traded in 2011, where silver stood 1st followed by gold, copper, natural gas and crude oil.

The nearby futures price series of gold, silver, copper, crude oil and natural gas are taken for the analysis. The futures series of the aforesaid commodities are constructed by taking into account the nearby futures contract (i.e. contract with the nearest active trading delivery month to the day of trading). The nearby futures contract is used because it is highly liquid and the most active. Daily futures and spot closing prices are taken from September 1, 2005 to December 30, 2011 for gold, silver, copper, and crude oil. Natural gas futures and spot closing prices are taken from November 1, 2006 to December 30, 2011 based on availability. Data period includes 38 gold futures contracts with 1872 observations, 32 silver futures contracts with 1876 observations, 31 copper futures contracts with 1893 observations, 76 crude oil futures contracts with 1894 observations and 62 natural gas futures contracts with 1554 observations. Futures contracts and observations differ from commodity to commodity as official allocation of contracts differs commodity wise. For example, gold has six futures contracts per year where as crude oil have 12 contracts per year. All the observations are reported excluding Sundays and holidays. Further, we have created data series in such a way that both spot and futures data are available in a given date. In other words, in a specific trading day, if both spot and futures data are available then we consider that data for analysis.

In examining the impact of futures trading on commodity inflation, the study uses monthly Wholesale Price Index (WPI) from November 2006 to December 2011. WPI data are collected from RBI database and MOSPI. Average monthly crude oil and natural gas futures prices data from November, 2006 to December, 2011 are collected from MCX. In examining the macroeconomic dynamics and impact of futures trading, data are transformed into log return[13].

VI. Tools of Time Series Analysis

Different time series techniques are applied to examine above objectives. Engle-Granger co-integration technique and error correction mechanism are used to examine price discovery in Indian commodity futures market. To examine macroeconomic dynamics of Indian commodity futures market, ARCH family models are used for different sub-objectives, e.g., ARCH and GARCH models are used for volatility clustering effect. E-GARCH and GJR-GARCH models are used to examine asymmetric properties. FIGARCH is applied to examine long memory. Multi-variate GARCH (BEKK) model is used to examine spillover effect. Granger causality test is used to show the impact of futures trading on commodity inflation. We have used econometric software i.e. Eviews 7 and RATs 7.3 for the analysis of the above mentioned time series models.

VII. Major Findings of the Study

In examining the price discovery and price volatility in the Indian commodities market the study has revealed the following results:

- The investigation of cointegration properties of all the futures and spot series under the study affirm long-run equilibrium relationship across all the series.
- Error correction models findings suggest information flows from the futures to the spot market and price discovery takes place in the futures market first and transgress into the spot market in Indian commodity market.
- In examining price volatility through ratio of standard deviation of futures to spot, the study finds that inefficient utilisation of information in the gold market while there is an efficient utilisation of information in silver, copper, crude oil and natural gas market.

Examination of macroeconomic dynamics of commodity futures market has focused on issues around volatility clustering, volatility asymmetry, long memory and spillover effects

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[13] Data are transformed into log return i.e., $\log\left(\frac{R_t}{R_{t-1}}\right)$

relating to the commodities chosen under the study. The summary of findings for the macroeconomic dynamics of the Indian commodity futures market is reported as follows:

- All series under the study show heteroskedasticity effect except the natural gas futures which suggests inapplicability of dynamic models to natural gas futures series.
- Volatility is observed to be persistent both in spot and futures market across all the commodities but the degree of persistence differs across the time period for the commodities under the study.
- Volatility is persistence both in spot and futures market across all the commodities but the degree of persistence differs across the time period for the commodities.
- Volatility is observed to be persistently high around the global financial crisis for all the commodity series. Gold futures and spot returns do not have any asymmetric behaviour that means bad news and good news has similar impact on current changes in gold returns.
- Silver futures and spot, and copper spot do not have any asymmetric behaviour properties too. However, asymmetric property exists in the copper futures, crude oil futures and spot, and natural gas spot, which indicates bad news, creates more volatility in the mentioned commodities than good news of similar magnitude.
- In examining long memory process model reveals that all the commodity series contain long memory properties.
- The study reveals the prevalence of spillover effect between spot and futures market in gold, silver and crude oil. However, copper spot and futures market do not show any spillover effect.
- Bi-directional shocks transmission as can be observed across the commodities like gold, silver and crude oil which means shocks in the futures market do have impact on spot market volatility for gold, silver and crude oil.
- As the fractional coefficient value of copper spot is equal to one IGARCH model may perhaps fit the best for examining the long memory process in the series.

In examining the impact of futures trading on commodity inflation the following results are obtained:

- Using the Granger causality test between a sub-component of wholesale price index of fuel and power, and futures prices of crude oil and natural gas the study suggests the presence of uni-directional causality between crude oil futures and inflation.
- Using the Granger causality test between a sub-component of wholesale price index of fuel and power the study suggests that the inflation granger causes the natural gas future price otherwise.

VIII. Conclusion

In conclusion, the study finds that price discovery takes place in the futures market first and transfers into the spot market in the Indian commodities market. Secondly, in examining the volatility clustering effects, the study affirmed that previous period news/shocks impact current price changes for all the commodities under consideration. Further volatility persistence is observed to be felt across all the commodities but the degree of persistence differs across the time period for all the commodities. It is inferred from the graphical analysis that the volatility is observed be persistently high during global financial crisis. Thirdly, in examining the asymmetric behaviour, the study finds that gold and copper futures and spot returns do not have any asymmetric behaviour which suggests that good news has similar impact on current changes in return series. However, asymmetric property exists in the copper futures, crude oil futures and spot, and natural gas spot, which indicate that bad news creates more volatility for said commodities than good news of similar magnitude. Fourthly, the study reveals the presence of long memory properties in gold, silver and crude oil spot and futures series. However, the natural gas spot price series contains the long memory process as well. In examining the fractional coefficient value of copper spot, it is observed to be equal to one and statistically significant that may suggest the presence of long memory. Fifthly, the study also concluded that the realisation of spillover effect between spot and futures market in gold, silver and crude oil but not in the context of copper spot and futures market. Finally, the Granger causality test between a sub-component of wholesale price index of fuel and power suggests that futures prices of crude oil granger cause inflation.

IX. Policy recommendations

The following policy recommendations emanate from the present study:

- As the price discovery takes place in the commodity futures market and transfers into the spot market in India, in a policy stance it is suggested that policy makers may allow the commodity futures market to behave freely with least regulation in its functioning.
- In case of gold, inefficient utilization of information might lead inefficient price discovery. Therefore, policy makers should make the policies in such way that market will incorporate all the information efficiently.
- Futures trading on crude oil should be banned as it causes inflation.
- Policy makers should design liberalized macro policy tools that would facilitate commodity futures market functioning with a continuous watch into national and international macroeconomic dynamics in a regular basis.

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