BEHAVIOUR OF COMMODITY PRICES IN INDIA: RECENT ISSUES AND EVIDENCES

A thesis submitted to the University of Hyderabad
in partial fulfillment of the requirement for the award of

DOCTOR OF PHILOSOPHY

IN

ECONOMICS

BY
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APRIL 2014

DEDICATED

TO

MY GRAND MOTHER AND LATE GRAND FATHER

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CERTIFICATE

This is to certify that the research work embodied in the present thesis entitled **"Behaviour of Commodity Prices in India: Recent Issues and Evidences"**, has been carried out by **Pratap Kumar Jena** (Registration No. 09SEPH06) in partial fulfillment of the requirement for the award of the degree of Doctor of Philosophy in Economics, under our supervisions.

We declare that to the best of our knowledge, this thesis or a part thereof has not been earlier submitted for the award of degree at any other university or institute.

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Pratap Kumar Jena

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List of Abbreviations

ADF	Augmented Dickey Fuller Test
AIC	Akaike Information Criteria
ARCH	Autoregressive Conditional Heteroscedasticity
ARIMA	Autoregression Integrated Moving Average
BEKK	Baba,Engle,Kroner,Kraft
CFTC	Commodity Futures Trading Commission
EMH	Efficient Market Hypothesis
FMC	Forward Market Commission
GARCH	Generalised Auto Regresive and Conditional Heteroscedasticity
GARCH	Generalised Auto Regresive and Conditional Heteroscedasticity
GDP	Gross Domestic Product
IAC	India All Commodity Index
IENERGY	India Energy Index
IFOOD	India Food Index
IIP	Index of Industrial Production
IMETAL	India Metal Index
IMF	International Monetary Fund
IPSTA	Indian Paper and Spices Trade Association
LOOP	Law of one Price
MCX	Multi Commodity Exchange
NCDEX	National Commodity and Derivatives Exchange
NMCX	National Multi Commodity Exchange
OTC	Over-the-Counter
PP test	Philips-Perron Test
RBI	Reserve Bank of India
SIC	Schwartz Information Criteria
TBILL	Treasury Bill
UNCTAD	United Nation's Conference on Trade and Development
VAR	Vector Autoregression
VECM	Vector Error Correction Model
WAC	International All Commodity Index
WENERGY	International Energy Index
WFOOD	Intrnational Food Index
WMETAL	International Metal Index

ABSTRACT

The thesis examines three issues relating to the commodity price behaviour in India during 2001 to 2012 using the monthly domestic and international prices. Specific objectives of the study are (i) to analyse the role of fundamental factors on commodity price rise, (ii) to examine the financialisation of commodity market and its impact on commodity price in India, and (iii) to examine the impact of international commodity price integration on domestic price behaviour. These objectives are examined using the time series techniques of causality test, cointegration tests particularly the Johansen (1988) cointegration test and the underlying vector error correction model. The study uses the GARCH(1,1)-BEKK model to examine the volatility spillover impact. The entire analysis is based on the available time series secondary data.

Some of the main findings of this study are: (i) commodity prices (all commodity index) in India have been increasing since 2001 and the rise was very sharp specially after 2008. Among all groups of commodities, metal prices were at the top of rising trends. (ii) Due to the global financial crisis in 2008, structural breaks were observed in the price trends of all commodities. (iii) price transmission was the only factor, among the three groups of factors (fundamental, financialization and price transmission), found to be influencing towards the rising trends of commodity prices in India in the full-sample and pre-crisis period. (iv) the econometric results indicated that the change in the behaviour of agricultural prices in India was mainly by the fundamental factors. Metal prices were affected sometimes by the fundamental factors and sometimes by the international price transmission. However, the change in energy prices in India was mainly due to by the international price transmission.

CHAPTER- 1

Introduction

1.1 Background

Rising commodity prices and the underlying volatility in the last few years have been drawing attention of policy makers and academic researchers to study on commodity markets. The recent boom of commodity prices during 2002 to 2008 is an exceptional in terms of size and number of commodities. The recent boom in commodity prices has not only put a heavy burden on developing and emerging economies but there has also been an increase in the agricultural inflation world-wide. The recent increase in commodity prices is mainly due to growing world income which is not matched with supply of commodities. This has been mainly contributed by emerging countries like India and China where living standards are increasing more than proportionately. These countries have high-income-led high commodity demands (OECD-FAO, 2008). Similarly, the second fold of argument for rising commodity prices attributes to increase in the financialization of commodities markets. The strong and sustained increase in primary commodity prices during 2002 to 2008 coincided with the growing financial investors on commodity futures exchanges. These investors use commodity as an alternative investment asset (UNCTAD report, 2009). Thus, they either take positions on commodity index or on commodity futures. It has been observed that since 2002 to mid-2008, there has been continuous increase in the total value of various commodity index-related investments. This has been estimated to be between $15 billion and $200 billion (CFTC staff report, 2008).

India too has seen large changes in commodity prices since 2003. India's agricultural, metal and energy prices indicate that prices rose before the mid of 2008. But the price plummeted during the financial crisis. Before the mid 2008, energy prices more than doubled and it became $144 per barrel. Similarly, metal prices went up by 150 percent while agricultural prices went up by 77 per cent. But in the beginning of 2009, all commodity prices came to the old track due to the government's stimulus packages and policy actions. The commodities whose prices rose include rice, wheat, jute, cotton, coffee, major pulses (such as urad, arhar and chana), edible oilseeds (such as mustard seed, coconut oil, groundnut oil and sunflower), spices (such as pepper, chillies, turmeric and cumin seed), metals (such as aluminum, tin, nickel and copper), bullion (gold and silver) and crude oil, natural gas and polymers etc. (OECD, Agricultural Outlook 2011-2020). The total volume and value of bullion became 7.38 lakh tones and Rs. 5493892.12 crores respectively. The volume and value of metals other than the bullion became 1409.72 lakh tones and Rs. 2687672.99 crores respectively. Similarly, the volume and value of agricultural commodities increased to 12805.57 lakh tones and Rs. 11948942.35 crores respectively. Likewise, energy is placed with good volume and value in Indian commodity exchanges. In aggregate, the total trading volume and value of commodities in the Indian commodity exchanges were 12805.57 lakh tones and Rs. 11948942.35 crores in 2010-11 (MCX Handbook of Commodities, 2011).

India is the fifth largest producer of aluminium in the world with a production capacity of about 106 million MT per annum. India's primary consumption increased in 2009 and grew up by 7.1% to1.4 million MT. However, its per capita consumption of the metal was 1.3 kg. Copper price was Rs. 140.65 per kg on 2.05.2005 and rose to Rs. 309.2 per kg before its fall on 12.12.2006. Again it started rising up to Rs. 353.8 per kg on 11.07.2008, and then it started declining and further rose from 4.03.2009. The gold price which was Rs. 5,975 per 10 gm on 1.06.2005 touched a historic high of Rs. 20650 per 10 grams on 30th December 2010. The rise was by 100%. By the end of June 2011 (i.e., 30.06.2011), gold price touched Rs. 21,942. This is the only precious metal which has seen significant change in price within five to six years. One possible reason for such change may be the belief that gold is a safe heaven and during any crisis period, they get its value/price. Another important point to be noted here is that Indians consume the highest quantity of gold in the world in form of jewellery. Therefore, with the increase in standard of living of people in the 21st century, Indians started consuming more amount of jewellery to lend a luxurious life. Therefore, within a very short period of time, gold price, which was around Rs. 5,000 in 2005, rose to more than Rs. 20,000 per 10 grams in 2010. But in 2012-13, the gold price became Rs. 32,000 (MCX Handbook of Commodities, 2013).

The silver price, which was Rs. 10950 per kg in June 2005, rose to Rs. 22080 in May 2006. After that, there was a short fall in silver price and it became highly volatile. There was a large fall of silver price in the mid-2008. Thereafter, silver price increased significantly and by the end of June 2011, silver price touched Rs. 51859 per kg. In 2008, the refined lead production in India was around 165,000 MT in 2008. It increased to 207,000 MT in 2009. India's refined lead consumption in 2009 increased by 3% a year. Though the lead consumption is higher than the domestic production, India imported 125,000 MT of lead in 2009, an increase of 20% compared to last year in 2008 to meet the demand. The price of crude oil was Rs. 2480 per barrel on 7.05.2007 and it rose to Rs.

6291 per barrel on 5.07.2008. The crude oil price also fell from Rs. 6291 per barrel on 5.07.2008 to Rs. 1695 per barrel on 13.02.2009.

Thus, brief discussions given above show that commodity prices have been rising in recent years, both internationally and domestically in India. Although the public attention was largely drawn to the large increase in commodity price volatility in recent years, rapid growth of commodity investment seems to have gone unnoticed. The collapse of equity market in 2000 led to discovery of commodity futures market, which is used to reduce portfolio risk. The recent growth of investment in commodity resulted in financialisation of commodity markets through which commodity prices were more correlated with prices of financial assets and with each other.

In light of the above discussions, the present study makes an attempt to examine some recent issues and evidences of commodity price rises and factors underlying the recent behaviour of commodity prices in India. Accordingly, this chapter is organized in the following sections. Section 1.2 is on the factors affecting commodity prices in India. This section also explains the changing fundamental factors over the last few decades, financialization of commodity markets and the international commodity price transmission. We report the motivations and objectives in the section 1.3 and 1.4 respectively. Section 1.5 shows the methodology of the study. Section 1.6 reports the sample size and data sources. The last section describes the chapter structure of the study.

1.2 Factors affecting Commodity prices in India

There are several factors which are affecting the commodity price behaviour in India. These factors can be broadly categorized into three - (a) fundamental factors, (b) financialization and (c) the international price transmissions. These factors are briefed discussed in the following.

1.2.1 Changing Fundamental Factors in the Last Decade[1]

The increase in commodity prices between 2002 to the mid of 2008 may be attributed to certain common factors that are responsible for the price escalation across primary commodities at large. But the recent increase in primary commodity prices and the emerging price dynamics over medium term reflect profound changes in fundamental demand-supply relationships which affect simultaneously many commodities. It can be

[1] A more detailed discussion on this topic is taken up in Chapter 2.

said that the earlier changes in commodity prices are due to the “Asian Driver” story on the demand side. For example, the sharp increase in prices of mineral and metals are due to by upsurge in demand for these commodities from the emerging market economies, in general and by India and China in particular. These economies use commodities as raw materials for their industrialization, physical infrastructure building and urbanizations (Kaplinsky et al., 2010).

Likewise, there has also been a steady increase in demand for many agricultural commodities in growing emerging market economies, which increased their prices, though the effects of increased demand from Asian emerging economies for agricultural commodities were felt with a time lag of few years than oil, minerals and metals. On the other hand, there were also some common threads on the supply side too. Minerals, metals and oils were hit with supply constraints to meet the fast growing demand from India and China, as investment in these sectors were subdued for some time due to the historically low commodity prices in the previous decades. According to the World Bank report (2007), agricultural production has long been neglected with low investment in agricultural technology and supporting infrastructures in many low income developing countries, which were hit hard by the recent rising trends in World agricultural prices.

There are close inter-linkages between oil prices, agricultural commodities and other commodity prices. Similarly, there is also high correlation between metal prices and energy prices because the high energy intensive technologies are used both in mineral production/extraction and in the metal sector. In the early 2000s, there were various factors influencing fundamental demand and supply relationship, which many observers called as ‘supper-price cycle’ due to the supply socks, which was temporary. But the recent commodity price boom is associated with more permanent shifts in demand, which originates from the thirst for mineral resources and agricultural products by the ‘Asian drivers’ (Vansteenkiste, 2009).

It was unseen while commodity prices were booming before summer 2008 in India but many researchers, economists and policy makers were surprised when commodity prices experienced immediate fall in the second half of 2008 with deepening of the global financial crisis. But in the very short period of time, commodity price returned to its earlier trend. Historically, any crisis leads to invention of new assets to seek safe investments with faster liquidity promises. Therefore, the crisis led to investment flight to highly liquid assets by financial investors. This led to sharp drop in quality in other asset markets, including commodity markets and the subsequent collapse in the world trade and economic activities (Obstfeld and Taylor, 1997).

The major fundamental factors include economic growth, interest rate, exchange rate, biofuels, etc. Basically, these variables are both demand side as well as supply side factors. Krugman (2008) and Kilian (2009) said that the rapid growth of India, China and other emerging countries have caused the recent commodity price boom. The recent growth of the Indian economy stimulated demand for various commodities like metals, energy and other commodities, which led to price boom of these commodities. Second, interest rate is another important fundamental variable which affects commodity price. Rise in interest rate led to rise of cost of production and storage cost, which in turn led to commodity prices rise. Therefore, there exists positive relationship between these two variables, interest rate and commodity price.

Third important fundamental variable is the exchange rate. Commodity exporting countries are affected by fluctuation of exchange rate. Dornbusch (1985) investigates the impact of macroeconomic developments in the industrialized nations of less developed countries (LDCs), in part to assess such trade-offs as that between increased LDC exports and higher interest rates resulting from U.S. economic growth. He examined it by constructing a simple model of a semi-small open economy, identified the channels of external influences and specifying the way in which they affect economic performance. Particularly, he identifies three principal channels like - (i) the real price of primary commodities, which is determined in world markets, (ii) the world rate of interest on the LDC's debts and (iii) the level of world demand, which affects demand for LDC manufacturing exports of foreign influence on the LDC economy. Among the macroeconomics variables, he stressed on the exchange rate influence on commodity price. In that paper, he constructed a simple supply-demand two country model to highlight this effect. He also calculated the elasticity of commodity prices in relation to the U.S. real exchange rate and consumer price index (CPI). Theoretically, he assumed that the elasticity value of his formula should lie between 0 to -1. But in empirical research, it has usually been the case that it overshoots the lower limit of the theoretical value range, that is, lower than -1.

Fourth important fundamental factor is bioful. Though, crude oil is used as the main source of energy, the higher demand of crude oil led to rise in its price worldwide. Therefore, to avoid higher crude oil price and also the main source of energy, many countries including India have adopted new energy policies to promote the use of biofuel.

Since 2005, the production as well as the use of biofuel has increased in India but not much compared to other nations. Roberts and Schlenker (2010) said that the growth of ethanol production caused the food price to rise by 20-30 percent.

1.2.2 Financialization of Commodity Markets[2]

In the above section, the discussion is confined to the fundamental factors responsible for price variation. Whether ever-increasing volatilities observed in co-movements across a large number of commodities can be explained simply by shifts in supply-demand relationships on their own seem to be a question for research thought. This question became more important because the high price volatility could result from the intensifying two-way interactions between the commodity and financial markets (Maizels, 1994).

According to Keynes (1938 and 1994), financial investors have historically always been active in commodities as a part of their portfolios. Therefore, financial investors participated in commodity derivatives markets and dealt with different contracts, which influence commodity price dynamics. A financial investor prefers to invest in commodity markets due to high liquidity. Commodities in their portfolios are included without bearing the cost of holding commodities physically.

After the collapse of the International Commodity Agreements in the late 1980s, there was an increase of price volatility, which led to rapid expansion of commodity derivatives markets across different commodities. The rapid growth of derivatives markets led to subsequent increase in new players, particularly financial investors participating in commodity trading.

It is well known that financial investors prefer to invest in commodity markets to obtain an optimal risk-return from different assets through portfolio diversification. Generally, investors earn good returns on high asset price volatility because they get high risk premium by taking speculative positions on volatile prices.

The process, through which there is increasingly growing interlinkage between commodity and financial markets by portfolio investors, is called 'the financialization of commodity markets'. This process has increased over the last few decades, and commodity futures markets have seen explosive growth. In this case, Basu and Gavin (2011) have given two hypotheses. These are (i) commodity futures offered hedging opportunities against equity risk given a negative correlation between returns on equity and commodity

[2] A more detailed discussion on this topic is taken up in Chapter 4.

futures, which is popularly known as the ‘hedging hypothesis’, (ii) commodity derivatives used as a vehicle for obtaining higher yields from riskier assets in a low interest rate environment (known as the ‘yield hypothesis’).

According to Redrado et al. (2009), the term ‘financialisation of commodities’ has two different facts but partially linked to each other. First, derivatives market activity, which has experienced an impressive growth since the beginning of commodity trading in India. Secondly, the rise of financial investors in futures market occurred simultaneously. It means there is a close connection between price dynamics and speculative activity during the past few years. There is consistently rising commodity prices in conjunction with rise in turnover of commodities. There has been an increase in the trading volume of commodities in India. Total volume of trade increased from Rs. 129.36 thousand crore in 2003-04 to Rs. 2739 thousand crore in 2006-07. The total turnover of the Indian commodity market was Rs. 3375 thousand crores in the year 2007-08. This is mainly due to the recent rise of financial investors in commodity futures, motivated by portfolio diversification (UNCTAD trade and development report, 2009).

Financial investors obtain two exposures from commodity markets. First, they act through spot markets, leading to increase in price level. Second, the benefit in the commodity futures market depends on the changes in futures prices. In other way, the financial investor also can get benefits by investing in commodity markets. Commodity futures investments also provide good hedging strategy against future inflation and exchange rate depreciation. Therefore, it is important to examine the financialisation of commodity markets in an emerging economy like India.

1.2.3 International Commodity Price Transmission[3]

Excluding above mentioned two factors, market integration or transmission is also another important factor for changes in behavior of commodity prices in India. The domestic commodity prices exhibit diverse patterns of price transmission. Often, the impact of international price on domestic market is either small or delayed. In the globalization period, there is international market tranquility, which leads to increased global markets exposure, resulting in reduction in price volatility. The effect of international price transmission to the domestic market in India is either perfect or imperfect.

[3] Detail explanations on this aspect are given in Chapter 6.

Basically, the price transmission is based on the concept of competitive pricing theory. ‘The Law of One Price’ suggests that in the long run, price transmission is complete with price of a commodity sold in competitive foreign and domestic markets and it differs only by transport cost (Prakash, 2011). Just as the arbitrage and trade restores the market equilibrium, prices in the domestic market tend to equalize with those in foreign markets except for transport costs and hence the term ‘Law of One Price’.

To protect the domestic price from the international commodity price volatility, government of India has implemented short-run border measures, like import tariff reductions or export bans, in order to curb domestic price rise and shield consumers from increased commodity expenditure. Decrease in import tariffs makes price transmission easy, especially if tariffs were initially set at high levels. Apart from policies, domestic markets are also lagged by large margins due to high transport and marketing costs. Especially in India, the poor infrastructure, transport and communication services led to high costs of delivering the local produced commodities to export. Such high margins hamper the transmission of price signals. As a result, international price changes are not fully transmitted to domestic prices, leading to partially adjusted, if at all, to shifts in global supply and demand.

1.3 Motivation

The main motivation to carry out the present study comes from the fact that relatively a very few studies exist on the present topic. Hence, an attempt is made to fill that void.

The emerging economies like India are consuming more commodities compared to developed countries. This has led to high demand for both storable and non-storable commodities. There is high demand for certain agricultural commodities like cereals, pulses, oil & oil seeds, sugar, tea, coffee, vegetables, spices, meats, pulses, etc. Except above commodities, there is also high demand for energy commodities like mineral oil, coal, etc. Generally, there is also high demand for metals such as aluminium, gold, silver, copper, zinc, lead, etc.

Since 2003, there has been continuously rising of commodity prices in India but it could not be understood properly by many researchers why commodity prices rose. In 2007, Government of India said that commodity prices rose due to futures trading with unnecessary hoarding of commodities and that led to banning of some commodities like rice, wheat, sugar and urad from futures trading. Some economists like Abhijit Sen (2008) argued that fundamental factors, particularly the rise of demand and shortfall of supply, led to rise of commodity prices in India. But whatever may be the causes, the recent rise of commodity prices led to high inflation in India. To our knowledge, there are not many studies carried out to know the factors behind the recent rise of prices.

Like any other commodity, commodity futures price is also determined by the market demand and supply, and variation in any one of them creates price risk. Except these factors, another important factor is speculator. Many researchers argued that speculators make price variation for their profitable investment. But other economists like Krugman (2008), Hamilton (2009) and Kilian (2009) argued that the recent boom of commodity prices is not due to rise in speculative activities but due to rapid growth of China, India and other emerging economies. Krugman (2008) argued that the speculative activities led to inventory accumulation but no inventory accumulation was observed during the sharp increase in oil prices in 2007-2008. The economic development of these countries in 2000s has stimulated unprecedented demands for a broad range of commodities in different sectors particularly energy and metals, that led to a joint price boom. Thus, the main aim of this study is to examine the factors behind recent commodity price behaviour in India.

The real inflation affects negatively as it increases interest rate. Therefore, when inflation rises, interest rate also rises to balance between investments. As a result, the equity markets attract investors rather than commodity markets, because increase in interest rate affects negatively to commodity market as it increases the storage cost. Thus, the macroeconomic variables have a positive as well as negative impact on commodity prices. Therefore, it is interesting to examine the recent rise of commodity prices and consequent volatility.

1.4 Objectives of the Study

In light of the above discussions and motivations, the present study examines mainly the behaviour of commodity prices in India. Specific objectives are:

(a) to analyse the role of fundamental factors on the rise of commodity prices,

(b) to examine the financialization of commodity market and its impact on commodity price in India and

(c) to examine the impact of international commodity price integration on domestic price behaviour.

1.5 Methodology

The study is using modern time series techniques to examine the stated objectives. The first objective, i.e., the role fundamental factors on commodity price rise is examined using the cointegration techniques like Johansen (1988 and 92) cointegration test and the Vector Error Correction (VECM) model. Examining the role of fundamental demand and supply factors on commodity prices is very difficult in the sense that measurement presents serious difficulties. Therefore, the index of industrial production (IIP) is used as a proxy to represents the total demand for commodity. Although total demand for commodities depends on the total national income (i.e., GDP), due to unavailability of monthly data, we use the IIP as a proxy for GDP.

The second objective, i.e., to examine the impact of financialisation on commodity prices in India, is divided into two parts. First, we examine the relationship between stock/equity prices with the commodity prices. Second, we examine the relationship between commodity spot prices and the futures prices. These two parts are examined using the above mentioned cointegration test and the VECM. Besides these two techniques, we have also applied the volatility spillover model like GARCH (1, 1)-BEKK (1990) model to check whether there is any volatility spillover in these markets. The third objective, i.e., the impact of international commodity market integration on domestic price behavior, is also examined by using the above mentioned cointegration and VECM techniques.

Before examining the above objectives, as a prerequisite, we have checked the stationarity of selected study variables. Because it is necessary to check the stationarity conditions of each variable by applying Unit Root test such as Augmented Dickey-Fuller and Philips-Parron test. To find out the structural breaks in the sample period, the Gregory and Hansen (Gregory and Hansen, 1996a and 1996b) test is used.

1.6 Data Sources and Sample

The entire study depends on the available monthly time series secondary data. Main study variables are commodity prices, spot prices, futures prices and stock prices. Commodity prices are divided into three parts. These are prices of agricultural commodities, metals and energy. (i) Agricultural commodities include cereals (rice, wheat and maize), edible oil (groundnut oil, palm oil, rapeseed oil, soybean oil and sunflower oil), cotton, rubber and sugar. (ii) Metals include aluminium, metal products (gold and silver) and other non-ferrous metals (copper, lead and zinc). (iii) Energy commodities include coal and mineral oil particularly crude oil. For all these commodities, wholesale prices are collected from the Research Bank of India (RBI) publications. The international commodity prices are collected from the International Monetary Fund (IMF)'s online database. Except commodity prices, we have also collected both spot and futures prices of all commodity index prices, metal index, energy index and agri index prices from the Multi Commodity Exchange (MCX) online data base. The MCX Metal Index includes seven commodities - gold, silver, copper, zinc, aluminum, nickel and lead. Similarly, Energy Index includes two commodities - crude oil and natural gas. The Agri Index includes six commodities - refined soy oil, potato, chana, crude palm oil, kapaskhalli and menthe oil. Besides these variables, total trading volume and value, and number of contracts per day are collected from the websites of the MCX and Forward Market Commission of India (www.fmc.gov.in).

Though, the MCX index prices are available daily, we converted these prices into monthly data by taking its each month end price. Besides these variables, exchange rate, inflation rate, interest rate, IIP data have also been collected from the RBI and other reliable secondary sources. Therefore, data for study variables have been collected from various sources like IMF, National stock Exchange of India, RBI, MCX and FMC. The study uses monthly prices of all these variables. For those variables which are in daily prices, we convert these variables into monthly data by taking its month end price.

The sample period is from January 2001 to June 2012. We choose this sample period because particularly during this period, there has been high growth rate of commodity prices and also there was global financial crisis.

1.7 Organisation of the Study

The thesis is organized into seven chapters. Chapter 1 gives an introduction to the study. It contains a brief description on the factors affecting commodity prices in India, motivation, objectives of the study, methodologies adopted and data sources. Chapter 2 is on the analysis of behaviour of commodity prices in India. Chapter 3 examines the impact of fundamental variables on commodity prices in India. Chapter 4 is on the analysis of financialization of commodity market in India. In chapter 5, we analyze the impact of financialization on commodity prices in India. The financialization is measured in two ways – (a) first, we analyze the relationship between stock prices with commodity prices and (b) second, we analyze the relationship between commodity spot price with futures price. Chapter 6 is on the market integration and price transmission from international to domestic price. Chapter 7 provides the summary, conclusion and limitations of the study.

Chapter 2
Behaviour of Commodity Prices in India

2.1 Introduction

This chapter describes the behaviour of commodity prices in India. Accordingly, this chapter is organized into the following sections. Section 2.2 deals with trends of international prices. The trends of domestic prices in India are described in section 2.3. The characteristic of commodity price behavior in India is outlined in section 2.4. Section 2.5 analyzes the variability/volatility of commodity prices in India. Few debates and arguments on the behaviour of commodity prices are given section 2.6. The last section 2.7 gives the summary of the chapter.

2.2 Understanding the Trends of International Commodity Prices[1]

Commodity prices in the international market have dramatized trends, sometimes there is continuous commodity price rise and sometimes a fall. But, commodity price started continuously rising since 2002 and severely hit by the global financial crisis in the middle of 2008. It is observed that the prices of some commodities reached the historic high by the middle of 2008 in nominal terms but in real terms, it was high only for metals, minerals and crude oil (UNCTAD, 2009). After the crisis, commodity prices experienced a sharp fall due to global economic uncertainties and financial shocks and it continued till the global economy recovered from the crisis in 2009. Thereafter, commodity prices started upward trends during the first quarter of 2009 despite the continuation of the global economic downturn.

Basically, agricultural and food commodity prices were severely hit by the financial downturn and they are in the long-term decline by nearly 50% in real prices compared to other commodities. Such a price decline leads to low income and low economic growth of agricultural producers and developing countries. In the ‘Doha Round’ of WTO, the main motive was to reduce the agricultural support and trade barriers for the developed or high income nations- which lead to increase in commodity prices, increase in

[1] This section is drawn from various issues of UNCTAD research reports.

income and welfare of the agricultural commodity exporting countries (Aksoy & Beghin, 2005 and Anderson & Masters, 2009).

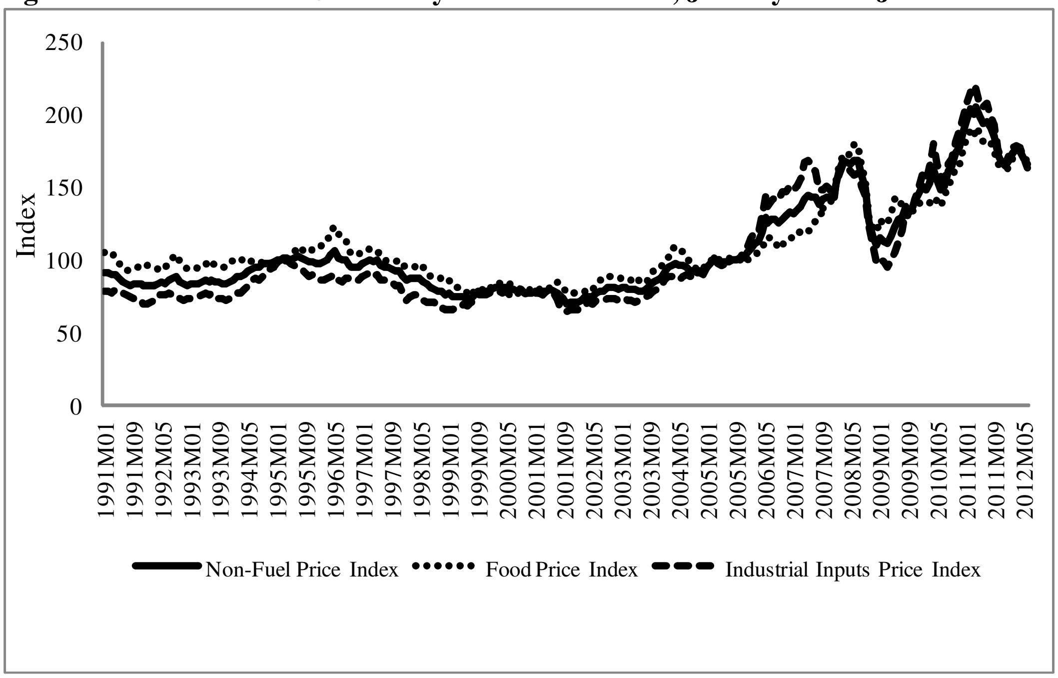
Although, there have been common factors influencing on all commodity markets but price dynamics have differed across commodity groups. For example, global economic recession has not affected all sectors in the same way. Some sectors, such as sugar and coffee, have benefited from increased demand, whereas others, such as cotton, have been hit hard by the crisis. Similarly, climatic shocks have also differed across agricultural commodity groups (UNCTAD, 2010).

If we look at the Figure 2.1, we can get to know that the recent boom (i.e., from mid-2002) shares two similarities with earlier major commodity booms of the post-WWII period, during the Korean war, and the early 1970s energy crisis (Rodltzki 2008, and Baffes & Haniotis, 2010). These booms led to high prices and sustained economic growth as well as an expansion of macro-economic environment and each followed by a severe slowdown in economic activity. But the recent boom after 2002 exhibits some differences from the previous ones, i.e., this boom is the longest lasting and the broadest in the number of commodities involved. That means it involves all three groups of broad commodities-agricultural, metals and energy prices. But agricultural price was the least increasing compared to metals and energy.

The long lasting commodity price boom (from 2002 to 2008) can partly be explained by the strong and sustained global demand for commodities led by emerging economies- particularly by China and India. On the other part, there was also lagging supply response arising from the underinvestment in the previous two decades (UNCTAD, 2010). The recent boom was also realized when the emerging countries like India was sustaining more than 9 percent economic growth, the highest five year average growth in the economic history.

In Figure-2.1, we have reported the IMF commodity index prices for various commodity groups since 1991 to 2012. It can be seen that there is continuously increase in all commodity index prices since 2002 to 2007. The non-fuel primary commodities index was 80.26 in 2002, which increased to 143.24 in 2007 and in 2008, it declined to 110.06. Thereafter, there has been continuous increase of non-fuel primary commodity price and it reached 164.6 in 2011. Food and beverage index price increased from 88.22 in 2002 to 144.53 in 2007. In 2008, it reduced to 120.87. Thereafter, it started rising and it reached 163.22 in 2011. Food price index also increased from 87.89 in 2002 to 145.97 in 2007, after its fall in 2008 (119.6), it started rising and reached 161.68 in 2011. Similarly, other price indexes increased up to 2007 and due to crisis, there was a decline in 2008, and then started rising since 2009. Now, if we look at the all commodity price index, we can find that the all commodity price index started rising since 2002 to 2007, but due to crisis, it fell in 2008 and, again it started rising since 2009 to 2011.

Figure-2.1: International Commodity Price Movements, January 1991 - June 2012

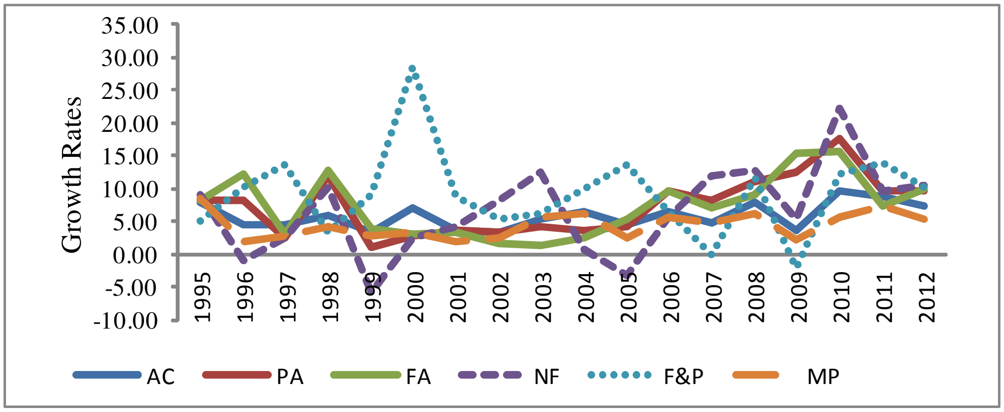


Source: IMF, Primary Commodity Indices Database, 2012

2.3 Recent Trends of Commodity Prices in India

It is observed that world-wide commodity prices have been increasing after 2002. In Figure-2.2 we have reported India's all commodity price index (AC), primary articles (PA), food articles (FA), non-food articles (NF), fuel and power (F&P), and manufactured products (MP). The Figure-2.2 indicates that AC, PA, FA and MP index prices were rising before the middle of 2008. But prices became low during the depth of the financial crisis. Before the mid 2008, energy prices were more than doubled and it became $144 per barrel and it had large volatilities. Similarly, metal prices were up by 150 percent while agricultural prices were 77 percent or higher. It can also be seen from Figure 2.2 that there was sharp fall of food, metal and energy prices while global economies were facing the financial crisis. But in the very beginning of 2009, all commodity prices came to the old track, possibly due to the government's stimulus packages and policy actions.

Figure-2.2: Growth Rates of Commodity Price Indices in India, 1995-2012



Source : Office of the Economic Adviser, Ministry of Commerce and Industry, Government of India.

Notes: AC : All commodities, PA : Primary articles, FA : Food articles, NF : Non-food articles, F&P : Fuel and Power and MP : Manufactured products.

In Table-2.1, we have reported the total value and volume of different commodities for India. In Table-2.1 part A, we show the total trading volume and value of bullion commodities, particularly gold, silver and platinum for the year 2009-10, 2010-2011 and 2011-12. It can be seen that the total volume and value of bullion was 4.73 lakh tones and Rs. 3164152.14 crores in 2009-10 but it gone up to 7.38 lakh tones and Rs. 5493892.12 crores in 2010-11 and again in 2011-12 it became 10.27 lakh tones and 10181957.22 crores. Similarly, the total trading volume and value of metals other than the bullion have also gone up. In 2009-10, the other metals trade volume and value was 4.73 lakh tones and 3164152.24 crores and it becomes 1409.72 lakh tones and Rs. 2687672.99 crores in 2010-11. Again it increased to 1387 lakh tones and Rs. 2896720.73 crores in 2011-12 respectively. Although, there is less number of trading of agricultural commodities than bullion and metals in exchanges, but still the total trading volume and value of agricultural commodities have increased tremendously from 2009-10 (3991.21 lakh tones and Rs. 1217949.04 crores) to 12805.57 lakh tones and Rs. 11948942.35 crores in 2010-11. It also became 4942.09 lakh tonnes and Rs. 2196149 crores in 2011-12 respectively. Likewise, Energy has the good trading volume and value in the Indian commodity exchanges, its total trading volume and value was 5162.95 lakh tonnes and Rs. 15777882.06 crores in 2009-10. But in 2010-11 the volume and value became 220.12 lakh tones and Rs. 2310958.58 crores respectively. Again this also increased to 7685.52 lakh tonnes and Rs. 2851268.52 crores in 2011-12. In an aggregate the total trading volume and value of commodities have increased from 10142.93 lakh tonnes and Rs. 7764754.05 crores in

2009-10 to 12805.57 lakh tones volume and Rs. 11948942.35 crores in 2010-11. In 2011-12, the volume and value are 14025.74 lakh tonnes and 181261097.33 crores respectively.

Table 2.1: Volume of Trading and Value of Trade fo Major Commodities in India

Name of the Commodity	Volume of Trading = in Lakh Tonne Value = in Rs. Crore					
	2009-10		2010-11		2011-12	
A. Bullion	Volume	Value	Volume	Value	Volume	Value
Gold	0.13	1997801.10	0.14	2700607.00	0.17	4355098.64
Silver	4.60	1165728.56	7.24	2793280.23	10.11	5826848.58
Platinum	0.00	622.59	0.00	4.89	0.00	10.00
Total for A	4.73	3161452.24	7.28	5493892.12	10.27	10181957.22
B. Metals other than Bullion						
Aluminium	57.38	53904.46	110.17	114081.70	131.73	145898.50
Copper	325.81	942590.17	335.36	1239261.20	386.46	1565984.17
Lead	244.50	240268.62	356.88	366422.24	336.10	364264.87
Nickel	33.79	284601.94	44.83	478789.31	42.76	427336.21
Steel	0.00	0.00	86.66	22759.03	37.23	11510.97
Tin	35.94	8813.97	0.00	18.35	0.00	2.70
Zinc	0.02	132.84	463.25	465375.27	372.85	375692.69
Iron	284.48	271324.32	12.56	965.89	80.72	6030.61
Total for B	981.92	1801636.31	1409.72	2687672.99	1387.85	2896720.73
C. Agricultural Commodities						
Chana/Gram	530.42	127950.47	523.59	126158.29	947.98	306411.78
Wheat	31.77	4015.01	26.78	3316.88	22.43	2661.42
Maize	8.41	790.56	16.36	1730.06	19.01	2294.48
Soy Oil	500.62	235605.92	617.15	345286.26	802.85	538383.46
Mentha Oil	2.31	13173.04	6.21	60527.10	7.11	101410.51
Guarseed	1226.69	283431.09	1056.04	254690.88	733.10	338216.19
Guar Gum	59.46	29593.86	83.15	49942.57	69.02	100515.47
Potato	61.63	4575.74	269.22	14428.17	229.11	14156.71
Chillis	3.68	1998.17	11.31	8493.79	14.07	11611.26
Jeera (Cuminseed)	26.50	33720.04	42.53	60864.48	37.38	55982.69
Cardamom	0.28	2503.69	0.77	10882.04	1.91	16373.87
Pepper	19.61	27705.73	42.25	84786.09	24.64	79518.79
Rubber	5.81	7123.20	11.78	23846.92	7.86	16697.51
Other Agri	1514.02	445762.51	1461.21	4114361.10	2025.61	611915.37
Total for C	3991.21	1217949.03	4168.35	1456389.62	4942.09	2196149.50
D. Energy	5162.95	1577882.06	7220.12	2310958.58	7685.52	2851268.52
E. Other	2.12	3134.40	0.00	29.04	0.00	1.35
Grand Total (A+B+C+D+E)	10142.93	7764754.05	12805.57	11948942.35	14025.73	18126097.33

Source: Compiled from the FMC Annual Commodity Reports

2.4 Characteristics of Commodity Price Behaviour[2]

The main aim of this section is to briefly analyse the characteristics of different commodities under study. We analyse the study commodities as grouping of metals, energy and food commodities in the following pages.

(i) Metals

Aluminium: Among all other metals, aluminium is highly demanded due to its unique characteristics. Though, it has various uses, it is mainly used in the transportation (i.e., construction of cars, aircrafts and train carriages), packaging (cans), defense and consumer electronic industries.

India is the fifth largest aluminium producing country in the world, with a production capacity of about 106 million MT per annum. Aluminium consumption in India has grown up in 2009 onwards. It grew up by 7.1% to 1.4 million MT in the year 2009-10, whereas its per capita consumption of the metal is 1.3 kg. Basically, Indian aluminium industry consists of four primary producers: Hindalco, NALCO (National Aluminium Company Limited, a government of India enterprise), BALCO (Bharat Aluminium Corporation Limited), and Vedanta Aluminium.

There are various factors like the rate that rules on the international spot market and rupee versus US dollar exchange rates which influence the aluminium prices in India. Other factors like economic events such as national industrial growth, global financial crisis, recession, and inflation effects also affect aluminium prices in India. Commodity specific events like construction of new production facilities or processes, new uses or the discontinuance of historical uses, unexpected mine or plant closures (natural disaster, supply disruption, accident, strike, and so forth), or industry restructuring etc. also affect aluminium prices. Apart from these factors, there are also some other factors like government trade policy and geopolitical events which can cause major changes of aluminium prices.

Figure-2.3 shows the aluminium price trend in India since 2005 to 2012. It shows that there was upward trend of the aluminium price before the financial turmoil. Due to the turmoil in 2008, there is downfall in the trend. Though, the government of India took initiative to overcome the crisis, again this price started rising since 2009 onwards.

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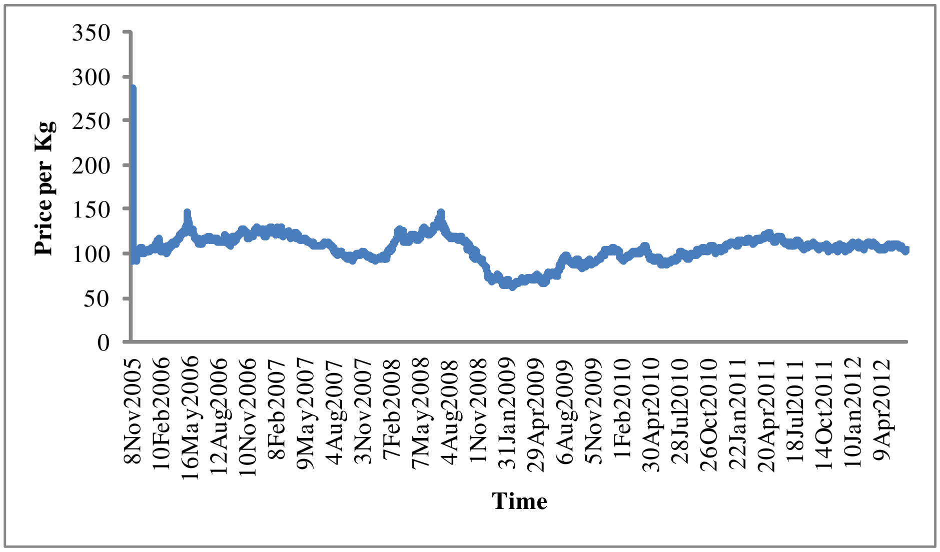
[2]Commodity leaflets collected from the Multi Commodity Exchange (MCX) Commodity Year Book, 2010.

Figure 2.3: Trends of Spot Price of Aluminium in India (Rs./ Kg)

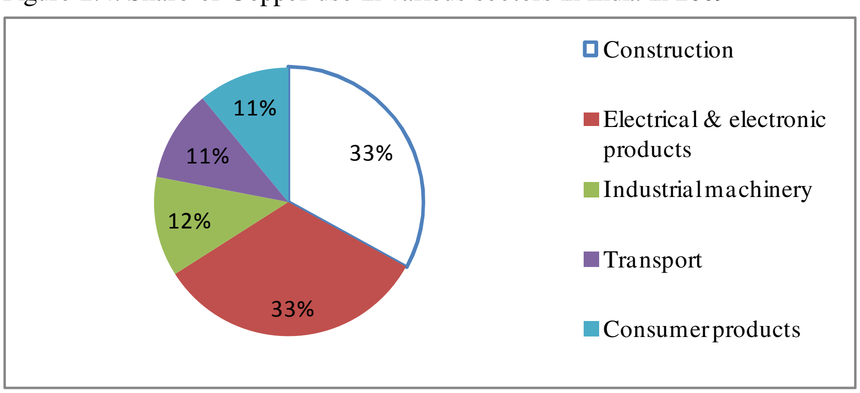


Source: Multi Commodity Exchange (MCX), India

Copper: Copper is the third consuming metal in the world after the steel and aluminium. It has been recognized that copper usage has surged by around 300% in the last 50 years owing to expanding sectors like electrical and electronic products, building construction, industrial machinery and equipment, transportation equipment, and consumer and general products.

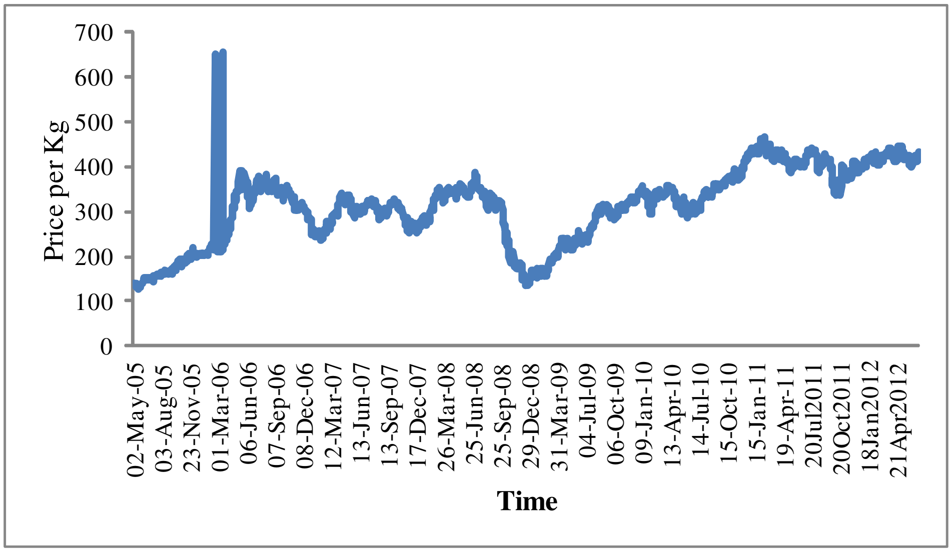
If we look at the Figure 2.5, we can see that the copper spot price is highly volatile at Multi Commodity Exchange (MCX) India. The ready copper prices were Rs. 140.65 per Kg on 2.05.2005 rose to Rs. 309.2 per Kg before its fall on 12.12.2006. Again it started rising up to Rs. 353.8 per Kg on 11.07.2008, and then it started declining and raising from 4.03.2009.

Figure 2.4: Share of Copper use in various sectors in India in 2009



Source: Same as in Figure 2.3

Figure 2.5: Trends of Spot Price of Copper in India (Rs./Kg)



Source: Data taken from Multi Commodity Exchange (MCX), India

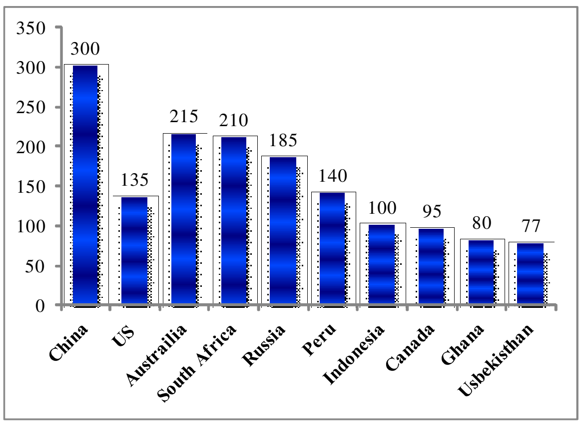
Gold Price: Gold is an asset which is used primarily as monetary asset and partly used as commodity. In recent years gold has the highest investment value, as more than two thirds of gold's total accumulated holdings are with central banks' reserves, private players, and held in the form of high-karat jewellery. It is believed that gold market is highly liquid and is less risky asset. Therefore, during the financial market stress it attracts investors on these occasions, so the correlations and volatilities of return for most asset classes increase.

In 2010, India was the world's largest gold consumer nation with an annual demand of 963 tones. As a result, in the year 2010, gold demand touched a 10 years high of 3,812.2 tones, worth US$150 billion due to increased demand for gold jewellery, the revival of the Indian market, strong momentum in Chinese gold demand, and a paradigm shift in the official sector where central banks became net purchasers of gold for the first time in 21 years. At the same time the total supply of gold coming into the market in 2010 reached 4,108 tones, a rise of 2% from 2009 levels (MCX Handbook of Commodities, 2010-11).

The ready price of Gold had tremendous changes within the last few years. The gold price which was Rs. 5975 per 10 gm on 1.06.2005 rose to Rs. 10250 on 8.05.2006 and after the gap of around four years, it touched a historic high price Rs. 20205 per 10 gram on 10.11.2010, that is, a rise by 100 %. In the end of June 2011 (i.e. 30.06.2011), the gold price became Rs. 21942s per 10 grm and again it rose to more than 30 thousands in 2012-13. This is the only one of the precious metals which has tremendous changes in price within five or six years. One possible reason for that is people believed that gold is a safe heaven and during any crisis period, they get its value/price. Another important point to be noted is that average Indian consumes the highest gold in the world in terms of jewellery. With the increase in standard living of people in the 21st century, Indians started to consume more amount of jewellery to maintain luxurious life. Therefore, within a very short period of time, gold price which was around Rs. 5000 in 2005, rose to more than Rs. 20000 in 2010.

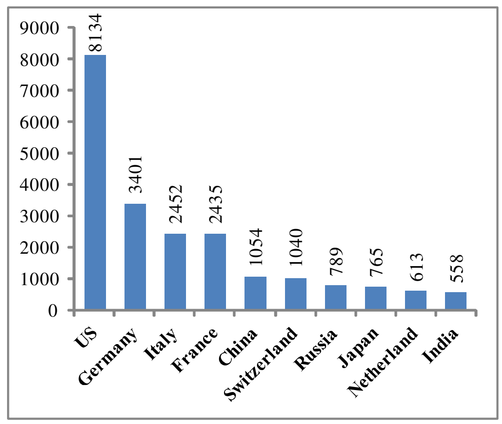
There are various factors that influence the gold price. Some of these include gold supply from central bank's sale, hedging interest of producers/miners, macroeconomic factors like exchange rate, interest rate and economic events, commodity specific events like construction of new production process, unexpected mine or plant closures, price level and its volatility.

Figure 2.6: Top-10 Gold Producing Countries, 2009 (in tones)



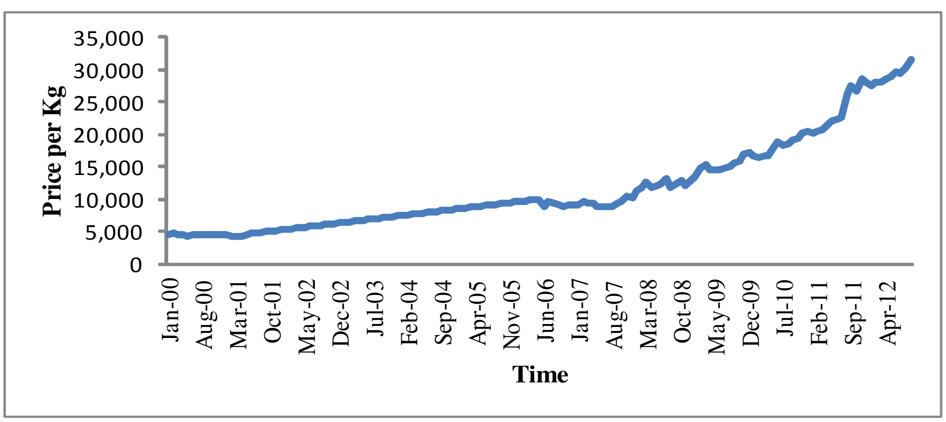
Source: MCX Hand Book of Commodities 2012

Figure 2.7: Top Ten World Gold Holding Countries as a % of Forex Researves in March 2011 (in tones)



Source: MCX Hand Book of Commodities 2012

Figure 2.8: Trends of Gold Price in India (Rs./10 grams)



Source: Hand of Statistics, Reserve Bank of India (RBI)

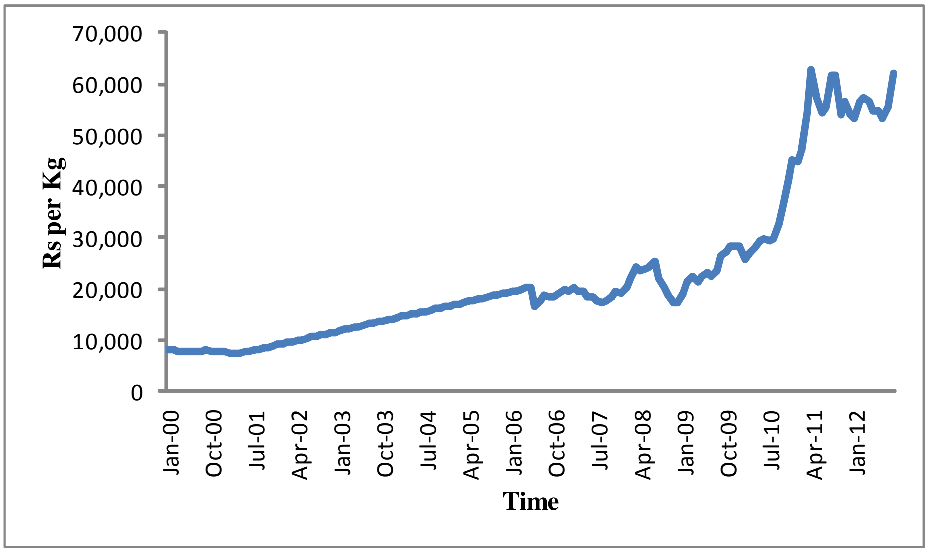
Silver: Now-a-days, silver is more demanded due to the fact that it can be used both as a precious metal and an industrial metal. The demand for silver mainly depends on three factors - (a) industrial and decorative uses, (b) photography, and (c) jwellery and silverware. These three categories together constitute about 77% of annual silver consumption. Excluding these three uses, it is also used as an effective portfolio diversifier. In India, the average demand of silver was 2500 tons per year, against the country's production of about 206.95 tons in 2010.

The demand for silver mainly was carried out by farmers in rural India, who demanded nearly 60% of total silver to store in the form of silver bangles and coins. The demand for silver has increased 4.6%, owing to stock-related gains in India (MCX Hand Book of Commodities, 2010-11). Basically the demand for silver for coins and medals surged higher from 2008, rising by 20.7% to reach a new record high of 78.7Moz (2,447 t) in 2009 on the back of strong investment demand. The net investment increased to 136.0 Moz in 2009 buoyed by safe haven concerns, which led to strong inflows into both ETFs and physical investment. On the other hand, internationally, supply was scraped and it decreased in 2009 by almost 6% to 165.7 Moz, despite a strong recovery in prices over the years. Net government sales fell by just over one half to 13.7 Moz (426t) in 2009, primarily driven by the lowest stock sales from Russia, coupled with the continued absence of any disposal from China and India.

The increase in silver prices over the years is affected by various factors like macroeconomic factors (such as national industrial growth, global financial crisis, recession, inflation), commodity specific events (the construction of new production facilities or processes, unexpected mine or plant closures, or industry restructuring), government trade policy (implementation of or suspension of taxes, penalties, and quotas), geopolitical events. Particularly in India, the demand for silver is determined to a large extent by its price level and volatility. The following figure-2.9 shows the trends of silver spot price in India.

The silver price which was Rs. 10950 per Kg on 1.06.2005 rose to Rs. 22080 on 12.05.2006. After that, there was a short fall of silver prices and became highly volatile. The figure-2.9 shows that there was a large short fall of silver price up to the mid 2008. Thereafter, silver prices increased in a tremendous way and by the end of 30.06.2011, silver price touched to Rs. 51859 per kg. One question may arise here why the silver prices which was declining and highly volatile after 2006 to before mid-2008 suddenly started rising. The most possible answer similar to gold is that the silver is also treated as a precious metal equal with gold. During the period of crisis or emergency, people can sell silver and get its value/price at any point of time. Another important point is that due to high price of gold, now-a-days people are demanding more silver than gold to keep in the saving form or jewellery form to meet the future requirement. Therefore, within a very short period of time the silver price which was around Rs. 10000, became more than Rs. 50000 per kg in 2011.

Figure 2.9: Silver price in India (Rs/Kg)



Soruce: As in figure-2.8.

Nickel: Nickel is the most volatile metal among all other metals due to its strong demand and tight supply. One important point to remember here is that the demand for nickel is derived from the growth of different industrial sectors and thus it exhibits high volatility. Nickel is primarily used (65%) in manufacturing of stainless steels, 20% in other steel and nonferrous alloys, 9% in electroplating, and about 6% used in coins and coins and nickel chemicals.

The demand for nickel in India depends on import. India imports around 30,000 tons of nickel per year. It is also estimated that with a growth in the stainless steel sector, the nickel import demand is expected to increase in the coming years.

Though, the nickel is supply constrained, various factors like supply from scrap, new mines discovery, uses in various industries, and growth in consumption of stainless steel influence the nickel market.

Lead: In 2008, the refined lead production in India was around 165,000 MT in 2008. It increased to 207,000 MT in 2009. India's refined lead consumption in 2009 increased by 3% year on year to 187,000MT, up from 181,000 MT in 2008. Since the lead consumption is higher than the production, India imported 125,000 MT of lead in 2009, an increase of 20% compared to last year in 2008 to meet the demand. In India, the main producers of lead are Hindustan Zinc Limited (HZL) and Indian Lead Limited (ILL).

Zinc: Zinc is the fourth most commonly used metal after iron, aluminium and copper in terms of annual production because zinc can be recycled indefinitely, without loss of its physical or chemical properties. Now, roughly 50% of all metallic zinc is used to galvanize other metals such as steel or iron to prevent corrosion. Large quantities of zinc are used to produce die castings, which are used extensively by the automotive, electrical and hardware industries.

The rise in world zinc mine production in 2010 (8.8% compared with 2009) was primarily influenced by higher output in Australia, China, India, Mexico and the Russian Federation. Global refined zinc metal production rose by a significant 13.3% in 2010, as much of the capacity suspended in 2009 was brought back on to the stream. In addition to a further rise of 18.5% in Chinese output, notable increases were recorded in Belgium, Brazil, India, Peru, the Russian Federation, the USA and Uzbekistan. Global output of refined zinc metal exceeded the usage by 264,000 MT; the fourth successive year that the market has been in surplus. After a sharp decline in 2009 caused by the economic crisis, world usage of refined zinc metal rebounded by 15.6% in 2010, surpassing 12 million MT for the first time (MCX Commodity Year Book, 2010-11).

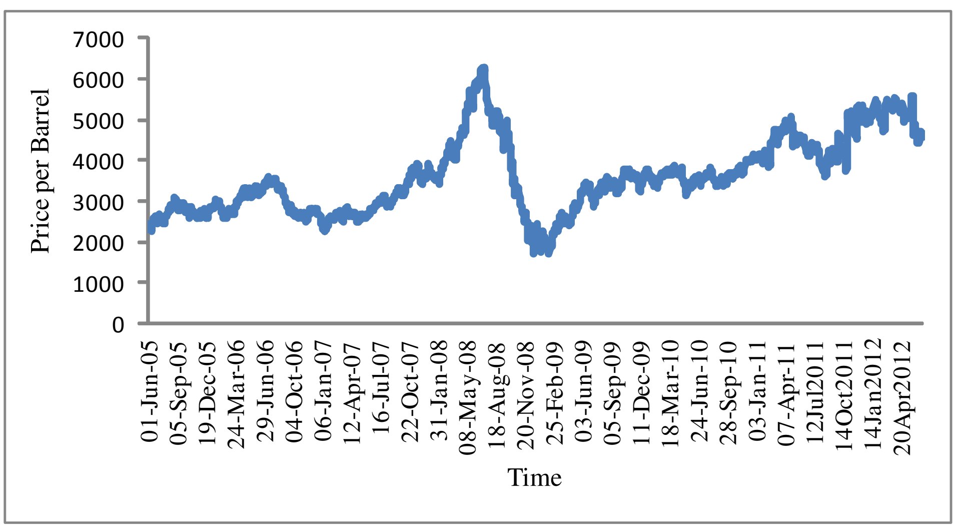
India's refined zinc production was 646,000 MT in 2009, an increase of around 8% to 9% from the previous year. Consumption of refined zinc in India reached 512, 000 MT in 2009, an increase of 20.8% from 2008. India's per capita zinc consumption is at a meager 0.4 kg, among the lowest in the world. The principal use of zinc in the Indian market is in the galvanizing sector, which currently accounts for an estimated 70% of the total production.

Zinc prices in India are fixed on the basis of the rates that rule on the international spot market, and Rupee and US Dollar exchange rates. Economic events such as national industrial growth, global financial crisis, recession, and inflation affect commodity-specific events such as the metal prices. Construction of new production facilities or processes, new uses or the discontinuance of historical uses, unexpected mine or plant closures (natural disaster, supply disruption, accident, strike, and so forth), or industry restructuring, all affect metal prices. Governments set trade policy (implementation or suspension of taxes, penalties, and quotas) that affect supply by regulating (restricting or encouraging) material flow. Geopolitical events involving governments or economic paradigms and armed conflict can cause major changes. There is also a national economic growth factor. Societies, as they develop, demand metals in a way that depends on their current economic position.

(ii) Energy

Crude Oil: Emerging countries like India ranked in the top 10 oil consuming countries in the world. India demands more crude oil for its rapid economic growth but most of its demand (around 80%) of crude oil is met through import. Therefore, a change in crude oil prices in international market affects Indian crude oil price. If we look at the Figure-2.10, we can find that the ready price of crude oil was Rs. 2480 per barrel on 7.05.2007, rose to Rs. 6291 per barrel on 5.07.2008. Thereafter, with the beginning of global financial crisis, immediately crude oil prices fell in international market due to fall in demand. Therefore, in India the crude oil prices also fell from Rs. 6291 per barrel on 5.07.2008 to Rs. 1695 per barrel on 13.02.2009. The stimulus package helped to early recovery of demand in the international market. Therefore, in the very beginning of 2009, there has seen recovery in demand as a result again crude oil prices started raising from 14.02.2009.

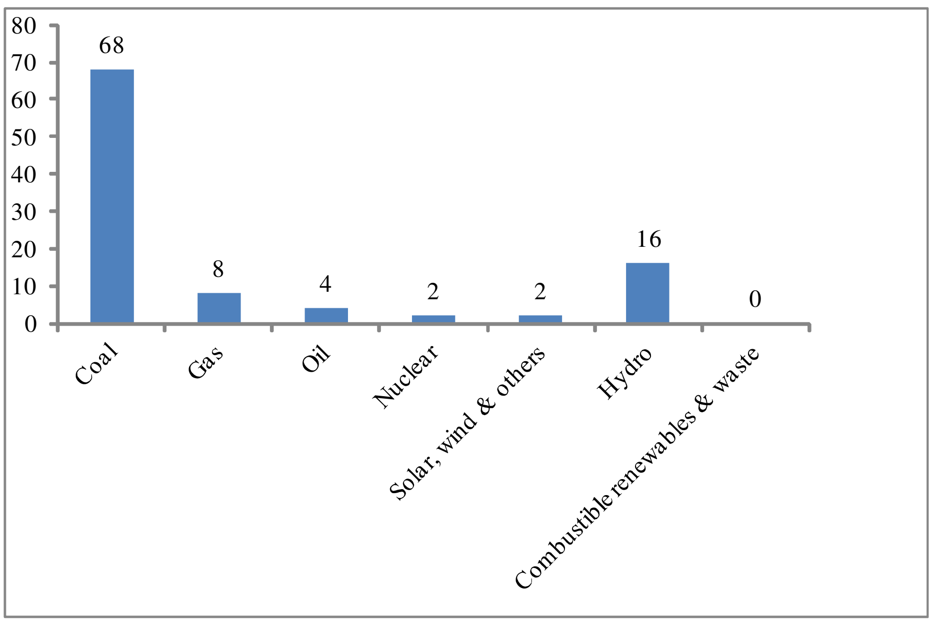
Figure 2.10: Trends of Crude oil Price in India (Rs./barrel)



Source: Data taken from Multi Commodity Exchange (MCX), India

Coal: Similar to the crude oil, Coal is also one of the most important and abundant fossil fuels in India. It accounts for about 55% of India's energy need. India's industrial heritage was built upon indigenous coal, largely mined in the eastern and the central regions of the country. Coal has been recognized as the most important source of energy for electricity generation in India. About 75% of the coal in India is consumed in the power sector. In addition, other industries like steel, cement, fertilizers, chemicals, paper and thousands of medium and smallscale industries are also dependent on coal for their process and energy requirements. In the transport sector, though direct consumption of coal by the Railways is almost negligible on account of phasing out of steam locomotives, the energy requirement for electric traction is still dependent on coal converted into electric power. The coal reserves of India up to the depth of 1200 m have been estimated by the Geological Survey of India at 247.85 billion tonnes as on January 1, 2005 of which 92 billion tonnes are proven. Hard coal deposits spread over 27 major coalfields, are mainly confined to eastern and south central parts of India (Indian Core Publishing, 2005, chapter 2).

Figure 2.11: Break-up of India's Electricity Generation (in % share in 2007)



Source: International Energy Agency, Energy Balance of Non-OECD Countries, 2009 Edition, (2009)

(iii) Food and Agriculture

Rubber: In India, the natural rubber production was 853, 000 tonnes in 2006-07 which was higher by 6% compared to the previous year, whereas consumption was 821,000 tons, up by 2%. India increased import in 2006-07 due to decrease in prices of natural rubber in the international market in terms of Indian prices. Exports were comparatively low at 55,000 tons, down by 25%, compared to the previous financial year. Rubber Price fluctuation in India is mainly due to the difference in the price of international market and Indian market. In India, around 90% of natural rubber is produced in Kerala, within which Kochi and Kottayam are main locations.

The price of natural rubber rose consecutively in the last two years (2006-07 and 2007-08). According to the rubber statistical news published by the Rubber Board of India, the average monthly price of rubber 4-grade rose to 38% during January 2005-January 2006. During the year 2006, the rise was sharp and volatile. The monthly average spot price of rubber (at Kottayam) gained by 45 per cent. It rose from Rs. 7,360 per quintal to Rs. 10,932 per quintal during January-June 2006. The rise in the natural rubber export demand also contributes to its price rise. However, the prices failed to sustain at higher levels and dropped to Rs. 8,169 per quintal in September 2006 due to softer crude oil prices and withdrawal of industrial buyers from the market on account of high prices. The prices again started rising in the first quarter of 2007.

Maize: In India, Maize is grown in a wide range of production environments. The total area under maize in India expanded from 3 m ha in 1951 to 7 m ha in 2004, growing annually at an average rate of about 2.9%. In the early 1970s, expansion in area under maize cultivation slowed dramatically, and for three decades the maize area remained virtually unchanged. A significant shift occurred in the 1990s when irrigated winter (*rabi*) maize cultivation expanded rapidly, particularly in the states of Bihar, Andhra Pradesh and Karnataka, where conditions are favorable for maize production. Overall, irrigated area increased from 16% in 1970 to 23% of total area under maize in 1997. At the same time, maize cultivation moved into marginal areas with relatively low production potential, as farmers reserved more productive areas for more profitable crops like wheat, paddy and sugarcane.

In India, maize is cultivated in locations where temperatures range from as low as $10^0{}_C$ to as high as 45^0C and where rainfall ranges from as little as 200 millimeters per year (mm/yr) to as much as 2,500 mm/yr. Indian maize production has traditionally been concentrated in the southern "Corn Belt" states of Karnataka and Andra Pradesh, where the main maize crop is grown during the summer (*kharif*) season. In recent years, introduction of cold-tolerant varieties has led to the emergence of an irrigated winter (*rabi*) maize crop in the northern states of Bihar and Uttar Pradesh (MCX Commodity Year Book, 2010).

The spread of improved crop management practices resulted in a continuous growth in average maize yields from the 1950s onwards. Rising yields, coupled with a steady expansion in area, led to growth in maize production of 5.9% and 5.2% per annum in the 1950s and 1960s, respectively. After slowing down in the 1970s as the area under cultivation stabilized, growth in maize production, fueled by continuing improvements in yield, averaged about 2.6% per annum in the 1980s and 3.2% per annum in the 1990s. Total maize production exceeded 10 million tons in 1997-98. Production of corn in India is showing increasing trend consistently except the year of 2002 when due to drought condition production showed a little decline. Major states that contribute in Maize productions are Karnataka, Andhra Pradesh, Bihar, Punjab, Uttar Pradesh and Madhya Pradesh.

Virtually all of India's maize is used domestically for food (70%), feed (15%) and industrial uses (15%). Direct human consumption of maize has declined over time, while feed and industrial uses have increased. Rising household incomes have shifted consumption from maize to other cereals like rice and wheat. They have also led to an increased consumption of meat, particularly of poultry, which has increased the demand for maize as feed. Increased industrial demand for maize comes primarily from the starch industry.

Groundnut Oil: Groundnut oil price has also been tremendously changing over the period in India. The groundnut price declined in 2008 but in the beginning of 2009 the price of groundnut again continued to rise with its earlier trend. The production of groundnut has been increased in India since 2000. In 2000-01, the groundnut production was 64.1 lakh tonnes. It rose to 91.82 lakh tonnes in 2007-08. But due to shortfall of demand in 2008, the price of groundnut has declined after the crisis. Therefore, in 2009-10 the groundnut production was 54.29 lakh tonnes. In 2011-12 it rose to 69.33 lakh tonnes and also again it rose to 87.14 lakh tonnes (Directorate of Economic & statistics).

Soybean Oil: America, Brazil, Argentina, China, and India are major producers of soybean in the world. In the US, India and China, the crop arrival begins in September-

October, whereas in South America, it begins in April-May. Soybean (215-225 MT) accounts for 55-60% and Soya oil (30-34 MT) accounts for 27-30% of the total global oilseed and oil production in 2007. In the entire soya value chain, 55-60 MT of soybean, 8-10 MT of soya oil, and 42-45 MT of soya meal are traded annually across the world.

The market share of soybean oil in India grew significantly from less than 2% in 1970s to approximately 21% in 2005-06. Soybean is a khariff crop, sown in June-July and harvested in September-October. The peak arrival of soybean takes place during October-November. Soybean oil accounts for 13% of the total domestic oil production. India produces approximately 6.2 MT of beans, 1 MT of oil, and 3-5 MT of soya meal in a normal year. Total soya oil availability in India, including its import, was around 2.8 MT in the year 2007-08. Madhya Pradesh (3.2-3.8 MT), Maharashtra (2.2-2.3 MT), and Rajasthan (0.4-0.6 MT) are major producers of soybean in India. Soybean prices follow domestic as well international sentiments and display high volatility.

2.5 Variability in Commodity Prices in India

In this section, we analyze the variability in commodity prices by estimating the standard deviation (SD) and coefficient of variation (CV). In Table 2.2, we have reported the descriptive statistics of index prices of all commodities for the period 2001 to 2012. At first, we can see the descriptive statistics of agriculture items. In agriculture commodities, it indicates that all have the positive average prices. The kurtosis is high for edible oils and cotton textiles (3.97 and 3.28) respectively. The SD and the CV show that all commodity index prices including the food index price are volatile but sugar price is more volatile followed by edible oils, cereal prices and cotton textiles prices.

Similarly, if we look at the metal sub-index prices, it can be seen that there is also increasing average price of all metal index prices including the aggregate metal index price in India. But, the SD and CV show that other non-ferrous metals are more volatile (6.41%) followed by metal products (4.59).

Table-2.2 also reports the descriptive statistics of energy commodities. It can be seen that all three index prices are volatile but mineral oil is more volatile than the coal mining's price. Table-2.2 reports the descriptive statistics of all commodity index prices for the whole sample period 2001 to 2012. But in the table, it is not confirmed that in which year, commodity prices have more average price or more volatile. Therefore, to know the individual commodity price behavior, we have estimated the average price return and price variation for each commodity. Results are reported in Table-2.3 to 2.5.

Table 2.2: Descriptive Statistics of All Commodities in India, Jan 2001 to June 2012

Commodities	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	CV(%)
Cereals	4.810	0.210	0.604	1.907	15.258	4.363
Cotton textiles	4.592	0.179	1.244	3.275	36.004	3.898
Edible oils	4.638	0.224	0.315	3.966	7.657	4.839
Rubber products	4.708	0.130	0.123	1.520	12.933	2.771
Sugar, khandsari & gur	4.793	0.237	0.597	2.092	12.929	4.942
Food index	4.715	0.183	0.611	2.158	12.654	3.886
Aluminium	4.739	0.132	-0.159	1.526	13.063	2.791
Metal products	4.789	0.220	1.287	3.878	42.519	4.590
Other non-ferrous metal	4.950	0.317	-0.204	1.258	18.417	6.412
Metal index	4.819	0.211	0.379	2.165	7.309	4.386
Coal mining	4.796	0.231	0.704	2.962	11.420	4.810
Mineral oil	4.826	0.259	-0.164	1.895	7.639	5.363
Energy index	4.821	0.251	-0.050	1.986	5.966	5.216

Notes: a. All variables are in logarithimic values of index prices for 2004 base,

b. Cereals= rice, wheat and maize; Edible oils = groundnut, palm, rapeseed, soyabean and sunflower; metal products= gold and silver, Other non-ferrous metals= copper, lead and zinc.

c. CV refers to coefficient of variation (in percent)

Data source: Author's estimations from Database of Indian Economy, RBI.

Table-2.3 shows that descriptive statistics of agriculture commodities. It can be seen that there is continuously rising of average price of cereals from the year 2001 to 2012. The standard deviation and CV results indicate that there is continuously rising in price fluctuation of cereals during the study period. The cotton textiles also show the same result, that is, in the study period there is rising average price with fluctuations. The other commodities like edible oils, rubber and sugar price indicate that there is continuously rising of average price of these commodities and also there is increasing price fluctuation in the study period in India. Finally, if we look at the Agri-index, we can find that there is increasing agri-index price in India and also there is increasing price fluctuation in the study period.

Table 2.3: Descriptive Statistics of Agriculture Commodities in India (2001-2012)

	Year	Mean	Std. Dev.	Skewness	Kurtosis	CV		Year	Mean	Std. Dev.	Skewness	Kurtosis	CV
Cereals	2001	4.589	0.010	0.645	2.312	0.224	**Rubber products**	2001	4.527	0.012	-1.703	5.082	0.275
	2002	4.596	0.018	0.083	1.440	0.402		2002	4.564	0.037	0.017	1.314	0.808
	2003	4.625	0.006	-0.616	3.087	0.121		2003	4.594	0.007	0.103	1.743	0.162
	2004	4.628	0.013	-0.394	1.734	0.289		2004	4.598	0.009	-0.777	1.869	0.202
	2005	4.664	0.015	-0.059	1.423	0.326		2005	4.615	0.021	-0.197	1.733	0.456
	2006	4.728	0.030	0.726	2.035	0.642		2006	4.672	0.033	0.447	1.602	0.704
	2007	4.795	0.016	0.244	1.471	0.328		2007	4.742	0.024	0.440	1.897	0.501
	2008	4.864	0.029	0.571	2.179	0.593		2008	4.801	0.012	0.527	1.654	0.258
	2009	4.989	0.041	0.521	2.384	0.817		2009	4.820	0.005	0.013	2.201	0.107
	2010	5.073	0.033	0.701	2.401	0.659		2010	4.873	0.016	-0.714	2.432	0.334
	2011	5.158	0.007	-0.252	1.374	0.130		2011	4.885	0.010	-0.903	2.281	0.208
	2012	5.203	0.020	-0.067	1.370	0.388		2012	4.905	0.005	0.245	1.403	0.112
Cotton textiles	2001	4.454	0.013	-0.477	2.198	0.294	**Sugar**	2001	4.596	0.010	0.534	4.365	0.211
	2002	4.423	0.018	-0.250	1.587	0.396		2002	4.537	0.036	-0.994	3.100	0.803
	2003	4.501	0.047	0.600	2.846	1.044		2003	4.506	0.050	0.016	1.317	1.105
	2004	4.588	0.029	-0.831	3.243	0.641		2004	4.651	0.053	-0.686	2.545	1.135
	2005	4.469	0.019	-0.353	1.626	0.425		2005	4.777	0.011	0.006	1.985	0.232
	2006	4.496	0.010	-0.086	2.308	0.216		2006	4.820	0.020	-0.859	2.501	0.414
	2007	4.498	0.019	-2.181	6.623	0.415		2007	4.671	0.037	0.632	2.171	0.801
	2008	4.523	0.071	-0.140	1.258	1.568		2008	4.683	0.044	0.131	1.372	0.936
	2009	4.607	0.027	0.995	3.250	0.581		2009	4.980	0.128	-0.014	1.804	2.570
	2010	4.795	0.066	0.306	2.006	1.379		2010	5.214	0.067	0.097	1.847	1.279
	2011	5.015	0.049	-0.833	2.205	0.986		2011	5.100	0.009	0.465	2.464	0.180
	2012	4.956	0.016	0.063	1.642	0.317		2012	5.143	0.010	0.343	1.734	0.199
Edible oils	2001	4.221	0.058	-0.131	1.390	1.363	**Agri index**	2001	4.482	0.012	-0.309	2.673	0.267
	2002	4.405	0.082	-0.062	1.411	1.867		2002	4.511	0.026	-0.066	1.218	0.577
	2003	4.572	0.033	-0.789	2.495	0.712		2003	4.568	0.021	-0.347	1.984	0.457
	2004	4.603	0.012	-0.381	1.989	0.266		2004	4.613	0.007	0.068	2.061	0.151
	2005	4.529	0.014	0.677	3.777	0.307		2005	4.610	0.006	0.193	1.554	0.126
	2006	4.540	0.040	0.518	1.859	0.885		2006	4.653	0.020	0.370	1.660	0.440
	2007	4.664	0.026	0.183	1.750	0.559		2007	4.688	0.008	0.391	1.516	0.177
	2008	4.782	0.033	0.328	1.770	0.690		2008	4.750	0.026	-0.329	1.458	0.557
	2009	4.714	0.011	0.647	2.727	0.242		2009	4.834	0.036	0.381	2.075	0.753
	2010	4.940	0.028	0.398	1.522	0.567		2010	4.987	0.080	0.248	1.379	1.599
	2011	4.868	0.017	0.300	1.902	0.357		2011	5.010	0.012	-0.774	2.248	0.243
	2012	4.961	0.022	-0.090	1.321	0.440		2012	5.040	0.015	0.095	1.371	0.294

Notes and Source: Same as in Table 2.2

In Table-2.4, we have reported the descriptive statistics of metals. We can see the continuously increasing aluminium price in India and also the volatility. In the year 2006, the aluminium price volatility was the highest compared to other years. Similarly, now if we look at the metal products which (includes gold and silver), it can be seen that there is continuously increasing average prices of these metal products but it had the highest volatility in the year 2010 compared to other years. There was also an increased in the average price of non-ferrous metals in India and the price volatility. But during the years 2005 to 2006, these prices became more volatile compared to other years. If we look at the Metal aggregate index, we can find that there is also continuous increase in the average price and volatility of metal index. During the period 2006 and 2010, there were more volatilities of metal index prices in India.

Table 2.4: Descriptive Statistics of Metals in India (2001-2012)

Metal	Year	Mean	Std. Dev.	Skewness	Kurtosis	CV
Aluminium	2001	4.560	0.008	-1.188	3.982	0.169
	2002	4.560	0.003	1.046	3.418	0.071
	2003	4.575	0.007	-1.209	3.455	0.162
	2004	4.619	0.019	0.818	2.048	0.404
	2005	4.695	0.019	-1.748	4.138	0.397
	2006	4.849	0.067	-0.581	1.613	1.377
	2007	4.907	0.046	0.001	1.483	0.933
	2008	4.879	0.016	-1.192	2.470	0.334
	2009	4.792	0.015	1.661	3.960	0.317
	2010	4.782	0.018	0.924	2.475	0.373
	2011	4.844	0.010	-0.312	1.965	0.210
	2012	4.872	0.011	0.459	1.937	0.233
Metal products	2001	4.585	0.017	-1.154	2.358	0.371
	2002	4.566	0.012	0.298	1.395	0.261
	2003	4.580	0.004	0.365	1.591	0.094
	2004	4.637	0.040	-0.213	1.681	0.867
	2005	4.719	0.021	0.103	1.476	0.446
	2006	4.760	0.015	0.382	1.916	0.324
	2007	4.806	0.009	0.403	1.363	0.184
	2008	4.822	0.003	1.591	5.728	0.063
	2009	4.807	0.027	-0.242	1.139	0.566
	2010	4.874	0.119	0.907	2.291	2.439
	2011	5.193	0.025	-0.248	1.685	0.489
	2012	5.342	0.014	0.862	2.618	0.257
Other non-ferrous metals	2001	4.538	0.011	-0.204	1.755	0.246
	2002	4.582	0.027	-0.541	1.740	0.590
	2003	4.550	0.011	1.190	3.361	0.241
	2004	4.614	0.014	0.306	1.604	0.313
	2005	4.735	0.087	0.281	1.494	1.831
	2006	5.131	0.171	0.188	1.542	3.326
	2007	5.346	0.020	-1.009	3.512	0.373
	2008	5.227	0.034	0.187	2.579	0.648
	2009	5.169	0.035	0.137	1.818	0.669
	2010	5.209	0.013	0.448	1.336	0.248
	2011	5.208	0.006	-0.719	2.729	0.121
	2012	5.221	0.004	-0.097	1.316	0.080
Metal index	2001	4.572	0.012	-1.130	2.320	0.254
	2002	4.568	0.010	0.039	1.625	0.213
	2003	4.574	0.003	-0.177	1.631	0.076
	2004	4.630	0.030	0.012	1.632	0.657
	2005	4.718	0.032	0.111	1.514	0.679
	2006	4.860	0.062	0.202	1.559	1.266
	2007	4.952	0.007	-0.767	3.337	0.151
	2008	4.923	0.006	0.136	2.122	0.113
	2009	4.885	0.009	0.002	2.142	0.179
	2010	4.934	0.072	0.974	2.428	1.462
	2011	5.141	0.019	-0.299	1.743	0.370
	2012	5.247	0.011	0.731	2.377	0.218

Notes and Source: Same as in Table 2.2

Table 2.5: Descriptive Statistics of Energy Commodities in India (2001-2012)

Energy	Year	Mean	Std. Dev.	Skewness	Kurtosis	CV (%)
Coal mining	2001	4.511	0.045	-2.822	9.414	0.998
	2002	4.517	0.000	NA	NA	0.000
	2003	4.561	0.046	0.000	1.000	1.004
	2004	4.686	0.077	-0.058	1.062	1.639
	2005	4.763	0.001	-2.736	8.917	0.021
	2006	4.763	0.000	NA	NA	0.000
	2007	4.767	0.015	3.015	10.091	0.311
	2008	4.854	0.004	-1.042	2.196	0.092
	2009	4.857	0.036	3.015	10.091	0.751
	2010	4.999	0.037	1.016	2.505	0.748
	2011	5.183	0.056	-0.847	1.890	1.072
	2012	5.348	0.001	-1.789	4.200	0.011
Mineral oil	2001	4.425	0.007	1.547	5.059	0.165
	2002	4.453	0.029	-0.666	2.214	0.657
	2003	4.539	0.028	0.192	2.021	0.617
	2004	4.661	0.059	0.403	1.737	1.270
	2005	4.798	0.049	0.275	1.463	1.025
	2006	4.898	0.029	-0.144	1.689	0.583
	2007	4.895	0.016	1.446	4.149	0.328
	2008	5.029	0.084	0.159	1.327	1.672
	2009	4.936	0.042	-0.125	1.253	0.861
	2010	5.056	0.025	-0.767	2.564	0.497
	2011	5.130	0.027	-0.202	1.622	0.518
	2012	5.262	0.007	0.141	1.554	0.138
Energy index	2001	4.441	0.005	-0.144	3.506	0.117
	2002	4.465	0.024	-0.660	2.206	0.528
	2003	4.543	0.026	-0.360	1.791	0.567
	2004	4.665	0.061	0.221	1.479	1.314
	2005	4.791	0.041	0.275	1.466	0.847
	2006	4.875	0.024	-0.140	1.688	0.490
	2007	4.873	0.015	1.727	5.132	0.315
	2008	5.000	0.071	0.154	1.331	1.427
	2009	4.922	0.038	0.053	1.485	0.771
	2010	5.046	0.026	-0.247	2.239	0.513
	2011	5.140	0.031	-0.511	1.718	0.608
	2012	5.279	0.006	0.140	1.538	0.112

Notes and Source: Same as in Table 2.2

The descriptive statistics of energy prices are reported in Table-2.5. It can be seen that the coal mining average price was increasing continuously. The STD and CV indicate the coal mining price fluctuations but in selected years of 2003, 2004 and 2011, there were more price variations in India.

From the above discussion we found that there have been tremendous changes in commodity prices in India particularly since 2002. The historical commodity prices in India show that the price trends are completely different in the 21st century compared the previous years. The commodity prices in India became historical high during 2005 to 2008 in India. But short fall in demand due to crisis in 2008, there was change in the price trends but it recovered very quickly and became equal with the previous trends. Therefore, it is important to discuss and to find out why in the 21st century commodity price became historical high.

2.6 Debate on the Behaviour of Commodity Prices

Now a question can arise that are the factors that behind such commodity price behavior in India. As it is well known that agricultural commodities prices are affected by changes in energy prices, weather, and the diversification of some commodities to the production of biofuels but it is not cleared except these uncontrollable factors, what are the other factors which affect agricultural food prices in India and similarly for the metals and energy prices in India. The debate on commodity price is not new but it started many years back in the development economics where the literatures are concentrated only on two questions- (i) the declining terms of trade in commodity export prices relative to imports of manufactured goods from developed countries (the Prebish-Singer hypothesis), and (ii) the high price volatility and instability (Nissanke, 2001). Prebish (1950) basically argued on the long-term declining of trade of primary exports in terms of the fundamental differences between primary commodities and manufactured goods both on demand and supply sides. The Prebish-Singer hypothesis is well known to every economist and young researchers, which was made by certain conditions such as (i) commodities have lower price and income-elasticity of demand compared to manufactures, (ii) developed countries are more superiority in technology than developing countries, therefore, they dominant in economic power and capture excess profits and (iii) due to the asymmetric impact of labour union power in developed countries and labour surplus in developing countries on the division of the benefits of increased productivity.

Coming to the fundamental factors affecting commodity prices, Maizels (1987, 1992 and 1994) explained that the sharpen decline of terms of trade for primary commodities in 1980s was due to the structural shifts in demand and supply relationships in primary commodities. The structural changes in the demand and supply of primary commodities are not only due to the technological changes but also due to the two oil shocks and the commodity booms in the 1970s.

Similarly, Maizels (1994, p. 1692) mentioned that large fluctuations of commodity prices can be explained in terms of frequent shocks to the fundamental demand-supply relationships of physical commodities. Specifically, due to the low short-term price elasticity of both supply and demand for the greater majority of primary commodities, any given disturbance in economic activity in the developed countries, or in commodity supply, result in a greater than proportionate change in commodity prices and export earnings of commodity dependent economies.

In recent years, changes in the demand-supply relationship have become less effective on their own for explaining the ever-increasing volatilities in price movements, which observed systematically across a large number of commodities, particularly large fluctuations found in high-frequency price data. In the very beginning of 1990s, the researcher found the evidence that the high price volatility could result from the intensifying two-way interactions between the commodity and financial markets. Basically, speculative activities in commodity markets exacerbate price volatilities but there is also evidence that key financial variables could also influence the volume of commodity stocks held and hence there is price dynamics over short-run. Therefore, Maizels (1994, p. 1692) said that instability in the commodity markets and in the financial markets feed on each other and constitute an inbuilt mechanism of short-term destabilization and uncertainty in the world economy.

The price volatility in 2008 could not be explained from the fundamental demand-supply factors, it goes beyond, as there were neither major changes in supply and demand, nor significant changes in stock level in the first half of 2008. However, there were extraordinary increases in the volume of commodity derivatives as asset classes, which attracted 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 the “financialization of commodity markets” (UNCTAD, 2010). For which, in 2008, these markets were heavily influenced by the reactions of institutional investors to growing economic and financial uncertainties. The rise in the notional value of commodity derivatives was one of the underlying cause of the increase in prices, and as the crisis unfold, the rapid unwinding of commodity futures’ positions aggravated the bust and amplified the price shocks (UNCTAD, 2009).

It could be understood that the main reason for the general increase in commodity prices since the first quarter of 2009 has probably been the "stimulus packages" introduced in many OECD countries and some emerging economics, in response to the economic and financial crisis. China in November 2008 lunched such package was the 4,000 billion Yuan ($586 billion), mainly to expand infrastructure (construction of new highways, roads and bridges) and to support the manufacturing industry, as a result, China increased its imports of metals, minerals, and to some extent, energy and cereals. Similarly, India government announced in December 2008 an economic stimulus package of $4 billion to shield its economy from recession. A substantial increase in government expenditure coupled with a cut in interest rates by RBI aims towards raising the aggregate demand.

2.7 Summary

This chapter-2 examined the behaviour of commodity prices and the role of fundamental factors or macro economic variables in India. With this aim, this chapter started with introduction where we reported why to study the behaviour of commodity price and how macroeconomic variables are related with this. Then we analysed the trends of international price as well as the trends of domestic price in India. After that we analysed the characteristics of commodity price behaviour in India. It is seen that there were continuous increases in the commodity prices in India. From the variability/volatility of commodity prices in India, we found that there was high volatility of commodity prices and then there were debates on the behaviour of commodity prices in India. Thereafter, we have reported the descriptive statistics of both the full sample and also for each year. From the full sample, it is observed that among the food items, edible oils and sugar prices were more volatile than other food items. Similarly, from the metal items, non-ferrous metal prices became more volatile than other metal prices. In case of energy prices, mineral oil price was more volatile than the coal price.

Cereals price's SD and CV showed that it was more volatile in the year 2009. But the 'cotton textiles' was more volatile in the year 2008 and 2010. So, there were high volatilities in these two years compared to the earlier years. Similarly, edible oil price had the highest volatility in the year 2008 but in case of rubber, the highest volatility was in the years 2006 to 2007. Sugar price had the highest volatility in the years 2003 and 2004, and again in the years 2009 and 2012. But the aggregate food Index descriptive statistics indicate that it was more volatile in the year 2010 compared to other years.

The descriptive statistics of metals indicated that there was a continuous increase in the aluminium price in India and also the volatility. But in the year 2006, the aluminium price was having the highest volatility compared to other years. Similarly, in case of the metal products (which includes gold and silver), there was a continuous increase in the average price of metal products. But it had the highest volatility in the year 2010 compared to other years. There was also an increase in the average price of non-ferrous metals in India and also the price volatility. But years 2005 to 2006 showed more volatile compared to other years. But, in case of Meta aggregate index, we found continuously increasing average prices and volatilities. In the years 2006 and 2010, there were more volatilities of metal index prices in India

Coal mining average prices were continuously increasing in India. The SD and CV indicated that there was also coal mining price fluctuation, but more price variations were observed in the years of 2003, 2004 and 2011. The descriptive statistics for mineral oil showed that price was more volatile in the year 2008 compared to other years. This might have been due to the effects of global financial turmoil. The descriptive statistics of the aggregate energy price index confirmed that the energy price index was more volatile in the year 2008 compared to other years.

From the debate on the behaviour of commodity prices, we found that there are three core factors which affect the behaviour of commodity prices in India. These factors are fundamental/macroeconomic factors, financialization of commodity market and lastly, the international price transmission.

Chapter 3
Relationship between Commodity Prices and Fundamental Factors in India

3.1 Introduction

This chapter discusses the relationship between commodity prices and fundamental factors in India. It is very important to understand the price behaviour and also to find out the factors behind the historical rise of the commodity prices not only internationally but also in India. Accordingly, this chapter is organized in the following sections. Section 3.2 describes the literature review on the drivers of commodity prices. Section 3.3 gives the sample size and data sources. We have analysed the construction of commodity price index in Section 3.4. Section 3.5 analyses the estimation techniques which are used in this chapter. Section 3.6 discusses the estimation results and findings, followed by the summary in Section 3.7.

3.2 Literature Review of Drivers of Commodity Prices

As stated earlier, a sharp rise and high fluctuations or volatility of commodity prices not only in India but also in the world have been giving headaches to policy makers, researchers, businessman and to consumers to find out the reasons behind that phenomenon. The recent rise of commodity prices is the greatest in the history of commodity markets because the price rise was taking longer, included more commodities and larger prices in real term increases than any other periods in the last half century (UNCTAD, 2010). It is very difficult to the policy makers and researchers to predict exactly the future prices of essential commodities due to its high volatility uncertainties. Among all arguments, there are basically two common factors which are called responsible for the recent commodity price rise and volatility. The two common factors are – (i) fundamental factors and (ii) financialization of commodity markets. The fundamental factors are those factors which play major role for the changes in demand and supply. Different economists have suggested different fundamental factors which affect commodity prices both in the short-run and in the long-run.

The study on the determinants of price rise at first was done by Professor Kemmerer (1907) and Professor Irving Fisher (1911). They believed that the increase of gold and credits, including bank deposits subject to check, and especially an increase in the volatility of circulation of money and credits are the most vital factors in raising the price level.

The original work of Kemmerer, viz., "Money and Prices", was published by Henry Halt & Company, and it appeared in its latest form in Irving Fisher's new book titled "The Purchasing Power of Money", published by Macmillan Company (1907). They specify into the simplest form as follows: "The price of produce and commodities is always equal to the money in circulation, multiplied by their volatility of circulation, plus credits, multiplied by their velocity of circulation, divided by the country's volume of trade". Mathematically, price P can be obtained from the following formula:

$$PT = MV + M'V'$$

where, M = Money in circulation, V = Velocity of circulation of M, M' = Deposit subject to check or credits, V' = Velocity of circulation or activity of M′, T = Volume of trade and P = Price level. Therefore, $P = \frac{MV+M'V'}{T}$

When, the factors M, V, M′ and V′ increase, P also increases and the price level advances.

Babson (2011) said that except the above factors, there are also other factors which make the price levels different in different localities. Some of these factors are - changes in expenses of production, tariffs & taxation, wages & unionism, change in agricultural conditions, monopolies and trust, general extravagance, competitive advertising and speculation. These factors are not the factors which raise the price level as a whole and are not the fundamental factors. But these factors are considered when referring to different figures in different localities.

Dornbusch (1985) investigated the impact of macroeconomic developments in the industrialized nations on LDCs (less developed countries), in part to assess such trade-offs as that between increased LDC exports and higher interest rates resulting from U.S. growth. He examined this by constructing a simple model of a semi-small open economy, identifying the channels of external influences and specifying the way in which they affect economic performance. Particularly, he identified three principal channels - (i) the real price of primary commodities, which is determined in the world markets, (ii) the world rate of interest rate on the LDC's debts and (iii) the level of world demand, which affects demand for LDC manufacturing exports of foreign influence on the LDC economy. Among the macroeconomics variables, he stressed on the exchange rate influence on commodity price. In that paper, he constructed a simple supply-demand two-country model to highlight this effect. He pointed out that the elasticity of commodity prices to the U.S. real exchange rate assumes the following expression:

$$\frac{\partial \ln \left(\frac{P}{CPI}\right)}{\partial ln\left(\frac{CPI}{eCPI^*}\right)} = -\frac{\beta^*}{\left(\frac{\beta\eta}{\eta^*} + \beta^*\right)}$$

Where, P is the price of a representative commodity basket, CPI and CPI^* are consumer price indexes in the U.S. and the rest of the world respectively; e is the multilateral nominal exchange rate (therefore $\frac{CPI}{eCPI^*}$ is the RER); η and η^* are the demand price elasticities, and β and β^* are the market shares of each country in the world demand. Theoretically, he assumed that the elasticity value should lie between 0 to -1. But in empirical research, it has usually been observed that it overshoots its theoretical value, i.e., lower than -1.

Lescaroux (2009) examined the excess co-movement of commodity prices- a special reference to how fundamental factors are playing a major role in short-run dynamics. He used a large price data set of 51 commodities over the period from 1980 to 2008 to confirm that raw resources exhibit co-movement at high frequencies. But his findings did not support the hypothesis of excess co-movement for oil and six metals but to a large extent, the tendency of commodity prices to oscillate together reflected the tendency of their fundamental factors to move together. Once stock changes were taken into account, there remained very little changes of cross-correlations between prices of raw resources and the interactions were limited to current month.

The traditional structural approach to determining real commodity prices has relied exclusively on demand factors as the fundamentals that explain the behaviour of commodity prices. This framework, however, was unable to explain the marked and sustained weakness in these prices during the 1980s and 1990s. Borensztein and Reinhart (1994) extended that framework in two important directions. First, it incorporates commodity supply in the analysis, capturing the impact on prices of the sharp increase in commodity exports of developing countries during the debt crisis of the 1980s. Second, it takes a broader view of "world" demand that extends beyond the industrial countries and includes output developments in the Eastern Europe and the former Soviet Union. The empirical results supported these extensions, as both the fit of the model improved substantially and, more important, its ability to forecast increased markedly.

Chambers and Bailey (1996) pointed out that the price fluctuations of storable commodities which are traded in open markets are subject to random shocks to demand, more particularly, to supply. It relaxes the common assumption that the shocks are identically and independently distributed (IID) in favour of temporally dependent and periodic disturbances. They examined a short-term commodity price determination. The empirical investigation is undertaken for the model with periodic disturbances using monthly time-series observations for seven commodities over the period 1960-93. The casual observation suggested that fluctuations in the weather over very short intervals of time (days or weeks) tended to be serially correlated, and hence, this could be important for agricultural commodities.

Labys and Maizels (1990) examined the commodity price fluctuations and macroeconomic adjustments in the developed countries. Particularly, they examined the world commodity (IMF) price fluctuation with the macroeconomic variables like world GDP, world trade (export value), exchange rate, interest rate, balance of payment and index of industrial production price by using the granger causality for quarterly data. They found a stronger relationship between primary commodity prices and domestic prices, cost and other macroeconomic variables in the selected countries than was anticipated. The first set of tests dealing with direct and indirect impacts of commodity prices on domestic prices and wages were mixed, and the indirect effects were not as strong as others had suggested. This may have been due to present limitations to perform tests of the ratchet effect, i.e., the hypothesis that direct and indirect price and wage effects operate differently in the upward phase and in the downward phase of cyclical movements. The relation of industrial share prices to commodity prices was unexpectedly strong in several countries and should be further explored.

The second set of tests by Labys and Maizels (1990) dealt with a variety of theories and hypotheses describing the impacts of commodity prices on adjustments in macroeconomic behavior. The results achieved in most of these tests suggest that commodity price fluctuations might play a more important role in the economic instability and performance of the developed countries, than was previously believed. The commodity price and output relations were strong, as would have been expected. But more important has been the identification of the direction of causality, which is from prices to output. There was also strong confirmation that commodity prices have led changes in interest rates and, to a lesser extent, adjustments in the money supply. This suggests that the major countries did, in fact, practice monetary policy adjustments of some form, to counter major commodity price swings. Again, these responses might more usefully be evaluated by distinguishing between upward and downward price movements.

Frankel and Hardouvelis (1985) examined the reactions of money supply announcement on prices of nine commodities (gold, silver, sugar, cocoa, cattle, feeders, soybeans, wheat and corns), to assess the degree of market credibility that the Fed has in its commitment to money growth target using the regression analysis. They found that the reactions of the various markets to the money announcements can be used for two distinct purposes: (i) they support the proposition that during the 1980-82 period, the market had confidence in the Fed's commitment to correct deviations from money growth rate targets; and (ii) they support the proposition that movements in the interest rate rather than the expected inflation rate, as in the overshooting model. The reaction in the prices of foreign exchange and commodities support the first proposition, whether one believes in an overshooting model or not. If one believes that all prices are perfectly flexible, even those of manufactured goods, then monetary policy should be instantly reflected in all prices. Some prices are sticky in the short run. Hence, the monetary price will reflect in foreign exchange price and commodities and so more.

Christie-David et al. (2000) examined the effects of macroeconomic news releases on gold and silver futures prices using intraday data over a period of 4 years (1992-1995). They included twenty-three month macroeconomic news. In addition, they have also estimated the effects of macroeconomic news on Treasury bond and municipal bond futures. The interest rate instrument is used as a basis of comparison. The robust nonparametric tests show that there were differences in response to the announcements between the metal and interest rate futures. While the announcements substantially affect interest rate futures, the metal futures show modest responses to the release of macroeconomic news. The regression results show that the interest rate futures respond strongly to the release of many of the announcements, particularly the announcements issued shortly after the market opens for trading. Gold and silver responded strongly to the release of capacity utilization. Gold also responds strongly to the release of the CPI. The unemployment rate, gross domestic product and the PPI also have significant effects on gold. The results also suggest weak responses by gold and silver futures to a few other announcements. Gold responds weakly to the release of the Federal deficit, whereas silver responds weakly to the release of the CPI. Overall the results show that the news releases strongly affect interest rate futures, but have less pronounced effects on metal futures.

Using a structural VAR with block erogeneity, diagonality and identifying restrictions Kim et al. (2011) analyze, first, the macroeconomic linkages among the oil price, U.S. output, interest rate, money supply, general price level and exchange rate; and second, the relationships of the macroeconomic variables with the price indices of ten international nonfuel commodity groups. By assuming the block exogeneity of U.S. macroeconomic variables with respect to the international nonfuel commodity prices, they discuss how exogenous oil/macroeconomic shocks affect the international commodity prices. They finally explored, which oil/macroeconomic shocks are important in explaining the variations in international commodity prices. The results show that the sources of major fluctuations in the international commodities differ greatly by commodity. Soft and hard commodity prices such as those of seafood, industrial metals and gold seem to be strongly affected by the financial factors. Moreover, for some commodities, price fluctuations are more affected by the financial factor than by the real factor, supporting the view of "financialization" of commodities. Those commodities include vegetable oils and protein meals, meat, seafood, and industrial metals. The financial factor is also an important source of fluctuations in the oil prices. Oil price shocks have effects on the volatilities of interest rates, money supply, and general price level instantly, as well as on the exchange rate instead of the general price two years after the shock. Over the whole forecasting horizon, the degree of exchange rate pass-through is low on the general price level but is positive and high on oil and nonfuel international commodity prices.

Nag and Goswami (2008) analysed the different sources of commodity price fluctuation and their attendant macroeconomic implications for developing countries in terms of the over (under) shooting hypothesis under perfect foresight. They constructed a two-sector (agriculture and industry) open economy macro model to examine the effects of different shocks on commodity price, wage and employment under the flexible exchange rate regime. They found that the short run expansionary effect of rise in money supply does not persist in the long run through an equiproportionate rise in the price of primary commodity, the nominal exchange rate and the industrial price level. The striking result of the paper arises in the context of agricultural trade liberalization. The paper clearly shows that short run inflationary outcome is purely a temporary phenomenon. The short run adverse effect on commodity price completely disappears once the economy sees off its transitional phase. In fact, in the long run, commodity price comes back to its initial level signifying an improvement in the real wage rate. Hence, the clear policy message is that the short run effect is not a reliable guide to the design of macroeconomic policy.

Kaabia and Gil (2000) examined the relationships between macroeconomic variables and the agricultural sector in Spanish economy using the econometric techniques. In order to carry out the empirical analysis of the linkages between macroeconomic variables and the agricultural sector, two blocks of variables have been considered. The first one is the macroeconomic block which contains the more relevant macroeconomic variables - real effective exchange rate, the real money supply, interest rate, inflation expressed as consumer price index in first differences; and real gross domestic product. The second one is the agricultural block, which includes the following variables - real farm input prices, real farm output prices and real agricultural exports. Results from the long-run analysis indicate that most of the theoretical relationships among macroeconomic and agricultural variables hold. The real quantity of money is neutral with respect to aggregate income. It has also been found that in the long run agricultural prices are homogeneous, that is, input and output prices reactions are of the same magnitude. It is also noticeable that, in the long run, changes in agricultural variables have not had a significant impact on macroeconomic variables. Finally, taking into account the speed of adjustment coefficients, there is empirical evidence of a demand-pull transmission mechanism between agricultural input and output prices. The analysis of short-run dynamics has also provided some useful information. In spite of the fact that agricultural prices are homogeneous in the long run, output prices seem to be more flexible in the very short run and react quicker than input prices. However, over the longer time horizons, output prices are not significantly different from their original level while input prices remain on a significantly higher level. This would indicate that the terms of trade for the agricultural sector would get worse. Also, in the very short-run, agricultural exports are more sensitive to agricultural prices than to any other macroeconomic variable. The current trend of lower interest rates in Spain has important effects on the foreign competitiveness of the Spanish agricultural sector. On the other hand, since the inflation was under control so it was expected that in the future, the main determinants of the competitiveness of the agricultural sector would be domestic prices and interest rate.

Kaufmann (2008) argued that whether commodity price spike and collapse of 2007-2008 were driven by changes in both market fundamentals and speculative pressures. He said that the demand shock in 2007-2008 was due to increase of Chinese oil demand, led to a sudden increase in non-OPEC production. But halt in demand in 2008 led to loss in OPEC spare capacity. These changes were reinforced by speculative expectations, but it was difficult to measure directly.

Palaskas and Varangis (1990) examined a long-run relationship between primary commodity prices and macroeconomic variables like real interest rate, money supply, inflation, exchange rate, etc. They found that there was a long-run quantifiable relationship between real interest rates and real commodity prices, but not between real commodity prices and their consumer prices or money supply. Commodity prices in nominal terms strongly affected consumer prices but not the reverse and some groups of commodity prices could be reliable indicators of movements in consumer price- but not the reverse, and the relationship was not quantifiable.

Frankel (2006) looks at the connections between monetary policy, and agricultural and mineral commodities. He started with the monetary influence on commodity prices, first for a large country such as the United States, followed by the small states. The claim is that low real interest rates lead to high real commodity prices. The relationship between real interest rates and real commodity prices is also supported empirically. There is a negative effect of interest rates on the desire to carry commodity inventories.

Gilbert (1989) examined the impact of exchange rates and developing country debt on commodity prices. He found that the interaction between dollar appreciation and dollar-denominated debt was responsible for the recent low real level of primary commodity prices.

Anderson and et al. (2003) examined the micro effects of macro announcements-real time price discovery in foreign exchange using a new dataset consisting of six years of real-time exchange rate quotations, macroeconomic expectations, and macroeconomic realizations (announcements). They found that announcement surprises (that is divergences between expectations and realizations, or "news") produce conditional mean jumps, hence, high-frequency exchange rate dynamics are linked to fundamentals. The details of linkages are intriguing and include announcement timing and sign effects. The sign effect refers to the fact that market reacts to news in an asymmetric fashion - bad news has greater impact than good news, which is used information processing and price discovery.

Palaskas and Varangis (1990) studied the relationship between commodity prices and various macroeconomic variables. Particularly, they focused on interest rate because of the important role they play in the portfolio adjustment model, in which investors move between commodities, bonds, and money as interest rates change. Their test did not rule out the hypothesis that there is a measurable, long-run equilibrium between real interest rates and real commodity prices. Changes in real interest rates significantly affect prices on metals, minerals, nonfuel commodities, and agricultural raw materials. They rejected the hypothesis of a long-run relationship between real commodity prices and either consumer prices or the money supply.

They have used causality test, cointegration techniques and error correction model to analyze the relationships between macroeconomic variables and commodity prices. The causality test shows that commodity prices in nominal terms (except for metals and minerals) strongly affect consumer prices but there was no inverse relation. This test also shows that changes in the money supply cause changes in commodity prices, but commodity prices do not affect the money supply.

Barnhart (1989) examined the effects of macroeconomic announcement on commodity prices. Particularly, he analyzed the immediate reaction of a representative sample of commodity prices and two T-bill yields to the unanticipated components of thirteen macroeconomic announcements. He finds that monetary variables cause the majority of the significant commodity prices responses, while these plus other cyclical surprises, such as the unemployment rate, cause significant lumber and T-bill reactions.

There are studies like Fleming and Remolona (1999), Andersen et al. (2003) which examined the impact of macroeconomic variables like inflation, money supply, interest rate, etc. on stock markets, bond markets and foreign exchange markets. But there are very less number of studies is available which have examined the macroeconomic impacts on individual commodities. Some of such studies include Barnhart (1989), Christie et al. (2000) and Cai et al. (2001). The dotcom crisis in 2000 has increased the importance of alternative asset investment. It is believed that commodity futures are safe and best alternative asset. Therefore, there has been an increased commodity futures trading world-wide. But, one interesting thing is that the correlation between different groups of commodity futures is very low, much lower than the correlation between different stock sectors (Erb and Harvey, 2006).

One important point to be noted here is that one emerging country like India, commodity price has been increased and highly volatile in the last couple of years but there are very few studies available which examined what are the macroeconomic factors which are responsible for this. Broadly, we categorized the factors into three: macroeconomic factors, external price factor and the financialization of commodity markets in India. In this chapter we are analyzing how macroeconomic factors are responsible for the recent commodity price rise and volatility in India. From the above literature, it is not cleared what fundamental factors or macroeconomic variables really affecting commodity prices either in short run or in the long-run. Therefore, in this chapter, we are examining the relationship between macroeconomic variables with commodity prices in India in both short run and in the long-run using econometric techniques.

From the above literature survey, we found the macroeconomic variables like demand, interest, money supply, exchange rate, inflation and biofuels, etc. affect the commodity price in India. Already we discussed briefly in the Chapter-1 how these variables affect commodity price in India**.** The real inflation affect negatively as it increase interest rate. Therefore, when inflation rises, interest rate also rises to make balance between investments. The macroeconomic variables have a positive as well as negative impact on commodity prices. But to know which fundamental factors affect commodity price in India, we have empirically examined in the below.

3.3 Sample Size and Data Sources

The impact of fundamental variables/macroeconomic variables shock on individual commodity price will be very negligible and could not be justified whether there is any impact or not. Therefore, to know the effects of fundamental macroeconomic variables on commodity prices, we have constructed commodity price indexes, which are the combination of different groups of commodities like agricultural, metals and energy commodities in India. Though, there are various commodities, consumed by consumers, it is very difficult to analyse all commodities. Therefore, in this study, we have selected few commodities from the basket of commodities and these are categorized broadly into three – (a) agricultural, (b) metals and (c) energy. These commodities are selected based on their demands. We have collected the wholesale index price of cereals, sugar, edible oil, cotton, rubber & plastic products, aluminium, metal products, other non-ferrous metals, coal and mineral oil prices. All these commodities are categorized into three groups - food or agricultural (cereals, sugar, edible oil, cotton and rubber & plastic products), metal (aluminium, metal products and other non-ferrous metals) and energy (coal and mineral oil price). These commodities sub-index prices are collected from the Reserve Bank of India (RBI) and then we constructed the final commodity index for the study. Except commodities wholesale sub-index prices, we have also collected the monthly exchange rate (Indian currency with US dollar), interest rate and demand. Though, there are different available interest rates, in this study, we have used the 3-months Treasury Bill rate for the interest rate. Similarly, though there are no data particularly as demand, we have used index of industrial production (IIP) as a proxy for demand. All these variables are collected from the Reserve Bank of India (RBI) database from January 2001 to June 2012. Though the commodities wholesale index prices in RBI are available in two different base periods, i.e., 1993-94 and 2004-05, we have converted the wholesale price sub-indexes for the base year 1993-94 to 2004-05 base year. Similarly, the IIP data are in two base years (i.e., 1993-94 and 2004-05) but we have converted to 2004-05 base year. In this study, we use the logarithmic value of all variables except the T-bill rate.

3.4 Construction of Commodity Price Index

In this chapter, we have constructed a specific commodity price index to assess the impact of macroeconomic variables on commodity prices. While constructing the commodity price index, we capture the relative importance of the commodity for India using the weight of the commodity in the WPI basket (base 2004-05). In Table-3.1, we have reported the commodity price weight in WPI (2004-05). Though, it is necessary that the aggregate weights of commodities should be equal to 100, we reweight to each commodity by distributing 100 and the new weights of commodities are used to construct the commodity index using wholesale index prices of the selected variables. We normalize the component prices to a common scale, so that the weights are not distorted by the difference in values of different components. For this purpose, we construct the commodity index by anchored 100 for the April 2004 and the values for all other periods are divided by the average price for the April 2004 to obtain the component value before combining the individual components into a combined index. The formation of commodity price index is followed by the Laspeyres price index. The Laspeyres' price index formula is given as below:

$$L_t = \frac{\sum_{j=1}^{n} p_{jt} q_{j0}}{\sum_{j=1}^{n} p_{j0} q_{j0}} \times 100$$

Where, the subscript "j_0" refers to the base month value for commodity j, and, t refers to the current month. By using this formula, we have estimated four commodity indexes, viz., food index, metal index, energy index and all-commodity index.

The selected macroeconomic variables are 3-month T-bill rate, exchange rate and economic growth (IIP as a proxy variable) which captures the key links of commodity prices with interest rate, demand and exchange rate. For instance, the links with the exchange rate is affected by both demands for physical commodities and demands for index investment from investors. Similarly, the links with interest rate may reflect effects of economic fundamentals, as well as portfolio rebalancing of index investors (Tang and

Xiong, 2010). The total sample period in the study goes from January 2001 to June 2012. All commodity indexes are used in logarithm form except the T-bill rate.

Table 3.1: WPI Weights for the Base Year 2004-05 (India)

Commodity	WPI Weight	New Weight	Commodity Index	Weight
Cereals	3.37	11.94		
Sugar, khandari and gur	2.09	7.40		
Edible oils	3.04	10.78		
Cotton textile	2.61	9.22		
Rubber & plastic products	2.99	10.58	Food index	49.9
Mineral oils	9.36	33.16		
Coal	2.09	7.42	Energy index	40.6
Aluminium	0.49	1.73		
Other non-ferrous metal	0.52	1.82		
Metal products	1.68	5.95	Metal index	9.5

Source: Author's calculations from RBI database

3.5 Descriptions of Estimation Techniques[1]

In the above section, we have discussed briefly the fundamental factors which affect commodity prices in India. Before examining any linkage between the fundamental factors with commodity prices, it is essential to check whether the selected data series are stationary or not, because stationary series of data can give a stable relationship between variables. In this section, at first we proceed to check the stationarity of selected data series using the econometric techniques of unit root or integration test, because before examining the co-integration between any two or more series for a long-run equilibrium relationship to exist, it is necessary that the series have the same inter-temporal characteristics. If a series has at least invariant mean and variance and whose autocorrelation is "short memory", then it is called I (0). That is, the series is called non-stationary or unit root and it is denoted by "integrated of order zero". If that series is made first difference to become stationary, i.e., I (0), it is called the "integrated of order one". Similarly, if a series is differenced 'd' times to become I(0), it is said to be integrated of order 'd' and denoted as I(d).

A time series model is called (weakly) stationary if its mean, variance and the covariance are time invariant and the data, which do not possess this property is called non-stationary, in case of random walk process. Most of the macroeconomics time series data are followed by shocks which are known to be nonstationary. Since econometrics

[1] This section draws upon Tsay (2010) and Chris Brooks (2010).

models use nonstationary data, they are likely to violate some important statistical properties of the estimators and give misleading inferences. So it is necessary to test the stationarity of the series before estimating any econometric model. A simple first order autoregressive process can be written as:

$$Y_t = \mu_0 + \mu_1 t + \alpha Y_{t-1} + \varepsilon_t \tag{3.1}$$

Where Y_t is the stochastic process, and μ_0, μ_1 and α are parameters. Here, t is the time period and ε_t is a random error term, with white noise properties of zero mean, constant variance and the zero covariance. Here, μ_0 is called the drift parameter or constant or intercept term and the nature of the time series in the equation (3.1) depends on the parameter values. If $\mu_1 \neq 0$ and $|\alpha| <1$, then Y_t follows a deterministic trend. The autoregressive component, αY_{t-1}, means that there may be short run deviations, but the series will return to trend eventually. This series is called a trend stationary (TS) process, as the residuals from the regression Y_t on a constant and a trend will be stationary. If $\mu_0 =0$, $\mu_1 =0$ and $\alpha =1$, then the series is called a simple random walk, a unit root process. And if $\mu_0 \neq 0$, $\mu_1 =0$ and $\alpha =1$, the series is said to follow a random walk with drift parameter. A stochastic process becomes stationary after the first difference is called a difference stationary process. Likewise, any time series, which becomes stationary after de-trending is called a TS process.

Several tests have been developed for testing non-stationarity, more popularly known as unit root, in time series. These include the Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) tests to check the presence of unit root in the time series. These tests are necessitated when a time series is non-stationary because the usual t-test is inappropriate to test the null hypothesis, $\alpha =1$, in equation (3.1). Now we discuss each type of unit root test in the following sections.

3.5.1 Augmented Dickey-Fuller Test

The Dickey-Fuller test says that in the equation (3.1), the first order difference equation has a unit root. Specifically, assuming the absence of trend term in equation (3.1), the modified form will be as the equation (3.2):

$$\Delta Y_t = \mu_0 + \delta Y_{t-1} + \varepsilon_t \tag{3.2}$$

Where $\Delta Y_t = Y_t - Y_{t-1}$. Here the null hypothesis is the $\{Y_t\}$ process has a unit root, i.e. H_0: $\delta = \alpha - 1$. Since $-1 \leq \alpha \leq 0$, it follows that $-2 \leq \delta \leq 0$.

More generally, if the above equation follows a p^{th} order autoregressive process, then it is called Dickey-Fuller test. But if it follows both p^{th} and q^{th} order of both autoregressive and moving average processes [ARIMA (p,q)], this extended Dickey-Fuller test is called augmented Dickey-Fuller test. Specifically, if the time series follows AR(p), it can be represented as,

$$Y_t = \mu_0 + \sum_{i=1}^{p} \alpha_i Y_{t-1} + \varepsilon_t \tag{3.3}$$

After the mathematical manipulation, equation (3) can be written as,

$$\Delta Y_t = \mu_0 + \delta y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-1+1} + \varepsilon_t \tag{3.4}$$

Where $\delta = -(1 - \sum_{i=1}^{p} \alpha_i)$ and $\beta_i = \sum_{j=i}^{p} \alpha_j$.

Equation (3.4) is also recommended if the residuals sequence, $\{\varepsilon_t\}$ in equation (3.2), is not a white noise, for example, when ε_ts are auto correlated. There are different forms of DF and ADF tests, which are possible by including trend terms in equation (3.2) and (3.4), and also excluding drift (intercept or constant) term, μ_0 from these equations. DF test is a special case of ADF test when p=1. To test the significance of δ in equations (3.2) and (3.4), the usual Student's t-statistics critical values cannot be used but τ-statistics are made available under alternative assumption of drift, trend, sample size and level of significance. They are abbreviated as τ (no drift and no trend), τ_μ (only drift) and τ_τ (with both drift and trend). DF test has also provided the critical F-test values, known as Φ_1, Φ_2, and Φ_3 for pair-wise joint tests of significance for μ_0 and μ_1. Thus, the null hypothesis that δ=0 can be rejected if the computed t value for the coefficient δ is greater than the critical τ-value in absolute magnitude. It has been shown that the same DF test critical values are valid for the ADF test as well.

3.5.2 Phillips-Perron Test

One of the important assumptions of DF test is that the error terms are uncorrelated, homoscedastic as well as identically and independently distributed (iid). Phillip and Perron (1988) have modified the DF test, known as PP test, which can be applied when the above properties are not valid. The PP test has been shown to follow the same critical values as that of DF test; but has greater power to reject the null hypothesis of unit root. However, it cannot reject the null hypothesis when the error series follows a negative moving average process. In such situation, it is recommended to use the DF test rather than the PP test.

3.5.3 Johansen Cointegration Test

In the above equation (3.5), if both variables are *I(1)*, Johansen cointegration test are conducted. Consider a VAR with kth lags containing these variables could be written as;

$$y_t = A_1 y_{t-1} + \dots\dots + A_p y_{t-p} + Bx_t + \varepsilon_t \qquad (3.5)$$

Where y_t is a k-vector of non-stationary I(1) variables, x_t is a d-vector of deterministic variables, and ε_t a vector of innovations. We can rewrite this VAR as

$$\Delta y_t = \Pi y_{t-k} + \Gamma_1 \Delta y_{t-1} + \Gamma_2 \Delta y_{t-2} \dots\dots\dots\dots + \Gamma_{k-1} \Delta y_{t-(k-1)} + u_t \qquad (3.6)$$

Where, $\Pi = \left(\sum_{j=1}^{k} \beta_i\right) - I_g$ and $\Gamma_i = \left(\sum_{j=1}^{i} \beta_j\right) - I_g$

Here, Y_t is an $(n \times 1)$ vector and $\Delta Y_t = Y_t - Y_{t-1}$, and Π and Γ are matrices of coefficients. If the variables are not cointegrated, then the rank of Π will not be significantly different from zero. Particularly, if the rank $\Pi = 0$, it implies no cointegration but there will be cointegration if the $\Pi = 1$. According to Johansen approach, there are two test statistics for cointegration;

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{g} ln\left(1 - \widehat{\lambda_i}\right) \qquad (3.7)$$

$$\lambda_{max}(r, r+1) = -T\, ln\left(1 - \widehat{\lambda_{r+1}}\right) \qquad (3.8)$$

Where r is the number of cointegrated vectors and $\widehat{\lambda_i}$ is the estimated value for the ith order eigenvalue from the Π matrix and T is the total time period. The null hypothesis should be tested for r= 0 and r = 1. The null hypothesis cannot be rejected if r = 0, that means there is no cointegration vector and there is no cointegration. On the other hand, if r = 0 is rejected, we conclude that there is cointegration between the variables. Thus, the value of r is continually increased until the null is no longer rejected.

3.5.4 Causality Test

Causality test is different from causality. For instance, the causality from A to B indicates that A causes B directly. Causality is an econometrics tool based on the standard Chi-square-test framework to determine whether one time series is useful to predict the future of another series. For example: variable say X causes Y if the past changes of X could help to predict current changes of Y. If X causes Y and not vice versa, it is called unidirectional causality. If X causes Y and Y also causes X, it would be said that there is bi-directional causality between that variables (Chris Brooks, 2010).

When we conduct causality tests, two cases are considered depending on whether the variables are cointegrated or not.

First, if variables are integrated, the following (Vector Autoregressive) VAR estimation equations in the first differences are tested

$$\Delta Y_t = \sum_{j=1}^{n} b_j \Delta X_{t-j} + \sum_{j=1}^{n} c_j \Delta Y_{t-j} + u_{t-1} \tag{3.9}$$

$$\Delta X_t = \sum_{j=1}^{n} b_j \Delta Y_{t-j} + \sum_{j=1}^{n} c_j \Delta X_{t-j} + u_{t-1} \tag{3.10}$$

Secondly, if the variables are cointegrated, the following vector error correction models (VECM) are tested. The reason to use VECM is that regressing on the first difference cointegrated variables could lead to misspecification error.

It should be noted that causality really represents only a correlation between the current value of one variable and the previous values of others. It doesn't mean that movements of one variable cause movements of another (Chris Brooks, 2010). Moreover, although causality in VAR examines whether the current value of variable X can be explained by the past values of variable Y, it still does not explain the sign of the relationship or how long these effects last.

3.5.5 Vector Error Correction (VEC) Model

The Vector Error Correction Model (VECM) allows the short-run dynamic adjustment of variables to the long-run behavior of the endogenous variables. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. Take a simple example of VECM model with two variables as:

$$\Delta y_{1,t} = \alpha_1 (y_{2,t-1} - \beta y_{1,t-1}) + \varepsilon_{1,t}$$

And $\Delta y_{2,t} = \alpha_2 (y_{2,t-1} - \beta y_{1,t-1}) + \varepsilon_{2,t}$ (3.11)

In this model, the right hand side is the error correction term. In long run equilibrium, this term becomes zero. If y_1 and y_2 deviate from the long run equilibrium, this term will be non-zero and each variable adjusts partially to restore equilibrium. The coefficient α_i measures the speed of adjustment of the i^{th} endogenous variable towards the equilibrium.

3.5.6 Choice of Lag Length Selection

To estimate the values of variables in estimation model, it needs to choose an appropriate lag length. Though, there are different lag length selection criteria such as the Final Predicted Error (FPE), Akaike Information Criteria (AIC), Schwartz Information Criteria (SIC) and HQ (Hendricks Quant) respectively. But we have adopted AIC and SIC to select maximum lag for the estimation models. But this is relaxed for Johansen cointegration test.

3.6 Analysis of Estimation Results

3.6.1 Analysis of Stationarity Test

As stated above, in time series analysis, it is always useful to look at the time series plots of the variables before undertaking any econometric estimation because this will help to understand the data for trends, volatility etc., which has a bearing on stationarity of the series. The results of the unit root tests are given in Table-3.2a and Table-3.2b. In these tables, we have reported the Augmented Dickey-Fuller (ADF) test and Phillips Perron (PP) test results for commodity indexes and also for fundamental variables. Before we estimate, we have estimated the Gregory-Hansen Cointegration test for structural break, is reported in the Appendix Table-3.1A.

Table-3.2a shows the ADF test at the level and also first difference value in three different periods. It is observed that there are existences of unit roots for these variables but all the variables become stationarity after taking the first difference at 1% significance levels. Similarly, in Table-3.2b, we have reported the unit root test results of PP tests. It can be seen that all the selected variables are non-stationary at their level values but all become stationary in the first difference at 1% significance level.

Table 3.2a: Augmented Dickey Fuller Unit Root Test Results

	2001M01-2012M12				2001M01-2008M09				2008M10-2012M06			
	Int		Int with Trend		Int		Int with		Int		Int with Trend	
Variable	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff
IAC	0.81	-9.72*	-2.77	-9.76*	0.84	-7.60*	-3.10	-7.63*	-0.17	-6.83*	-2.40	-6.71*
IAGRI	0.14	-11.84*	-2.28	-11.84*	-0.21	-8.17*	-2.19	-8.1*	-1.57	-6.64*	-2.22	-6.61*
IENERGY	-0.18	-8.35*	-2.77	-8.34*	0.34	-8.21*	-2.25	-8.24*	0.68	-7.63*	-2.39	-7.20*
IMETAL	0.35	-4.09*	-2.02	-4.26*	-0.46	-3.31*	-2.01	-3.49*	-0.02	-3.96**	-2.49	-3.12**
TBILL	-2.24	-13.38*	-2.56	-13.49*	-1.57	-12.5*	-2.85	-12.92*	-0.63	-5.98*	-2.05	-6.26*
IIP	-1.86	-3.16**	-0.72	-3.71**	1.67	-3.63*	-3.27	-3.67*	-1.86	-10.12*	-0.72	-10.26*
EX	-0.81	-10.22*	-0.82	-10.33*	-1.36	-7.87*	-1.30	-7.86*	-0.57	-5.95*	-0.82	-5.67*

Notes: a. Critical values for unit root test (ADF & PP) are: -3.49 and -4.10 (without trend) and -4.04, -4.10 (with trend) respectively at 1% level and 5% levels

b. * and ** denote significant at 5 percent and 1 percent respectively

Source: Author's estimations

Table 3.2b: Phillips Perron Unit Root Test Results

	2001M01-2012M12				2001M01-2008M09				2008M10-2012M06			
	Int		Int with Trend		Int		Int with		Int		Int with Trend	
Variable	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff
IAC	0.63	-9.70*	-2.31	-9.73*	0.72	-7.58	-2.75	-7.58*	-0.07	-7.88*	-2.49	-7.79*
IAGRI	0.64	-12.50*	-2.09	-12.81*	0.45	-8.17	-2.01	-8.17*	-1.48	-7.06*	-2.27	-7.41*
IENERGY	-0.19	-8.36*	-2.52	-8.35*	0.27	-8.18	-2.25	-8.18*	0.39	-8.02*	-2.76	-7.51*
IMETAL	0.73	-6.33*	-1.66	-6.57*	-0.08	-6.34	-1.85	-6.34*	0.35	-3.96*	-2.18	-3.06**
TBILL	-2.27	-13.30*	-2.53	-13.44*	-2.10	-13.3	-2.63	-13.26*	-0.73	-5.96*	-2.21	-6.25*
IIP	-1.03	-33.87*	-7.58	-33.63*	-0.63	-20.4	-3.37	-20.42*	-1.03	-33.87*	-2.43	-33.63*
EX	-1.03	-10.23*	-1.03	-10.34*	-1.61	-8.11	-2.02	-8.11*	-0.66	-5.93*	-0.21	-3.06**

Notes and Source: Same as in Table 3.2a

3.6.2 Analysis of Co-integration Test Results

The relationships between commodity prices with fundamental factors, i.e., macroeconomic variables are examined using the econometric techniques of co-integration test. The Johansen co-integration test is generally used to estimate the long-term co-movement among more than two variables. The results of the Johansen co-integration test of commodity index prices with fundamental variables are reported in Table-3.3a to Table-3.3c. The Johansen co-integration test reveals two hypotheses- null hypothesis and alternative hypothesis. The acceptance or rejection of null hypothesis depends on the trace statistics and maximum test statistics. The trace statistics of commodities index prices have a null hypothesis that the variables are not co-integrated (r=0), against the alternative hypothesis of existence of one or more co-integrating vectors (r > 0). In the Table-3.3A, we have reported the cointegration results of commodity index prices in full sample period from January 2001 to June 2012. Like other econometric technique, there is requirement of appropriate lag length selection to examine the Johansen cointegration test and the VECM. Therefore, in this study we use the Swartz Information Criteria (SIC) and Akaike Information Criteria (AIC) to choose the maximum lag length and the suggested optimum lag length by these criteria are reported in Table-3.4. If we look at the Table-3.3A, we have reported the cointegrated results for commodities index prices with the macroeconomic variables for January 2001 to June 2012. It is seen that the trace statistics of IAC is not statistically significant; hence, there is no long-run equilibrium relationship between fundamental variables with IAC. If we look at the IAGRI, the trace and maximum eigen statistics is significant at 5% significance level at one cointegrating vectors. Similarly, the maximum Eigen value shows that it is significant at 1% level at the one cointegrating vectors, thus, the two statistics of Johansen co-integration test result shows that there is long-term correlation/co-movement between fundamental variables with IAGRI in the full sample period, i.e., for the period 2001M01 to 2008M09. If we look at the IENERGY and IMETAL, the trace statistics and maximum statistics value, both statistics of Johansen cointegration tests are not significant even at 5% significance level. That means, there are no long-term correlations or co-movements between IENERGY and IMETAL with the fundamental variables in the full sample period.

Similarly, we have also reported the co-integration test for the pre-crisis period in Table-3.3b. The trace statistics and maximum Eigen value for all the commodity index (IAC) are not significant, that means there is no long-run relationship between IAC with fundamental variables. In case of IAGRI, the trace and the maximum eigen value is statistically significant at 5% significance level at one cointegrating vectors. That means there is long-term correlation between IAGRI price index with the fundamental variables. Similarly, for IENERGY the trace statistics and maximum statistics value are statistically significant. Hence in the pre-crisis period, there is a long-run equilibrium relationship fundamental variable with IENERGY price index in India. There is no long-run relationship between IMETAL with the fundamental variables. Therefore, in the pre-crisis period, it is found that there exists long-run equilibrium relationship between fundamental variables with IAC and with IENERGY index prices.

In Table-3.3c, we have reported the co-integration results for the post-crisis period, i.e., for the period from October 2008 to June 2012. The trace statistics and maximum eigen values for the IAGRI is statistically significant at 5% significance level but other price indices such as IAC and IENERGY are not statistically significant. But there is significant trace and maximum eigen value for IMETAL. That means there is long-run equilibrium relationship between the fundamental variables with the IAGRI and with IMETAL price indices but there is no long-run relationship between fundamental variable with the IAC and IENERGY price index.

Table 3.3a: Results of Johansen Cointegration Test for 2001M01 to 2012M06

Commodity	Null hypothesis		Alternative Hypothesis	Eigen Value	Statistics	Critical Values 5%	Prob.
Comdex	λ_{trace} test	r = 0	r > 0	0.124	29.050	47.856	0.766
		r ≤ 1	r > 1	0.063	11.826	29.797	0.938
	λ_{max} test	r = 0	r = 1	0.124	17.224	27.584	0.561
		r = 1	r = 2	0.063	8.515	21.132	0.869
Agri	λ_{trace} test	r = 0	r > 0	0.223	61.543	54.079	0.009
		r ≤ 1	r > 1	0.112	28.571	35.193	0.217
	λ_{max} test	r = 0	r = 1	0.223	32.972	28.588	0.013
		r = 1	r = 2	0.112	15.513	22.300	0.334
Energy	λ_{trace} test	r = 0	r > 0	0.137	41.261	47.856	0.181
		r ≤ 1	r > 1	0.086	21.170	29.797	0.347
	λ_{max} test	r = 0	r = 1	0.137	20.090	27.584	0.335
		r = 1	r = 2	0.086	12.215	21.132	0.527
Metal	λ_{trace} test	r = 0	r > 0	0.184	42.913	47.856	0.135
		r ≤ 1	r > 1	0.064	15.411	29.797	0.753
	λ_{max} test	r = 0	r = 1	0.184	27.501	27.584	0.051
		r = 1	r = 2	0.064	8.921	21.132	0.839

Note: r denotes the cointegration vector

Source: Author's calculations

Table 3.3b: Results of Johansen Cointegration Test for 2001M01 to 2008M09

Commodity	Null hypothesis		Alternative Hypothesis	Eigen Value	Statistics	Critical Values 5%	Prob.
Comdex	λ_{trace} test	r = 0	r > 0	0.165	28.837	29.797	0.064
		r < 1	r > 1	0.034	4.655	15.495	0.844
	λ_{max} test	r = 0	r = 1	0.091	12.824	19.387	0.342
		r = 1	r = 2	0.034	4.654	12.518	0.647
Agri	λ_{trace} test	r = 0	r > 0	0.339	75.414	54.079	0.000
		r < 1	r > 1	0.241	40.196	35.193	0.013
	λ_{max} test	r = 0	r = 1	0.339	35.218	28.588	0.006
		r = 1	r = 2	0.241	23.488	22.300	0.034
Energy	λ_{trace} test	r = 0	r > 0	0.318	58.006	47.856	0.004
		r ≤ 1	r > 1	0.167	23.581	29.797	0.219
	λ_{max} test	r = 0	r = 1	0.318	34.426	27.584	0.006
		r = 1	r = 2	0.167	16.480	21.132	0.198
Metal	λ_{trace} test	r = 0	r > 0	0.254	44.924	47.856	0.092
		r ≤ 1	r > 1	0.139	18.810	29.797	0.507
	λ_{max} test	r = 0	r = 1	0.254	26.114	27.584	0.076
		r = 1	r = 2	0.139	13.299	21.132	0.425

Note: r denotes the cointegration vector

Source: Author's calculations

Table 3.3c: Results of Johansen Cointegration Test for 2008M10 to 2012M06

Commodity	Null hypothesis		Alternative Hypothesis	Eigen Value	Statistics	Critical Values 5%	Prob.
Comdex	λ_{trace} test	r = 0	r > 0	0.476	45.780	47.856	0.077
		r ≤ 1	r > 1	0.259	17.980	29.797	0.568
	λ_{max} test	r = 0	r = 1	0.476	27.500	27.584	0.067
		r = 1	r = 2	0.259	12.879	21.132	0.463
Agri	λ_{trace} test	r = 0	r > 0	0.601	70.273	47.856	0.000
		r ≤ 1	r > 1	0.443	32.575	29.797	0.023
	λ_{max} test	r = 0	r = 1	0.601	37.698	27.584	0.002
		r = 1	r = 2	0.443	23.965	21.132	0.019
Energy	λ_{trace} test	r = 0	r > 0	0.337	34.187	47.856	0.492
		r ≤ 1	r > 1	0.245	16.520	29.797	0.675
	λ_{max} test	r = 0	r = 1	0.337	17.668	27.584	0.523
		r = 1	r = 2	0.245	12.094	21.132	0.538
Metal	λ_{trace} test	r = 0	r > 0	0.531	54.786	54.079	0.043
		r ≤ 1	r > 1	0.254	22.188	35.193	0.583
	λ_{max} test	r = 0	r = 1	0.531	32.598	28.588	0.015
		r = 1	r = 2	0.254	12.588	22.300	0.597

Note: r denotes the cointegration vector
Source: Author's calculations

3.6.3 Analysis of Vector Error Correction Model

Generally, to strengthen the long-term relationship between variables, we need to estimate the short-run dynamic relationship between more than two variables by using the Vector Error Correction (VECM) model. Similar to other econometric model, the lag length of the Vector Error Correction Model (VECM) is chosen on the basis of Akaike's information criteria (AIC) and Schwarz criteria (SC). The VECM estimated values for different commodity price indices with macroeconomic variables are reported in the Table-3.4**.** In Table-3.4 (block I), it is noticed that the error correction coefficient for IAGRI is only significant at 1% level but other commodity price indices like IAC, IENERGY and IMETAL's VECM coefficients are not significant. That indicates that there is short-run dynamic relationship between IAGRI with the fundamental variables but others are not in the full-sample period for January 2001 to June 2012.

Similarly, the Vector Error Correction Model (VECM) results for the pre-crisis period, i.e., January 2001 to September 2008, are reported in the Table-3.4 (block II). It is observed that the ECM coefficient value for IAC is not significant, which suggests that there is no short-run dynamic equilibrium relation with between fundamental variables with IAC. The VECM coefficients for IAGRI price index value (-0.010) is significant at 5% significance level, that means there is short-run dynamic relationship between fundamental variables with the IAGRI index price. Similarly, the VECM coefficients value (-0.026) for IENERGY are significant at the 5% significance level. It suggests that there is short-run dynamic adjustment between the fundamental variables with the IENERGY index price. The VECM coefficient value for the IMETAL is insignificant, which suggest that there is no short-run dynamic relationship between fundamental variables with the IMETAL index prices in India in the pre-crisis period i.e. for the period January 2001 to September 2008.

Likewise, the VECM results for the post crisis-period, i.e., October 2008 to June 2012, are reported in Table-3.4 (in block III). It is observed that the ECM coefficient value except the IAGRI and IMETAL are statistically insignificant. But the ECM coefficients for the IAGRI and IMETAL (-0.024 and -0.031) are statistically significant at 5% significance level. That means there is short-run dynamic adjustment in the macroeconomic variables to the long-run equilibrium relationship with the IAGRI and IMETAL price indices in India. In case of other commodity price indices (IAC and IENERGY), there is no adjustment required for the long-run equilibrium relationship for the post-crisis period.

Table 3.4 : Results of the Vector Error Correction Model

I. 2001M01- 2012M06			
Variable	ECM Coeff	T-test	Lag
IAC	0.000	-0.021	2
IAGRI	-0.041	-4.497	5
IENERGY	-0.003	-0.463	2
IMETAL	-0.001	-0.630	2
II. 2001M01- 2008M09			
IAC	0.000	-0.021	2
IAGRI	-0.010	-2.791	3
IENERGY	-0.026	-3.026	2
IMETAL	-0.009	-1.313	2
III. 2008M10 - 2012M06			
IAC	0.045	1.157	1
IAGRI	0.024	2.179	3
IENERGY	-0.006	-1.460	1
IMETAL	-0.031	-2.099	1

Source: Author's estimations

3.6.4 Analysis of Causality Test

From the Johansen cointegration test and the VECM test analysis, it is observed that there is long-run and short-run relationship existing between some commodity price indices with fundamental variables. But there are some commodity price indices which have no relationship with the fundamental variables. But it is clear which fundamental variables individually have relationship with the commodity prices in India. Therefore, we have reported the VECM co-efficient values to know the causal relationship between fundamental variables with the commodity price indices and the results are reported in the Table-3.5 to Table-3.8.

In Table-3.5, we have reported the lag coefficient values of the VECM results which indicate the causal relationship between each fundamental variable with the IAC index price. It is seen that there is no causal relationship between fundamental variables with IAC index prices in the three periods, i.e., full sample period, pre-crisis period and in the post crisis-period.

If we look at the Table-3.6, it is seen that in the there is causal relationship between demand (IIP) with the IAGRI index price at lag 2 and 3 in the full-sample period. Except that, there is also relationship between interest rate (Tbill) with the IAGRI index price at lag lag 1. That means in the full sample period, the change in IAGRI prices is caused by the demand (IIP) and the interest rate (Tbill). In the pre-crisis period, there is causality from the exchange rate and from the demand (IIP) to IAGRI index price in India. In the post-crisis period, there is causality from the demand (IIP) to the IAGRI index prices. Therefore, it can be said that the change of food index price in India is mainly due to change in the demand and exchange rate in India.

In Table-3.7, we have reported causality between fundamental variables with the IENERGY index price. It can be seen that in the full-sample period, there is no causality from the fundamental variables to the IENERGY prices. That means, in the full-sample period the change in IENERGY index price is not caused by the macroeconomic variables but some other factors. In the pre-crisis period, it is seen that exchange rate causes the IENERGY price that means the change in IENERGY index price is due to change in exchange rate. In the post-crisis period, there is no causality from the fundamental variable. Hence there is no relationship between IENERGY prices with the fundamental variables.

In Table-3.8, we have reported the causal relationship between fundamental variables with the IMETAL price. There is no causality from the fundamental variables to the IMETAL prices in the full-sample and in the pre-crisis period. But there is causality in the post-crisis period that is from the interest rate (Tbill) to the IMETAL index price. That means the change in IMETAL index price is caused by the change in Tbill prices in India in the post crisis period.

Table 3.5: Causality Tests between IAC with Fundamental Variables

	2001M01 to 2012M06	2001M01 to 2008M09	2008M10 to 2012M06
Variable	D(LOG(IAC))	D(LOG(IAC))	D(LOG(IAC))
D(LOG(IAC(-1)))	0.186(2.056)	0.186(2.056)	0.0004(0.002)
D(LOG(IAC(-2)))	0.007(0.076)	0.007(0.076)	
D(LOG(EX(-1)))	-0.002(-0.033)	-0.002(-0.033)	0.035(0.375)
D(LOG(EX(-2)))	0.013(0.257)	0.013(0.257)	
D(LOG(IIP(-1)))	-0.001(-0.060)	-0.001(-0.060)	0.005(0.139)
D(LOG(IIP(-2)))	-0.018(-0.824)	-0.018(-0.824)	
D(TBILL(-1))	0.000(0.784)	0.000(0.784)	-0.001(-0.198)
D(TBILL(-2))	0.000(0.189)	0.000(0.189)	

Note: Figures in brackets are t-statistic values

Source: Author's estimations

Table 3.6: Causality Tests between IAGRI with Fundamental Variables

	2001M01 to 2012M06	2001M01 to 2008M09	2008M10 to 2012M06
Variable	D(LOG(IFOOD))	D(LOG(IFOOD))	D(LOG(IFOOD))
D(LOG(IAGRI(-1)))	-0.074(-0.809)	0.215(1.855)	0.200(1.102)
D(LOG(IAGRI(-2)))	-0.066(-0.735)	-0.146(-1.257)	0.091(0.523)
D(LOG(IAGRI(-3)))	-0.133(-1.507)	0.017(0.155)	0.046(0.255)
D(LOG(IAGRI(-4)))	-0.173(-0.1958)		
D(LOG(IAGRI(-5)))	-0.170(-01.900)		
D(LOG(EX(-1)))	-0.049(-0.605)	-0.052(-1.004)	-0.156(-0.786)
D(LOG(EX(-2)))	0.046(0.566)	0.044(0.860)	0.196(0.927)
D(LOG(EX(-3)))	-0.061(-0.751)	0.106(2.297)	-0.080(-00.403)
D(LOG(EX(-4)))	-0.047(-0.582)		
D(LOG(EX(-5)))	-0.022(-0.274)		
D(LOG(IIP(-1)))	-0.053(-1.448)	-0.021(-1.169)	-0.174(-1.587)
D(LOG(IIP(-2)))	-0.099(-2.283)	-0.047(-2.218)	-0.122(-1.121)
D(LOG(IIP(-3)))	-0.128(-2.882)	-0.015(-0.899)	-0.224(-2.210)
D(LOG(IIP(-4)))	-0.023(-0.506)		
D(LOG(IIP(-5)))	-0.000(-0.007)		
D(TBILL(-1))	0.000(2.025)	0.000(0.311)	0.029(1.615)
D(TBILL(-2))	0.000(1.389)	-0.000(-0.103)	0.013(1.050)
D(TBILL(-3))	0.000(1.193)	0.000(0.303)	0.006(0.418)
D(TBILL(-4))	0.000(0.821)		
D(TBILL(-5))	0.000(0.696)		

Note: Figures in brackets are t-statistic values

Source: Author's estimations

Table 3.7: Causality Tests between IENERGY with Fundamental Variables

	2001M01 to 2012M06	2001M01 to 2008M09	2008M10 to 2012M06
Variable	D(LOG(IENERGY))	D(LOG(IENERGY))	D(LOG(IENERGY))
D(LOG(IENERGY(-1)))	0.359(4.067)	0.190(1.741)	0.476(3.833)
D(LOG(IENERGY(-2)))	0.003(0.037)	-0.048(-0.463)	
D(LOG(EX(-1)))	0.010(0.136)	0.318(2.469)	0.051(0.697)
D(LOG(EX(-2)))	-0.128(-1.777)	0.188(1.473)	
D(LOG(IIP(-1)))	0.001(0.037)	-0.039(-0.891)	0.011(0.328)
D(LOG(IIP(-2)))	-0.040(-1.288)	-0.053(-1.205)	
D(TBILL(-1))	0.000(1.199)	-0.000(-1.004)	-0.007(-1.522)
D(TBILL(-2))	0.000(0.190)	-0.000(-1.282)	

Note: Figures in brackets are t-statistic values

Source: Author's estimations

Table 3.8: Causality Tests between IMETAL with Fundamental Variables

	2001M01 to 2012M06	2001M01 to 2008M09	2008M10 to 2012M06
Variable	D(LOG(IMETAL))	D(LOG(IMETAL))	D(LOG(IMETAL))
D(LOG(IMETAL(-1)))	0.442(5.092)	0.250(2.405)	0.703(6.898)
D(LOG(IMETAL(-2)))	0.247(2.846)	0.404(3.865)	
D(LOG(EX(-1)))	-0.044(-1.222)	0.024(0.442)	-0.115(-1.884)
D(LOG(EX(-2)))	0.036(0.978)	0.0182(0.355)	
D(LOG(IIP(-1)))	-0.015(-0.951)	0.003(0.159)	0.002(0.077)
D(LOG(IIP(-2)))	-0.019(-1.076)	0.009(0.503)	
D(TBILL(-1))	0.000(0.416)	0.000(1.002)	0.009(2.579)
D(TBILL(-2))	0.000(0.074)	0.000(0.497)	

Note: Figures in brackets are t-statistic values

Source: Author's estimations

3.7 Summary

This chapter examined the relationship between commodity prices and fundamental factors in India. At first, we reviewed the existing literature on the linkages between fundamental/fundamental variables with commodity prices. From the literatures review, it was found that macro economic variables like demand, interest rate, inflation, exchange rate, bio-fuel, etc. are affecting commodity prices in India. Though, in this study we used the nominal prices of commodities, we used the selected macroeconomic variables particularly, demand (IIP), interest rate (TBILL) and exchange. There is no data availability of bio-fuel.

Next, we used the Gregory-Hansen cointegration test for structural change to find out whether there was any structural change due to the global turmoil in 2008, and we found that there was structural change in the year 2008. Since the global financial crisis was realized in September, we used September as the structural point and then we categorized the total sample into two periods - pre-crisis period, i.e., from January 2001 to September 2008, and post-crisis period, i.e., from October 2008 to June 2012.

Before estimating any relationship between commodity prices with fundamental variables, we had examined the unit root test by applying the ADF and PP test and the results showed that all the selected variables are non-stationary at their level values but all were stationary at their first difference. Then we examined the both long-run and short-run relationship between the commodity price indices with the macro economic variables by using the Johansen cointegration test and VECM. Though these two tests required the appropriate selection of lag length, we had selected the appropriate lag length for both these test by using the lag length criteria such as Schwartz information criteria (SIC) and Akaike information criteria (AIC).

The Johansen cointegration test indicated that there was no long-run correlation/co-movement between IAC with fundamental variables in all the three sample periods. There was longer-run correlation/co-movement between IAGRI with fundamental variables in the three sample periods. Only in the pre-crisis period, there was long-run relationship between IENERGY index prices with the fundamental variables. But, there was no long-run relationship between IENERGY price index with the fundamental variables in other two sample periods. There was no long-run relationship between the IMETAL index prices with the fundamental variables in the full sample and pre-crisis period but it existed in the post-crisis period.

The VECM result showed that there was no short-run relationship between IAC with macroeconomic variable but there was short-run dynamic relationship between IAGRI with macroeconomic variable in all the three periods. There was short-run dynamic relationship between IENERGY with macroeconomic variable only in the pre-crisis period. And similarly, there was only short-run relationship between IMETAL with the fundamental variables in the post-crisis period.

The causality test indicated that there was no causal relationship between fundamental variables with the IAC in the three periods. But there was causality from the demand (IIP) with IAGRI and also causality from the Tbill to IAGRI in the full-sample period. But in the pre-crisis period, there was causality from the exchange rate and from the demand (IIP) to IAGRI index price in India. In the post-crisis period, there was causality from the demand (IIP) to the IAGRI index prices. There was causality from the exchange rate to IENERGY in the pre-crisis period. Similarly, there was only causality in the post-crisis period, that is, from the interest rate (Tbill) to the IMETAL index price in India. The main finding of this chapter 3 is almost similar to those of Alexandratos (2008), Byrne, et al. (2013) and Dwyer (2011). They found that financial investors affected the short-run price dynamics for some commodities but the level and volatility of commodity prices appeared to be primarily determined by fundamental factors. The sharp rise of basic food commodity prices in the international markets were due to the shortfalls of global supply in relation to the demand.

Appendix-A.3

The Gregory-Hansen Cointegration test (see Gregory and Hansen, 1996a and 1996b) is used in the time series data to find out the break points. This test gives three types of breaks – (i) it shows the break in intercept only, (ii) it shows break in trends only, and (iii) it gives the break in intercept with trend. In Table A.3.1, we have reported the results of Gregory-Hansen test for India. It is seen that commodity price indices have structural breaks in trends only, and the intercept with trend. In this study, we considered the structural break in intercept with trend.

Appendix A.3.1:
Gregory-Hansen Cointegration Test for Structural Breaks in India, 2001-2012

	Break Date	GH Test Statistics	5% Critical Value	Reject null hypothesis of no Cointegration
I. All Commodity Index				
GH-I	2010-10	4.832	5.280	No
GH-II	2010-06	5.580	5.570	Yes
GH-III	2008-10	6.109	6.000	Yes
II. Food and Agriculture Index				
	Break Date	GH Test Statistics	5% Critical Value	Reject null hypothesis of no Cointegration
GH-I	2010-01	5.333	5.280	No
GH-II	2010-06	5.756	5.570	Yes
GH-III	2008-10	6.140	6.000	Yes
III. Energy Index				
	Break Date	GH Test Statistics	5% Critical Value	Reject null hypothesis of no Cointegration
GH-I	2010-10	4.142	5.280	No
GH-II	2008-10	5.601	5.570	Yes
GH-III	2008-11	6.665	6.000	Yes
IV. Metal Index				
	Break Date	GH Test Statistics	5% Critical Value	Reject null hypothesis of no Cointegration
GH-I	2008-09	3.654	5.280	No
GH-II	2010-04	5.684	5.570	Yes
GH-III	2008-10	6.098	6.000	Yes

Source: Author's Estimations from RBI database.

Notes: GH-I is break in intercept, GH-II is break in trend and GH-III in intercept with trend

Chapter 4
Financialization of Commodity Market in India

4.1 Introduction

We have already mentioned that commodity prices are not only in India but also world-wide have experienced a significant price surge in recent years. The sustained price rise that peaked in the mid 2008, led by soaring crude oil prices, global commodity markets fell sharply and bottomed out in early 2009 and after that price rose again (Inamura et al., 2011). Researchers have found that the following factors are responsible for the high volatile commodity prices in India. These factors include (i) fundamental factors, i.e., demand and supply factors and (ii) financialization of commodity markets including speculation, particularly by institutional investors such as hedge funds, pension funds and investment banks and other exchange traded funds and notes (UNCTAD, 2010).

In the UNCTAD TDR (2009), it is mentioned that there is financialization of commodity market if there is positive correlation between commodity prices and stock price. In this chapter, we are examining the dynamic relationship between commodity prices and other assets. Now question may arise that if financial investors are playing in commodity markets, is there any relationship between commodities futures price with spot prices? And is there any price co-movement between commodities? Though, in India commodity index trading has not yet started, financial investors may be active in commodity futures market. This is worth examining.

The equity market crisis in 2000 gives an opportunity to find out an alternative investment asset, whose return is negatively related to financial assets. Therefore, the investors are focused on the commodity markets, whose returns are negatively correlated with financial/stock returns (Gorton and Rouwenhorst, 2006). As a result, there are wider uses of commodity market particularly commodity futures market, which is used as an alternative asset to stock market, which attracted billions of dollars of investment worldwide from financial institutions, insurance companies, pension funds, hedge funds, and wealthy individuals (Tang and Xiong, 2010).

One interesting point to note here is that when the financial investors choose to invest in commodity markets, they have two options - either to invest (a) in individual commodities or (b) in commodity indexes to avoid storage cost, convenience yield and also marketing. Therefore, to avoid such type of cost, investors prefer to invest either in commodity futures or indexes. As we have already mentioned that returns of commodity prices are negatively co-integrated with stock prices, it can be seen that while there is a financial crisis, investors prefer to invest in commodity market.

According to the Kyle and Xiong (2001), the diversified index investors' act like a channel to correlate commodity prices with prices of other assets in their portfolios, as a result the nature of such spillover effects depends on the index investors' portfolio composition and rebalancing strategies. Though, commodity index investors invest a large fraction of their portfolios in stocks, commodity prices are exposed to shocks to stocks. Therefore, the relationship between the commodity markets and stock market varies from country to country and also from time to time. When a positive shock increases the weight of stocks in the investors' portfolios, diversification incentives motivate them to shift some money into commodities, which cause commodity prices to move positively with stock prices and vice versa. The rapid growth of commodity futures investments in recent years in India is a global phenomenon and a significant fraction of the investment flow comes from international investors who are exposed to shocks to the exchange rate.

This chapter is organized in the following way. In section-4.2, we have reported the role of speculation in commodity markets. In section-4.3, we have reported the commodity futures market in India. Section-4.4 deals with the structure of the commodity futures market in India. In section-4.5, we have reported the recent trends of commodity prices in India. Section-4.6 deals with the commodity price formation and information. In the section-4.7, we have reported the role of futures market in commodity price formation in India. The section-4.8 deals with the motivations of financialization of commodity market. In section-4.9, we have analyzed various instruments that are used in the financialization of commodity markets followed by the summary in section 4.10.

4.2 The Role of Speculation in Commodity Markets

Recent global financial and food crisis has evidenced and realized the assumptions of speculation trading. Speculators are trend-spotters. The concern is that trend spotting creates the trends that are subsequently identified. J.M. Keynes and J.R. Hicks are well known for the "theory of risk-transfer hypothesis" [Keynes (1930), v.2, Chapter 29 and Hicks (1946), p. 137-139]. The major distinction between hedgers ("commercials"[1]) and

[1] An investment in a commodity index is involved in the buying and/or selling of goods and/or services that is expected to generate cash flow. A commercial investment can be assumed by an individual, group or institution. Frequently, a commercial investment is shared by a group of investors combining assets in order to fund the investment. A commercial investment arise where an investor commits money or capital to purchase, either entirely or a percentage of, a for-profit property or business.

speculators ("non-commercials"[2]) is that speculators are relatively risk-tolerant individuals who are rewarded for accepting price risks from risk-averse "hedgers". Speculators in the forwards or futures markets may be on the long or short side of any such single transaction, but in aggregate their commitments must upset any net imbalance of the long and short hedger's position. Speculation is commonly understood to mean the purchase of a good for later re-sale rather than for use, on the temporary sale of a good with the intention of later re-purchase – in the hope of profiting from an intervening price change (Hirshleiper, 1977), which has the following fundamentals and idealizing assumptions- (a) speculation occurs only in "informative situations", (b) in informative situations individuals must adjust both to "price risk" and "quantity risk", (c) in an informative situation, there are two inter-related market equilibrium, and (d) speculative behaviour is conditioned upon the scope of markets.

Speculation in commodity derivatives markets performs a valuable economic function. Firstly, speculation in these markets allows for the transfer of price risk from those least willing to bear it (commodity producers and consumers, or end users) to those with the greatest appetite and capacity to do so (generically, speculators). Secondly, derivatives markets transmit valuable information about supply and demand conditions. In recent times, increased amounts of capital have been flowing into the commodity futures trade, and thus there is a need to analyze the role futures market participants can possibly play in forming or distorting prices in the market for the underlying commodity (Bose, 2009). Increasing speculative activity in futures markets, i.e., large percentage of market place has no intent of taking futures to delivery, causing price volatility, commodity markets have started setting price of commodities as an asset. Therefore, speculators can create a price distortion and speculative bubble with the anticipation of making significant profits from major movements in the markets (Hull, 2008, p.40). Persistent inflationary pressures in global commodity prices in the recent past has sparked a debate over its nature with speculation in commodity markets being singled out as the primary factor behind rising prices, even leading to a demand for a ban on futures trading for several important commodities. Index investments are different from traditional speculative positions in three respects, such as (a) traditional speculators can be long or short positions. Index investors are almost invariably long, (b) traditional speculators hold for short periods.

[2] A classification used by the Commodity Futures Trading Commission (CFTC) to identify traders that use the futures market for speculative purposes.

Index investors hold over long periods and roll positions forward at contract maturity, and (c) traditional speculators pick markets (for details, see Appendix Table A.4.1). Index investors track specific indices rather than taking positions on specific markets. They can also be large (up to 30-40% of total interest) in relation to the overall market. Now the question is whether speculators (traditional or dynamic) can influence movements in commodity prices, if so, whether they have created any distortion and bubble in Indian commodity markets. A more appropriate characterization of this debate is the scope for commodity markets to be affected by destabilizing speculation. The present analysis attempts to shed some light to provide empirical evidence for the above.

4.3 Commodity Futures Market in India[3]

Commodity futures market in India has a long history despite its underdevelopment as compared to those in U.S.A., U.K. and other developed countries. Several factors are responsible for India's underdevelopment in futures trading.

The year 1875 is regarded as the birth year for organized commodity futures market in India. This is the year when the Bombay Cotton Trade Association Limited was set up for trading of cotton. But with the increased number of cotton mill owners and merchants, a separate/independent association by the name 'Bombay Cotton Exchange' Ltd was set up in 1893. Thus, it is needless to say that cotton was the first commodity to be traded in futures market. This was followed by oilseeds, wheat, raw jute and others.

The futures trading in oilseed started with the setting up of the Gujarati Vyapari Mandali in 1900. This Mandali also carried out trading in groundnut, castor seed and cotton. West Bengal, Assam and other eastern states of India are well-known for jute cultivation. At that time, one market centre was being badly needed in eastern India. Futures trading on raw jute and jute products began in Calcutta with the setting up of the Calcutta Hessian Exchange Ltd. in 1919. Later, the East Indian Jute Association was formed in 1927 for futures trading in jute in Calcutta. The East India Cotton Association, formed in 1921, organized futures trading in cotton in Mumbai also.

At the end of Second World War, there were several oilseeds futures market in the states of Gujarat and Punjab. Futures market in Bullion began in Mumbai in 1920. Later, the same type of markets was established in Rajkot, Jaipur, Jamnagar, Kanpur, Delhi and Calcutta. Wheat futures exchanges were established at several centers in Punjab and Uttar Pradesh. In due course of time, other exchanges were established at several places of the

[3] Descriptions on this topic can also be found in Sen (2008), Jena (2010) and Mishra (2007).

country like Amritsar, Maga, Ludhiana, Jalandgaer, Meerut, Saharanpur, Hapur, Ghaziabad, Secunderabad, Bareilly. Futures trading were gradually extended in spices and food items also such as, turmeric, pepper, potato, sugar and jaggery. Before independence, futures trading in India were confined to few selected commodities.

After independence, India adopted its own independent constitution. The Indian constitution listed the subject of 'Stock Exchanges and Futures Markets' under the union list. Thus, the central government became the sole body to define rules and regulations for the development of the commodity futures markets. In December 1952, the Forward Contracts (Regulation) Act was passed in the Indian Parliament. In 1954, the Forward Contracts (Regulation) rules were notified by the Forward Market Commission (FMC) under the central government. Since then all central government departments have been regulating production, distribution and quality of products by using the FCRA rules.

As a result of the FCRA 1952, three–tier regulating authorities existed: (a) Firstly, an association (the exchange) recognized by government of India. The exchange, which organizes forward trading in commodities, can regulate trading on a day-to-day basis. (b) Secondly, the FMC provides regulatory oversight under the powers delegated to it by the central government and (c) Thirdly, the Central Government (the Department of Consumer Affairs, Ministry of Consumer Affairs, Food and Public Distribution) is the ultimate regulatory authority. According to this FMC Act, selected commodities started trading.

In the FMC report, it is clearly mentioned that (i) Commodity market should be competitive, that means, there should be large demand for and supply of commodities. No individual or group should influence the market. (ii) Commodity market should be free from government control and (iii) Commodity could be stored and standardized.

In 1954, the Forward Market Commission (FMC) gave permission to start trading in futures market. As a result futures trade in spices was first started by the Indian Pepper and Spices Trade Association (IPSTA) at Cochin in 1957. But futures trading in most of the commodities except pepper and turmeric were banned in 1966 due to shortage of crop production and Indo-China war in 1965. Subsequent to the ban of futures trade, many traders resorted to unofficial and informal trade in futures (Mishra, 2008).

The futures trading in commodities in India were interrupted in the mid seventies because the government of India wanted to usher in an elusive socialistic pattern of society. But soon after, India embarked on economic liberalization policies and signed the GATT agreement in the early nineties. The government of India realized the need for futures trading to strengthen the competitiveness of Indian agriculture and the commodity trade and industry. In 1979, the A.M. Khusro Committee was set up to further review the functioning of the forward markets and FMC. After recommendations of the A.M. Khusro Committee, futures trading were permitted on selected commodities like gur, potatoes and castor seed.

After initiating economic reforms, the Government of India appointed an expert committee on forward markets under the chairmanship of K. N. Kabra in June 1993. The Kabra committee submitted its report in September 1994. Some of the key recommendations of the Kabra Committee include - (i) the commodity exchanges should enroll more members, (ii) the commodity exchanges should be computerized so that online trading can be ensured, (iii) the Forward Markets Commission should be strengthened with more power, (iv) more commodities should be included in the futures trading like basmati rice, cotton seed, ground nut, rapeseed, linseed, copra, sesame seed, mustard seed, soyabean etc.

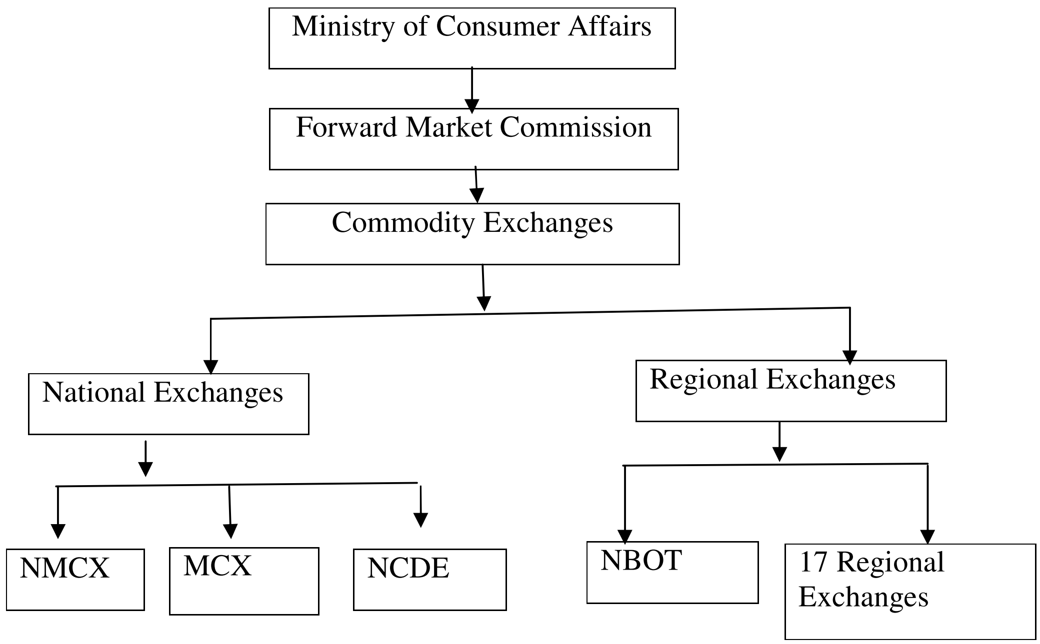
The Kabra committee in 1994 recommended only 17 commodities that would start futures trade. The committee unanimously opined against granting permission for futures in wheat, pulses, non-basmati rice, tea, coffee, dry chilies, maize, vanaspati and sugar, on the basis of a case-by-case review of the suitability of each commodity in the light of its present and likely position in the coming years [GoI, Ministry of Civil Supplies 1994, pp 33-63, cited in Kabra 2007]. However, when the second phase of liberalization was started in 2003, the National Democratic Alliance government issued a notification permitting futures trade in 103 commodities [Lingareddy, 2006, p. 212].

With the recommendation of several committees, the government approved futures trading in several commodities. Soon several commodities exchanges were born. Some of the significant among them are the Multi Commodity Exchange (MCX), the National Commodity and Derivatives Exchange (NCDE) and the National Multi Commodity Exchange (NMCX).

The nature of commodity trade in India has undergone a sea change as a result of the revival of commodity futures in a big way in 2003. The government of India notified on April 1, 2003 to start futures trading on various commodities on the basis of three conditions as follows (FMC, Government of India): (i) Commodities can be prohibited in futures trading when they fuel unnecessary speculation. (ii) There are certain commodities in which there can be either future trading or prohibition but such commodities need to have a certificate from the Forward Market Commission. (iii) Commodities should be traded with a recognized association.

Thus, first on cotton, futures trading on commodities in India gradually expanded to several commodities with the recommendations of several committees and the government's approval.

Figure 4.1: Structure of the Commodity Market in India



4.4 Structure of the Commodity Futures Market in India

The structure of the Indian commodity futures market can be represented as shown in Figure 4.1. Currently, in India, commodity futures contracts and the commodity exchanges are regulated by the government under the Forward Contracts (Regulation) Act, 1952. The nodal agency to regulate the future market is the Forward Markets Commission, situated at Mumbai. This FMC functions under the aegis of the ministry of consumer affairs.

As a result of the government of India's notification on futures trading in 2003, as many as 24 commodity exchanges (three national commodity exchanges and 21 regional commodity exchanges) have started futures trading on various commodities. As per the recommendation of the FMC, the government of India recognized the Multi Commodity Exchange (MCX), National Multi Commodity Exchange (NMCE) and National Commodity and Derivative Exchange (NCDE) as the nation-wide multi commodity exchanges[4]. The NMCE started trading in November 2002, MCX in November 2003 and NCDE in December 2003. After FMC notification, 91 commodities were registered under

[4] Brief profiles on MCX, NMCX, NCDE and NBOT are given in Appendix A.4.2

the FMC Act. At present, more than 146 commodities are being traded in national commodity exchanges and rest of the commodities is free commodities. While the national exchanges are multi-commodity exchanges, regional ones are offering single commodity contracts. However, now attempts are being made to convert some of these regional exchanges into multi-commodity exchanges (Kabra, 2007).

4.5 Recent Trends of Commodity Futures Markets in India[5]

Commodity futures exchanges in India have grown tremendously in terms of the trading volume, value and turnover from the beginning of 2002. The number of commodities traded in exchange markets was only 59 in January 2005. However, after a gap of about two years, 94 commodities were traded in December 2006 in the commodity futures markets. These commodities included major agricultural commodities such as rice, wheat, jute, cotton, coffee, major pulses (such as urad, arhar and chana), edible oilseeds (such as mustard seed, coconut oil, groundnut oil and sunflower), spices (such as pepper, chilies, turmeric and cumin seed), metals (such as aluminium, tin, nickel and copper), bullion (gold and silver), crude oil, natural gas and polymers etc. Gold accounted for the largest share (31 percent) of trade in terms of value, followed by silver (19 percent), guar seed (11 percent) and chana (10 percent) in 2006.

Now the Multi Commodity Exchange is the second largest trading exchange in the world right after Dow Jones AIG Commodity Index (DJAIG) for Gold, crude oil and petroleum crude oil. Likewise, NCDE is one the largest futures trading commodity exchange for agricultural commodities. As the largest commodity futures exchange during 2006-07, both in terms of turnover and number of contracts, the growth of the MCX is comparable with some of the international commodity futures exchanges such as the Dow Jones AIG Commodity Index (DJAIG) and Reuters/Jefferies Commodity Research Bureau (Sahoo and Kumar, 2008, p.6). In the following paragraph we have analysed the recent developments of commodity futures prices of the studied variables, i.e., metals, energy and agricultural commodities.

As we have already mentioned that the chief motives of investors to prefer commodity index investment, which refers to the buying of basket of commodities to diversify their investment portfolio. According to Markowitz (1952) the main investment goal of investor’s is to identify the set of portfolios that maximize expected return for a given level of risk. Traditionally, investors used to concentrate only on stocks, bonds, and

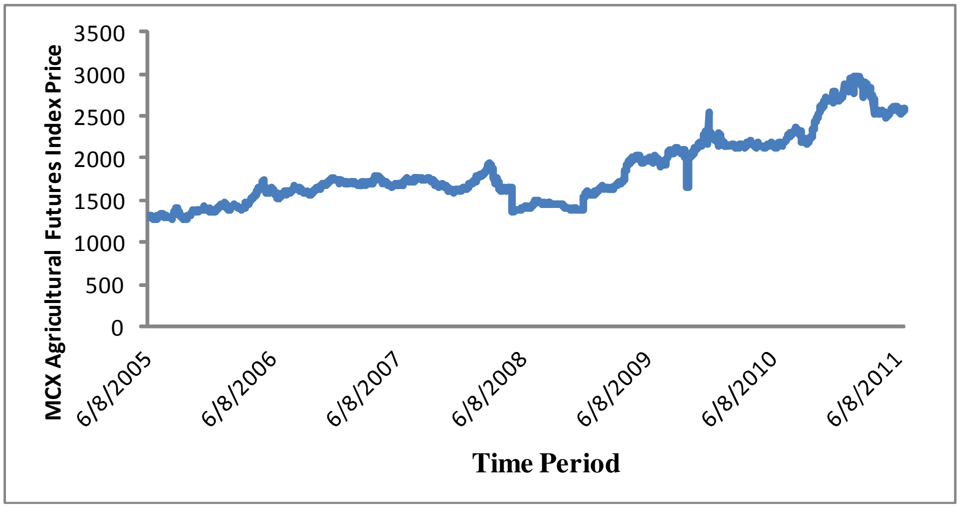
[5] This section draws upon Sen (2008), Mishra (2007) and Jena (2010).

cash market. Over the period, after the development of modern portfolio theory, there was development of alternative investment strategy, where physical commodities were included in one such alternative investment. The main advantage of including commodities in an investment portfolio is that commodities are inversely/uncorrelated with the returns of the traditional asset classes. It has been seen that during the periods of rising inflation, traditional asset classes perform poorly where as commodities generally perform well.

Over the period of time, the commodity index portfolio in India has been increased considerably. There are three national commodity exchanges in India but MCX commodity Indexes have been eyewitnessed in terms of trading volume and market turnover. Although, commodity exchanges in India are very old, well organized trading exchanges were set up in 2003 but the nation-wide commodity index trading was started in 2005. Among the three national commodity exchanges, MCX is the most leading commodity exchanges as well as index trading exchanges in India. The composition of commodity index in India is based on commodity futures prices of an exchange. The multi Commodity Exchange (MCX) India provides three different group of indices; agricultural index (i.e., MCX AGRI), Metal Index (i.e., MCX Metals) and Energy Index (i.e., MCX Energy) on commodity futures prices to represent different commodity segments as traded on the exchange. The main criterion of including commodities in MCX commodity Index is liquidity of individual commodities in a specified period of time. The MCX COMDEX weight is determined by the futures market liquidity on the exchange and the physical market size. In Appendix-A.4.2-a to A.4.2-d, we have reported the composition of commodities and their weights in the MCX-COMDEX.

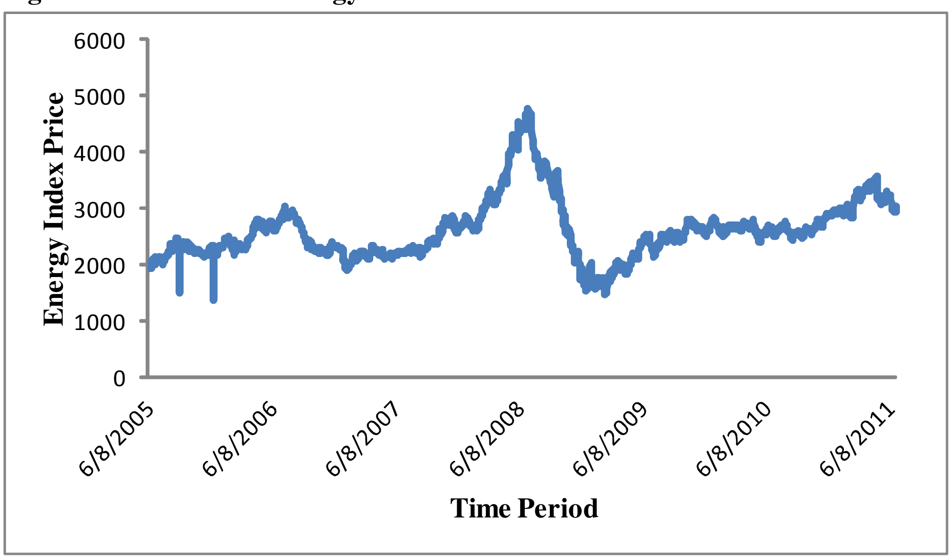
The performance of MCX commodity futures indexes are shown in the following from Figure 4.2 to Figure 4.4. Figure-4.2 shows the trends of MCX Agricultural Commodity Futures Indexes. It can be seen that there has been a continuous increase in the agricultural futures index prices from June 2005 to September. After that, from October 2008 is seen that there is a decline of agricultural commodities futures index prices. But, since 30th October 2008 there has been a continuous increase in the agricultural futures index prices in India. Similarly, if we look at the trend of energy commodities futures Index prices in India in Figure-4.3, we can find out that initially there is increase in the index prices from 8th June 2005 to 14th July 2006 and thereafter it starts declining till 10th January 2007. Again, the energy futures index prices show upward trend from 11th January 2007 to 1st July 2008. Due to global recession in 2008, again there has been a fall in energy index prices from the period 2nd July 2008 to 15th January 2009. Since 16th January 2009 onwards it shows the upward trends, which leads to the recovery of global financial recession.

Figure 4.2: Trends of Agri Futures Index Price in India from 2005 to 2011.



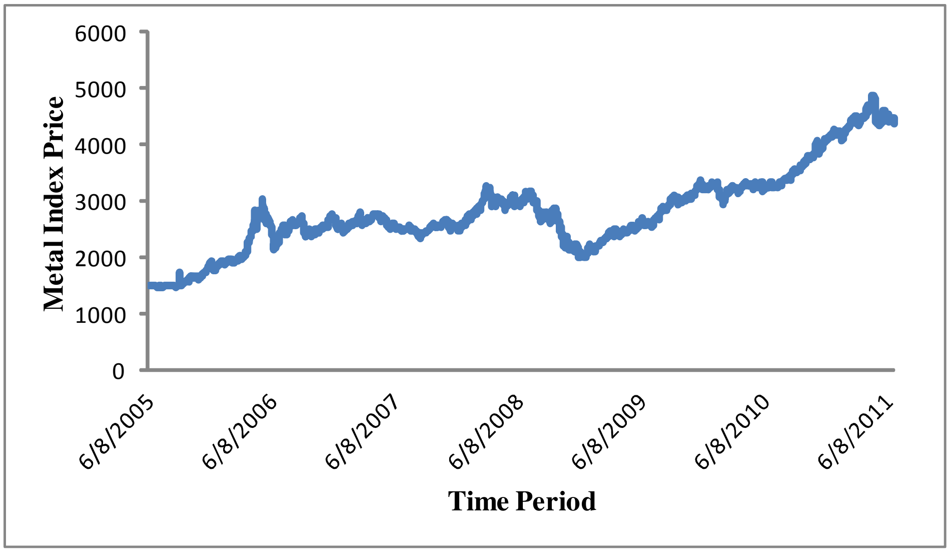
Source: MCX online data base.

Figure 4.3: Trends of Energy Futures Index Price in India from 2005 to 2011



Source: As in figure-4.2.

Figure 4.4: Trends of Metal Futuere Index Price in India from 2005 to 2011



Source: As in figure-4.2.

If we look at the MCX metal futures index price in Figure-4.4 it shows that there has been a continuously rising of the index price of metal in MCX commodity exchanges from 8th June 2005 to 20th May 2008, thereafter it falls up to 11th November 2008. After that, there has been a continuous increase in the prices of metal futures index. It can be understood that initially with the global financial recession, metal index prices behaved similarly with the prices of energy commodities though it is believed that both are positively related. The second part, i.e., from 12th November 2008 onwards, from the continuous increase in the metal index prices, it can be understood that when the global recession aggravated, investors may have diverted their assets towards metals especially gold, though it is believed that gold is the most precious metal which retains its value in each and every economic situations. Therefore, there may be asset allocation towards metals, as a result the futures index prices of metals have increased since 12th November 2008 in MCX commodity exchange in India.

The study of financialization becomes very important during the periods of high inflation in order to understand whether the finance investors or institutions play any role to raise commodity prices. The term "financialization of commodity markets" means raising the role of financial motives, financial markets and financial actors in the operation of commodity markets (UNCTAD, 2011). That means, financial investors use commodity markets for the purpose of asset allocation or portfolio diversification as it is evident that commodity has the following characteristics (UNCTAD Report, June, 2011).

Firstly, commodity futures markets exhibited the same returns as investment in equities. Secondly, over the business cycle commodity futures markets returns are negatively correlated with returns on equities and bonds. Gorton and Rouwenhorst (2004) examined these two facts of commodity futures market using the data over a longer period of time, from 1959 to 2004. They also have found that commodity price returns are less volatile than those on equities and bonds, because the pair-wise correlations between returns on futures contracts for various commodities (i.e., oil and copper, or oil and maize) were relatively low.

Thirdly, they said that commodity futures contract is used as a good hedge against inflation, which is commodities futures contract price returns are positively correlated with inflation. This is, because futures prices reflects information about expected changes in commodity prices, which is raise or fall in line with deviations from expected inflation.

Fourth, commodity futures is also used as a hedge against changes in the exchange rate of the dollar, as most of the commodities in world-wide are traded in dollars. Therefore, if there are depreciations of dollar, the commodity prices in dollar terms tend to increase and vice versa. According to the IMF (2008: 63), commodity prices are generally less correlated with the dollar; indeed, the sign of the correlation is reversed. Which means changes in the value of the dollar against other currencies may partly explain the negative correlation between the prices of dollar-denominated commodities and the dollar.

4.6 Commodity Price Formation and Information

This section explains the commodity price formation in spot and futures markets and also explains the role of information in commodity markets. Information plays an important role in price formation but the kind information that determines the behaviour of the most influential market participants has rarely been investigated. Particularly, in commodity markets, the information is closely related to the high degree of uncertainty. The UNCTAD (2011) report mentioned that there are three factors:

(i) Medium-and longer-term commodity supply and demand conditions are subject to unknown factors like effects of climate change on agricultural production.

(ii) Inventory data, which provide available signals for short-term price expectation, suffer from significant measurement errors (Khan, 2009) and

(iii) Data on current global commodity supply and demand conditions are published with long time lags and are frequently revised, as a result, even a well informed trader must formulate price expectation on the basis of partial and uncertain data.

Except these three factors, there is also another one important factor which is the most recent. Due to rapid industrialization, urbanization and changes in dietary habits in emerging economies like India, there is a growing demand for commodities which creates a new business cycle, that leads an uncertainty in accurate determination of supply and demand. This leads not only to uncertain prediction of economic growth but there is also often wide gap in the availability of data regarding commodity demand, supply and inventory situations.

It has been recognized that supply uncertainty is more comparable to demand uncertainty because commodities production depends on many factors. For example, agricultural commodities production uncertainty occurs due to less land use, water shortage, climate change and more recently generation of biofuels, seems to have greatly increased the relevance of information on energy for trading in agricultural commodities and vice versa.

Information about supply and demand in commodity markets today has been supplemented by expectations that prices could rise anytime soon, and for a long period of time. In this situation of price uncertainty, the conventional role of commodity futures exchanges in price discovery and risk transfer has gained significant importance. Only commodity exchanges appropriately fulfill these roles if market participants trade on the basis of independent and individual information derived from an infinite knowledge of specific events related to commodity markets and on their own plans to supply or demand commodities. But this function of commodity exchanges has been jeopardized by the financialization of commodity trading. Because, financial investors in commodity markets base their position-taking on risk and return considerations in which information about other asset markets and the overall economy plays a very important role, as financial motives more generally do so.

Specifically, the financialization of commodity trading poses the risk of herd behaviour and of self-fulfilling properly due to the pecuniary power of these market participants.

Commodity market in India is categorized broadly into two types– (i) spot market and (ii) futures market[6]. Spot market is also known as physical or cash market. Spot market or physical/cash market is a market where both buyers and sellers interact with

[6] Futures market is a part derivative market, which includes *forward, futures*, *options* and *swaps*. Out of these four markets, *commodity futures market* plays an important role in price discovery and risk management. Indian market is limited to commodity futures only (Mishra, 2007).

commodities in a place and commodity price is determined by the market demand and supply. So, commodity price will be high if there is more demand than supply and price will be low if there is high supply. The main problem in this market is that farmers do not have any prior information about the market price and the quantity they should produce to meet demand.

On the other hand, commodity futures market is a market where there is contract between two parties through a registered exchange. This contract may be made through certain rules and regulations. There is also a clearinghouse to clear the market after every delivery. The main players in the futures market are speculators, traders, arbitrators and farmers. Commodity futures contracts can be made through the speculators and market traders who bringing the commodity for delivery to the market. In commodity futures market, it is possible for the market participants who need a certain commodity at the future time t, can either buy it in the spot market today and store it, or they can buy, i.e., take a long position in a futures contract and deliver when the contract expires. In the former case, the market participants will bear the storage costs and opportunist costs, as the funds are invested at the prevailing interest rates. Therefore, the futures price of a commodity should be equal to spot price plus interest rate and storage cost- so called cost of carry[7]. The futures price of a commodity can be expressed as:

$$F_0 = S_0 + I + W \tag{4.1}$$

Where, F_0= futures price of a commodity at time t=0, S_0= spot price of a commodity at time t=0, I= interest rate and W= storage cost.

If futures price of a commodity exceeds the sum of spot price and carrying cost, then investors take long position in spot market, i.e., they buy commodities in the spot market and take a short position (i.e., an obligation to sell commodity) in a futures contract, in such a way that which drive up spot price and lower the futures price. As a result, the arbitrageurs get profits as long as futures price is greater than the spot price and cost of carry, i.e., $F_0 > S_0 + I + W$. This activity will continue until the futures price is equal to the spot price plus the cost of carry.

On the other hand, if $F_0 < S_0 + I + W$, investors or arbitrageurs take short position in the spot market, i.e. they sell commodities in the spot market and take long

[7] Cost of carry is the cost that incurred when a commodity is 'carrying' or holding to use in future time t. If there is long position, the cost of carry is the cost of interest paid, where as if the position is short, the cost of carry is the opportunity cost.

position (an obligation to buy commodities) in the future market. This will continue until the processes have adjusted and futures price equals with spot price plus the cost of carry.

One distinctive characteristic of commodity market than the stock market is in the former case inventories could take place to protect against sudden disruption of commodity supply. As a result, the holder of an inventory gets benefits of convenience yield. If inventories levels are high, the marginal convenience yield is low and on the other hand, if inventories are low, the marginal convenience yields from an extra unit of inventories which is fairly high. Therefore, there exists an inverse relationship between the marginal convenience yield and inventory levels. Now, we can re-write the equation (4.1) in the following way:

$$F_0 = S_0 + I + W - C \tag{4.2}$$

Where, C is the convenience yield. If there is upward sloping of commodity futures price curve, we can say that the market is in '*contango*', as this is a situation where inventories are high, which causes storage cost and interest rate to exceed the convenience yield. That means, the futures price will exceed the cash price with rise in storage cost and interest rate, as it will be costlier for inventories, which provides an incentive to sell the commodity in the spot market. This leads to drive spot price down.

In the same manner, if there persists an opposite situation, i.e., a situation where futures prices are progressively lower than rising maturities, it is called '*backwardation*'. In this situation, futures price doesn't cover the cost of carry and there will be increased inventories level. But, when the inventories levels are low and convenience yield is high, market is called in backwardated as the high convenience yield offset the sum of the interest rate and storage costs[8]. For the formation of accurate commodity price expectation and an efficient functioning of commodity markets, we need up-to-date and reliable information on commodity supply, demand and supply (UNCTAD, 2011). In the cash/spot market, it could be seen that some commodities have low short-run piece elasticity of supply and demand, and it is also very difficult to access the market information. But on the other hand, commodity futures market is high liquidity market and also one can easily access information on futures prices. Therefore, commodity futures markets play a crucial role in commodity price discovery. The functioning of this process,

[8] This should not be confused with the Keynes' concept of "normal backwardation", which refers to an insurance risk premium paid by hedgers who take a short position, i.e., commodity producers and are more risk averse than their counterparts. It is only plausible if short hedgers are more risk-averse than long hedgers (UNCTAD, 2011).

i.e., price discovery depends on the efficient market hypothesis (EMH)[9]. Out of the three forms of EMH, it is widely believed that the EMH holds in its semi-strong form which deals with that any publicly available information about a commodity is reflected in its current price (Malkaiel, 1991). Below, we have discussed the role of futures exchanges markets in commodity price formation.

4.7 The Role of Futures Markets in Commodity Price Formation in India

In recent years, the commodity trading in exchange market has become extremely important as this market can influence the whole economy of a country through major macroeconomic variables. Commodity derivative products are traded either on organized commodity exchanges or bilaterally "*over-the-counter*" (OTC) market, depending on the concrete requirement of trade. But in India, commodity futures are traded on well organized commodity exchanges in nationwide.

At present, all goods and products of agricultural (including plantation), mineral and fossil origin are allowed for futures trading under the auspices of the commodity exchanges recognized under the FCRA. Commodity futures markets in India are among the well organized futures markets in the world. Some of the main characteristics of commodity futures market in India are the following: (i) futures contracts are standardized in terms of the quantity and quality, that means commodity futures exchanges clearly define the quality and quantity of the commodities, (ii) certain rules and regulations for trading, (iv) the place of delivery and schedule, cost of quality differences, transport costs, tradable lots and the modes of price quotes are predetermined. Except these characteristics, there is also a clearing house which settles transactions after every last trading day and it charges penalties for non-acceptance of deliveries. For the futures exchange, commodities must be durable and storable, the measurement units of the commodity must be homogeneous, there must have high supply and demand, price must be varying and lastly there must be flow of supply.

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[9] The efficient market hypothesis (EMH) was first given by Fama (1970). According to Fama (1970), a market is called efficient if it uses all the publicly available information in price formation. When a market is efficient, the difference between futures spot price and the expected price becomes zero. There are three types of market efficiency; weak form efficiency, semi-strong form efficiency, and strong form efficiency. The weak form efficiency uses the past information to forecast the futures price. In case of semi-strong form of market efficiency, the current price reflects all the past information and the current publicly available information like money supply, inflation, exchange rate, etc. Due to difficulties in acceptance of macro variables, it is not used to predict the futures price by the people. Like-wise, in the strong form efficiency, the private information is included in price formation, which is not possible to predict it. In general, a market is called efficient in terms of weak form of efficiency.

The main functions of commodity futures markets are price discovery, price risk management, resource allocation and providing guidance for decision making. Generally people believe that commodity futures market is dominated by the speculator, who gains profit with price differentiation. The unnecessary speculative market increases the price level. But several studies have found that speculation narrows down the price fluctuations of the current price relatively to the expected price. The speculator gets profit as similar with the wholesalers and the retailers for transferring commodities from less important use to more important use (Lofton, 2005). Hence, the speculator neither increases nor decreases the price level but does both simultaneously.

Commodity futures markets have been used for decision making by the policy makers not only to increase the agricultural production and price stabilization but also for efficient use of resources. It also provides information about the future demand for commodities, so that the farmers could make decisions today itself to meet the future demand (Shah, 1998). Hence, they will not be worried about lower prices during the harvest time, because they can sell their commodities in the futures market. So the major benefits of futures markets are as follows: (i) It leads to price discovery, that means, the futures price of commodity is an indicator of futures spot price, so that there will be efficient use of the resources. (ii) It provides hedging option to farmers to hedge their commodities against the price risk. (iii) It also provides investment choice because it is less risky than the financial investment. The commodity futures market, as an asset class, provides commercial commodities' producers and consumers with a means to transfer price risk to speculators who themselves have no direct commercial interest in the commodities themselves. (iv) it boosts up cropping pattern by increasing investment in agriculture. (v) it integrates the relation between the market and participants.

Apart from those benefits, there are also some other benefits. It increases the export competitiveness by reducing margins, it improves quality standard, it increasing credit availability, and it also providing financial stability by increasing the alternative source of investment. For these purposes, commodity futures trading in India have started with many commodities. Commodities in the futures markets are categorized into two types - storable and non-storable commodities, which include both agricultural and non-agricultural commodities. Agricultural commodities include cereals and pulses, sugar, gur, channa, groundnut etc. Non-agricultural commodities are again categorized into base metals, precious metals, ferrous metals, energy, polymer products and other commodities.

There is a higher degree of price transparency in commodity futures exchanges than that of those in spot markets. There are various studies that examined the dynamic relationship between spot and futures prices of various commodities. Among these studies, a recent study conducted by the International Food Policy Research Institute analyzed the dynamic relationship between spot and futures prices of agricultural commodities using the weekly data on returns and volatility for maize, hard wheat, soft wheat and soybeans (Hernandez and Torero, 2010). The study found that for these commodities, changes in futures prices lead to changes in spot prices more often than the reverse. According to the findings of Hernandez and Torero (2010:9), "the information flow from futures to spot markets has intensified in the past 15 years, probably due to the increase in the relative importance of electronic trading of futures contracts over open action trading, which results in more transparent and widely accessible prices."

4.8 Motivations of Financialization of Commodity Market

It cannot be said that financial investors are active in the recent years so that they will be active for longer periods in commodity markets. However, due to the above mentioned characteristics of commodities, after the 'dot com crises' [10] in 2000, the financial investors were encouraged to use commodity market for the purpose of portfolio diversification. As a result, commodity market gains popularity among the academicians and also potential investors, which makes the commodities enter into a new business super cycle.

Now a question may arise that do financial investors directly purchase and sell different commodities? Though, the aim of financial investors are for portfolio diversification, financial investors cannot trade commodities according to the market demand and supply, and also they do not purchase and sell commodities but they invest on a bunch of commodities like commodity indexes or futures. The commodity indexes are composites of different commodities futures contract prices, which are weighted average of a basket of commodities. The most trading commodity indexes in the world are the

[10] The DOT COM crisis (also referred to as the Internet and the Information Technology crisis) was originated after a speculative bubble covering roughly 1995–2000 (with a climax on March 10, 2000, with the NASDAQ peaking at 5132.52 in intraday trading before closing at 5048.62) during which stock markets in industrialized nations saw their equity value rise rapidly from growth in the more recent Internet sector and related fields. Over 1999 and early 2000, the U.S. Federal Reserve increased interest rates six times, and the economy began to lose speed. The dot-com bubble burst, numerically, on Friday, March 10, 2000, when the technology heavy NASDAQ Composite index, peaked at 5,048.62 (intra-day peak 5,132.52), more than double its value just a year before. By 2001 the bubble was deflating at full speed. A majority of the dot-com ceased trading after burning through their venture capital, many having never made a 'net' profit. Investors often referred to this failed dot-com as 'dot-bombs' (www.en.wikipedia.org, accessed in July 2013).

Standard & Poor's Goldman Sachs Commodity Index (S&P GSCI) and the Dow Jones-Union Bank of Switzerland Commodity Index (DJ-UBSCI), which are composites of broad range of commodities like agriculture commodities, energy products and metals.

4.9 Instruments of Financialization of Commodity Markets

There are various instruments adopted by the financial investors to get positive returns from their investment but they adopt certain instruments bellow when they choose to invest on commodity market. Those instruments are discussed below. In UNCTAD (2011), it is written that "Financial investors gain exposure in commodity indexes by entering into a bilateral financial agreement, usually a swap, with a bank or another large financial institution. The investor purchases parts in a commodity index from the bank, and in turn bank hedges its exposure resulting from the swap agreement through futures contracts on a commodity exchange". It is true that financial investors prefer to invest in commodity indexes in a rolling process- only for long positions (i.e., pledges to buy commodities) and relates to forward positions (i.e. no physical ownership of commodities is involved at any time)[11]. Consequently, the roll yields play an important role for index traders, which is positive in a *backward* market and negative in a *contango* market[12]. Therefore, all financial investors take positions on both sides of markets (i.e. long-term and short-term) through futures and options contracts, which enable them to earn positive returns both in declining and rising markets.

The second instrument, i.e., exchange traded products (ETPs) adopted by the financial investors in commodity markets is completely new and has been being used in international trading exchanges since 2009. The ETPs, comprising of both exchange-traded funds and exchange-traded notes, are derivatively priced securities which trades intra-day on a national stock exchange but they only replicate the return on a single commodity rather than the commodity groups. The ETPs consist of both futures contracts and also are backed by physical commodities exposing investors to counterparty risk, as transaction involving buying or selling of ETPs do not go through a clearing house on commodity exchange (UNCTAD, 2011). Therefore, it indicates that risk aversion and

[11] A long position is a market position which obligates the holder to buy a commodity and in contrast a short position which obligates the holder to sell a contract. The aggregate long position is equal to the aggregate short position.

[12] Contango is a market condition where forward or futures contract price is trading above the expected spot price at contract maturity, as result the future or forward curve would typically be upward sloping. On the other hand, backwardation is a market situation where spot price exceed forward or future contract price at maturity, and the forward or future curve slopes downward.

growing concern with counterparty risk have made it clear that financial investors bear the storage cost of the physical commodities.

Alternatively, it can be said that if the physical backed ETPs are increased, it may cause a tightening of supply of commodities as a part of commodities are kept in the warehouse of commodity exchanges and will not be available for delivery. As a result, the cash premium will increase which causes commodity market to move backward, and in turn, it increases the return on commodity index investments, which attracts more investment. Moreover, if there is an increase in investment, it further will increase the commodity prices and also will increase the need to hold more physical commodities. Hence, the combination of futures-backed ETPs may cause a speculative bubble. But in recent years, since 2006, the financial investors are using structured products, which take different forms but they prefer a derivative (i.e., option).

The study of financialization of commodity market is an emerging area not only in India but also in other developed and emerging economies in the world. The issue became more vibrant right after the recent global financial crisis in 2008. The term "financialization" of commodity market means the growing presence of financial investors on commodity futures exchanges. It is not a surprise that there have been active financial investors in commodities since early 1990s but they were mainly comprised hedge funds which provide short-term investment horizons. But, after the dotcom crisis[13] in 2000, there was a new paradigm of involvement of financial investors in commodity markets. Basically, after the dotcom crisis in 2000, there has been a new proportion of involvement of financial investors in commodity market, where most of the financial investment in commodities uses swap agreements to take long-term positions in commodity indexes, which are composites of weighted prices of a broad range of commodities, including energy, agricultural products and metals (UNCTAD, 2009).

Now a common question arises that why financial investors prefer to invest in a commodity index rather than in a single commodity. The main aim of financial investors to invest in commodity index is to diversify portfolios. In all index, fund transactions are related to forward positions- no physical transfer of commodities made through a rolling process, where they are also sold as expiry approaches and use the proceeds from this sale

[13] Dotcom crisis in 2000 was also known as dot-com bubble during the period from 1995 to 2000 where stock prices soared high in the internet and technology sectors of the Westerns nations but this bubble had burst on Friday, March, 2000, when the technology heavy NASADAQ composite index touched 5,048.62, which was more than double its value just a year before. NASADAQ had lost more than 10% within a few days from its peak value.

to buy forward again, which can be profitable when the prices of futures contracts with a long maturity below the prevailing prices of the futures contract with a remaining maturity of one month and vice versa.

4.10 Summary

In chapter 4, we examined the financialization of commodity market in India. Mainly, we analysed the meaning of financialization and its role in commodity markets. The chapter basically focused on the role of speculation in commodity markets. Speculation in commodity derivatives markets performs a significant economic role. Firstly, speculation in these markets allows for the transfer of price risk from those least willing to bear it (commodity producers and consumers, or 'end users') to those with the greatest appetite and capacity to do so (generically, 'speculators'). Secondly, derivatives markets transmit valuable information about supply and demand conditions. Therefore, speculators can create a price distortion and speculative bubble with the anticipation of making significant profits from major movements in the markets. The recent surge in commodity price has made to study the commodity market and to find out whether there is any role of speculators for commodity price surge in India.

Subsequently, we analysed the history of commodity futures market and its ban in India. Commodity futures market in India has a long history. After independence, the central government became the sole body to define rules and regulations for the development of the commodity futures markets. Till then all central government departments have been regulating production, distribution and quality of products by using the FCRA rules. With the recommendation of a number of committees, the government approved futures trading in several commodities. Soon after several commodity exchanges were born. The main among them are the Multi Commodity Exchange (MCX), the National Commodity and Derivatives Exchange (NCDE) and the National Multi Commodity Exchange (NMCX).

Then, we analyzed the structure of the commodity futures market in India. It was seen that right after the set up of all nationalized exchanges, there was a continuous rise of commodity futures prices in India. As a result, the rise in commodity spot price in 2007 led to the ban of some commodities futures trading but after the investigation it was confirmed that that price rise was not due to the futures trading but the shortage of production. However, the main aim of futures trading is to give the future price information to the public. Therefore, in this chapter, we also analyzed how futures market gives price information. Next, we have analyzed the role of futures markets in commodity price formation in India. Then we have analyzed the motivations of financialization of commodity market. As the main motive of financialization is to get profit with rise in commodity price in India, investors use various instruments like the futures market or swap agreements. Except these two, they also use the ETPs.

The next objective of this study is to empirically examine how the financialization of commodity markets affects commodity price. If it does so, then whether it is in the long-run or in the short-run. Answers of these questions are examined in the next chapter-5.

Appendix A.4.1

	Traditional Speculators	Managed Funds	Index Traders
General Market Position	Active positions on both sides of the market; able to benefit in both rising and declining markets	Active, often large, positions on both sides on market; able to benefit in both rising and declining markets; relatively opaque positions	Passive, large and long-only positions in swap agreements with banks, which in turn hold futures contracts to offset their short positions, able to benefit only in rising or backwardated (spot price>forward price) markets; transparent positions.
Position Taking Behaviour	React to changes in commodity market fundamentals (Supply, demand, inventories); mostly trade in one or two commodities of which they have intimate knowledge; leveraged positions.	Some (e.g., hedge funds) conduct research on commodity market fundamentals and thus react to changes in those fundamentals. Others (e.g., commodity trading advisors) mostly use statistical analyses (trend identification and extrapolation, automatic computerized trading), which extract information from price movements. They thereby risk misinterpreting noise trader position taking for genuine price information, engaging in herd behavior and causing snowball effects; leveraged positions.	Not interested in fundamentals of specific commodity markets but may have views on commodities as a whole; relative size of positions in individual commodities determined by an index weighting formula; idiosyncratic position taking such as rolling at predetermined dates; position changes are relatively easy to predict; fully collateralized positions
Impact on Liquidity	Improve liquidity	Active, large positions can improve liquidity and make hedging easier for large commercial users. In periods of rapid and sharp price changes, large positions are a "liquidity sponge", making it difficult for hedgers with commercial interests to place orders	Passive, large positions act as a "liquidity sponge"
Reaction to sharp price changes	May be taken by surprise if price changes are unrelated to fundamentals; can be forced out of the market if they lack liquidity to meet margin calls triggered by sharp price increases	Taking and closing positions are often automatically triggered by computer programs; risk of causing a snowball effect	Different price developments for individuals commodities require decompositions of relative investment positions to preserve a predetermined index weight pattern; sharp price declines may cause disinvestment
Reaction to changes on other markets	Operative only in commodity markets; normallyconcentrate on one or a few commodities, and thus react little to developments in other markets	Operate across different asset classes. Commodities tend to have a fixed weight in managed fund portfolios, so that price movements in other markets can lead to position changes in commodity markets	Operate across different asset classes. Potentially strong links between commodity futures activity and development on equity and bond markets, in two ways: a) risk-return combinations in other asset classes can become more attractive, causing a withdrawal from commodity markets; b) margin calls on other investments can trigger closing of positions in commodity and accelerate contagion across asset

			classes
Classification in CFTC Commitment of Traders Reports	Non-commercial user category	Mostly in non-commercial user category	Mostly in commercial user category

Note: UNCTAD, 2009

Appendix A.4.2: Major Commodity Exchanges in India

The profiles of major commodity exchanges in India have been outlined briefly here. These have been drawn from their respective websites, namely, www.mcxindia.com, www.ncdex.com, www.nmce.com and www.nbot.org.

A.4.2-a Multi Commodity Exchange (MCX): The Multi Commodity Exchange (MCX) Limited is a national commodity exchange in India. This exchange started operations in November 2003. It is headquartered in the financial capital of India, Mumbai. This is a demutualised nationwide electronic multi commodity futures exchange set up by Financial Technologies with permanent recognition from Government of India for facilitating online trading, clearing & settlement operations for futures market across the country. It offers futures trading in 59 commodities as on January 31, 2009. Out of the various commodities traded, the MCX provides the highest number of trading on the base metals, i.e., gold and silver. It has been accredited with ISO 9001:2000 for the quality standards. It provides futures markets both in agricultural as well as non agricultural commodities. MCX gold and silver trading are also competing with some international exchange markets such as Tokyo Commodity Exchange, Chicago Climate Exchange, London Metal Exchange, New York Mercantile Exchange, New York Board of Trade and Bursa Malaysia Derivatives, Berhad. MCX enjoys the confidence of blue chips in the Indian and international financial sectors. Some of the broad based strategic equity partners of MCX's include NYSE Euronext, State Bank of India and its associates, National Bank for Agriculture and Rural Development, National Stock Exchange of India Ltd., SBI Life Insurance Co. Ltd., Bank of India, Bank of Baroda, Union Bank of India, Corporation Bank, Canara Bank, HDFC Bank, Fid Fund (Mauritius) Ltd., ICICI Ventures, IL&FS, Kotak group, Citibank and Merrill Lynch.

A.4.2-b National Commodity and Derivatives Exchanges (NCDEX): Located in Mumbai, the National Commodity and Derivatives Exchange Limited is a professionally managed on-line multi commodity exchange. It is a public limited company incorporated on April 23, 2003 under the Companies Act, 1956. It commenced its operations on December 15, 2003. NCDEX is a nation-level, technology driven de-mutualised on-line commodity exchange with an independent Board of Directors and professional management - both not having any vested interest in commodity markets. It is committed to provide a world-class commodity exchange platform for market participants to trade in a wide spectrum of commodity derivatives driven by best global practices, professionalism and transparency.

Promoter shareholders of NCDEX are Life Insurance Corporation of India, National Bank for Agriculture and Rural Development and National Stock Exchange of India Limited. NCDEX has other shareholders. It is the only commodity exchange in the country promoted by national level institutions. This unique parentage enables it to offer a bouquet of benefits, which are currently in short supply in the commodity markets. NCDEX is regulated by Forward Markets Commission and is subjected to various laws of the land.

NCDEX currently facilitates trading of 57 commodities, major commodities being agricultural commodities like groundnut, basmati rice, wheat, cotton etc. It also offers futures trading in some metals (like aluminium ingot, gold, silver etc) and energy items (like crude oil, furnace oil etc.). It offers trading facilities to its members in about 550 centres in India.

A.4.2-c National Multi Commodity Exchange (NMCE): Headquartered at Ahmedabad, National Multi-Commodity Exchange of India Limited (NMCE) is the first De-Mutualised Electronic Multi-Commodity Exchange of India. It was granted the National status on a permanent basis by the Government of India. It commenced its operation since 26th November 2002. It provides electronic derivatives trading through robust and tested trading platform, Derivative Trading Settlement System, provided by CMC. It is the first national commodity exchange in India. It was established for the public interest rather than the commercial interest. It is the only Commodity Exchange in the world to have received ISO 9001:2000 certification from British Standard Institutions (BSI).

NMCE was promoted by commodity-relevant public institutions, viz., Central Warehousing Corporation, National Agricultural Cooperative Marketing Federation of

India, Gujarat Agro-Industries Corporation Limited, Gujarat State Agricultural Marketing Board, National Institute of Agricultural Marketing, Neptune Overseas Limited and Punjab National Bank. These institutions are represented on the Board of Directors of the Exchange and also on various committees set up by the Exchange to ensure good corporate governance. One unique feature of this exchange is that it is a zero-debt company.

In the very beginning, it provided futures trading in 24 commodities on November 2002 on a national scale. NMCX provides trading in both agricultural as well as non-agricultural commodities. It is the only one exchange which showed a way to introduce warehouse receipt system within existing legal and regulatory frameworks. It was the first Exchange to complete the contractual groundwork for dematerialization of the warehouse receipts.

A. 4.2-d National Board of Trade (NBOT): Located at Indore, NBOT today is one of the fastest growing commodity exchanges recognized by the Government of India under the aegis of the Forward Markets Commission. It was incorporated on July 30, 1999 to offer integrated, state-of-the-art commodity futures exchange in India. It was incorporated to offer transparent and efficient trading platform to various market intermediaries in the commodity futures trade. It has electronic online trading platform which is operated within the 60 kms radius of Indore city. It is the number one trading exchange for soya oil. Within a short span of seven years, NBOT has carved out a niche for itself in the commodities market. With a humble beginning of trading in February 2000 its average daily volume has reached a staggering 60000 mts (approximate) in terms of Soya oil. This exchange does futures trading mainly in three commodities as Soya products (soybean, soy meal, and soyoil), mustard products and crude palm oil. It has implemented the state-of-the-art technology and system for efficient handling of Trading, Margining, Clearing and Settlement in respect of all the transactions confirmed by the Exchange. The Board of Directors, adorned by a galaxy of the most respectful personalities drawn from different categories of trade and commerce has been giving necessary impetus and thrust for setting up of the exchange and provide guidance for its proper functioning.

Chapter 5

Empirical Analysis of Financialization of Commodity Market in India

5.1 Introduction

In the previous chapter, we have analyzed the different concepts of financialization of commodity markets, its instruments, etc. In the present chapter, we are going to empirically examine the evidence of financialization of commodity markets in India. We examine the evidence of financialization of commodity market in two ways - first, we examine the relationship between stock price with commodity index price. In the second part, we examine the relationship between commodity spot and futures price in India.

The rest of this chapter is organized in the following sections. Section 5.2 gives the review on some previous studies on the relationship between stock prices and commodity price. In section 5.3, we have provided data and sources. In section 5.4, we have analysed the estimation models that we have used in this chapter. In section 5.5, we have analyzed the estimation results. In section 5.6, we have analysed the estimation results between commodity spot and futures prices. The last section 5.7 summarizes the chapter.

5.2 Review of Some Previous Studies

In this section, we are going to review existing studies on the relationship between stock market and commodity markets. Basically, the relationships between stock market and commodity markets are studied by financial economists and practitioners to carry out better portfolio diversification. There are a very large number of studies available on the relationship between stock prices and exchange rate both for developed and developing countries but very less number of studies is available on the relationship both between stock prices and commodity prices and exchange rate and commodity prices. There are a very few studies which show the dynamic relationship between stock prices, bond and commodity prices in India. Studies like Irwin and Sanders (2011), Falkowski (2013), Mayer (2012) etc. also give reviews on the financialization of commodity markets.

A study by Macdonald and Taylor (1992) in the portfolio balance model states that if prices of domestic stock rise, investors buy more domestic assets rather than selling foreign assets to obtain domestic currency. Increase in demand of domestic currency in one hand will lead to appreciation of domestic currency on the other hand, if the prices of domestic assets rise, it will result in growth of wealth, which will also increase the demand for money by the investors and increase interest rates. Therefore, more foreign capital will flow which will increase the foreign demand for domestic currency and ultimately appreciate the domestic currency. Thus, according to portfolio balance model there is an inverse relationship between stock prices and exchange rate.

Ankrim and Hensel (1993) examined the return of collateralized commodities to determine whether the returns had been competitive, and verified their low correlation with other financial assets like real estate, stock and bond. They found that the collateralized commodities offered the greatest diversification for stock returns during periods of inflation. They also found that the correlations between the commodities and the S&P500 and the Ibbotson Intermediate Government Bonds Index were generally low and collateralized commodities had experienced competitive returns and appeared to offer good diversification opportunities.

Empirical studies on the relationship between commodity prices and stock prices are quite interesting as these studies are contradictory to each other. Some studies like Jurion (1990), Bartov and Bodnar (1994), Franck and Young (1972), Solnik (1987), Chow et al. (1997), and Bhattacharya and Mukherjee (2003), Bahmani and Sohrabian (1992), Neih and Lee (2001) found that there was no significant relationship between stock market and exchange rate. Some other studies like Aggarwal (1981), Giovannini and Jurion (1987), Roll (1992), etc. found that there was a significant positive relationship between the variables. But some other studies like Soenen and Hennigar (1988) found that there was a strong negative correlation between stock market and exchange rate.

Jensen et al. (2000) examined whether commodity futures was in efficient use in the portfolio diversification. Therefore, they had comprised commodity futures with stocks, bonds, T-bills and real estate for the period of 1973-1997. They found dramatically different results when they used a simple ex-ante measure of monetary stringency to dichotomize the sample period into expensive-versus-restrictive monetary policy periods. In restrictive monetary policy, commodity futures are shown to have substantial weight in the efficient portfolios, with significant return enhancement at all levels of risk. But in expensive monetary policy period, commodities futures are shown to have little or no weight in the efficient portfolios, with no return enhancement at all levels of risk.

Lee et al. (1985) examined whether commodity futures market provide diversification for the underlying stock market and there were arbitrage possibilities between stock and commodity markets resulting from lead-lag relations. They found that there was no relationship between the rates of return of the two series. Risk and return increased with time horizon, whereas skewness and kurtosis were generally negatively related to horizon. The lead-lag relationship shows that two series were independent. Therefore, the results suggested that commodity futures might be used in conjunction with an equity portfolio to help reduce risks and enhance portfolio returns.

Miffre and Rallis (2007) investigated whether the short-term price continuation and the long-term mean reversion identified in equity markets were present in commodity futures market. They also looked at the performance of 56 momentum and contrarian strategies in commodity futures market. They found that the momentum returns were less correlated with the returns of traditional asset classes, making commodity futures relatively strength portfolios for inclusion in well-diversified portfolios. The momentum strategy bought backwardated contracts and sold contangoed contracts, which implicitly suggests that a momentum strategy that consistently trades the most backwardated and contangoed contracts is likely to be profitable.

Carter et al. (1983) evaluated the portfolio interpretation of futures market investment risk but they mainly focused on the generalization of the Keynesian notion of a risk premium provided by the capital asset pricing model (CAPM). They found that there was significant and positive systematic risk for a number of futures contracts. They also found that for an efficient portfolio, an application of CAPM model for changing speculative position was supported by the generalized Keynesian theory of normal backwardation.

Over the years, there had been increasing studies in the financial literature in the support of portfolio diversification in which commodity futures was an addition to the existing portfolio diversification instruments. But there are very few empirical studies which have examined whether the benefits are indeed statistically significant. Cheung and Miu (2010) examined several issues on potential diversification benefits of commodities. They found that there were diversification benefits existing and were statistically significant in the long-run. There was also regime-switching in commodity futures like most other asset classes but with low (high) return environment for commodity futures, it was also associated with low (high) volatility. Commodity futures are an asset class far more suitable for conservative investors with relatively high-risk aversion.

Scruggs and Glabadanidis (2003) investigated whether intertemporal variation in the market risk premium could be explained by time-varying covariances with priced risk factors. They estimated a conditional bi-factor variant of Merton's ICAPM in which excess returns on an equity index and a long-term government bond portfolio proxy for risk factors. They found that both stock and bond risk premia were liner functions of time-varying covariances with the two risk factors. The conditional bond variance responded symmetrically to bond return shocks but was virtually unaffected by the stock return shocks but conditional stock variance responded asymmetrically to both stock and bond return shocks. The conditional bi-factor model failed to adequately explain intertemporal variation in stock and bond risk premia.

Steeley (2006) examined a theoretical link between stock and bond market volatility using a two-factor no-arbitrage model. They found that short-term interest rate volatility might drive both stock and bond market volatility but pat bond market volatility affected both markets and fed back into short-term yield volatility. The time-varying correlation structure in the stock and bond markets showed reversed correlation over the last 20 years which is important implications for portfolio selection in financial markets.

Barsky (1989) tried to explore the possible roles of increased risk and reduced productivity growth in bond and stock prices in a simple general equilibrium model. He found that the effects of disturbances on the riskless rate were unambiguous, but that stock prices might rise or fall contrary to the earlier work. Both disturbances unambiguously lower the riskless interest rate, but causes stock market to respond perversely depending on the degree of aversion to intertemporal substitution and the share of the corporate sector in total wealth.

Baur and Lucey (2008) examined whether flight-to-quality and flight-from quality exists in stock and bond market, and what were the effects of flights on diversification and the stability of the financial system. They found that flights were a common feature in crisis periods and often occur simultaneously across countries. This simultaneity provides indirect evidence for cross-country contagion.

Baur and McDermott (2009) examined whether gold was a safe haven against stocks of major emerging and developing countries over a sample period of 30 years from 1979-2009. They found that gold was performed both as a hedge and a safe haven for major European stock markets and the US but not for Australia, Canada, Japan and large emerging markets such as BRIC countries. Gold also acts as a stabilizing force for the financial system by reducing losses in the face of extreme negative market shocks. During the peak of the financial crisis, gold was a strong safe haven for most of the developed markets.

Fleming et al. (1998) said that the study on the nature of volatility linkages between markets was important for a variety of investment and risk management decisions. Therefore, they examined the nature of volatility linkages in the stock, bond, and money markets. To examine the nature of volatility linkages, they estimated a stochastic volatility model such as GMM model. They found that the volatility linkages across stock, bond and money market were very strong since 1987 stock market crash.

Piplack and Straetmans (2010) examined the linkages between four different US asset classes, i.e., US stocks, government bonds, T-bills and gold in times of market turbulence or crisis periods and the linkages were characterized by their tail dependence. They used extreme value analysis to assess the bivariate exposure of one asset class to extreme movements in the other asset classes. They found that the bivariate extreme linkages estimates displayed time variation for certain asset pairs, caused by exogenous factors like oil shocks or shifts in monetary policy.

Sadorsky (1999) showed the relationship between oil price shocks and the stock market activity along with which he also examined the interaction between oil prices and economic activity. He found that oil prices and volatility both played an important role in affecting economic activity. The changes in oil prices impacted economic activity but changes in economic activity had little impact on oil prices. Oil price movements were important in explaining movements in stock returns. There was also evidence that oil price volatility shocks had asymmetric effects on the economy.

Sanders et al. (2008) expressed skepticism about the assertion that speculation had led to bubbles in agricultural futures prices. Other authors share somewhat different views. Robles et al. (2009) identified speculative activity in the futures market as a source of the 2007/08 agricultural commodity price increases. In the non-ferrous metals market, Gilbert (2007) found no direct evidence of the impact of investor activity on the prices of metals, but found strong evidence that the futures positions of index providers had affected the prices of soybeans (though not of maize) in the US futures exchanges. Perhaps, the strongest evidence was a subsequent study by Gilbert (2010), who concluded that "by investing across the entire range of commodity futures, index based investors appear to have inflated food commodity prices."

The increase in long speculative positions was surpassed by an increase in short hedging in commodity markets (Sanders et al., 2008), financial investment in commodity trading appears to have caused prices might deviate, at least in the short run (Mayer, 2009), index speculators frustrated the futures market (Van der Molen, 2009), the recent wide fluctuations of commodity prices had been driven by the financialization of commodity markets (UNCTAD, 2009).

The above review has shown that most of the studies have found that the relationship between two or three variables such as relationship stock market and exchange rate, stock market and commodity market, stock market or bond market, etc. But the results are different from each other. While some studies are showing the positive relationship, some other studies are showing negative relationship. Some studies are showing that there is no relationship between these variables. There are very few studies available which examined commodity futures market as alternative investment asset to stock market not only for developed countries but also for developing and emerging countries like India. Therefore, in this chapter, the main focus is on examining the Indian commodity futures market as an alternative investment portfolio asset than stock market.

5.3. Data and Sources

We have already mentioned that this study is using monthly data for both commodity price and stock price from the period January 2001 to June 2012 (i.e., sample period is 138 months). The specific variables are S&P CNF Nifty future index collected from National Stock Exchange (NSE) of India and commodity indexes (agri, energy, metal and all commodity indexes) of India. The specific commodity indexes are constructed by taking the respective index prices from the RBI Hand Book of Statistics. Though, in the National Stock Exchange (NSE), S&P CNX Nifty price is available in daily basis, so we have taken each month's end price to consider it as the monthly price of the particular month. The composition and construction of commodity indexes are shown in Appendix A.5.1.

5.4 Methodology Description[1]

The study uses the econometric techniques like the Granger-Causality to examine stated objectives. A variable X Granger-causes Y if the past changes of X could help to predict current changes of Y. If X Granger-causes Y and not vice versa, it is called unidirectional

[1] This section draws upon Tsay (2010), and Engle and Kroner (1995).

causality. If X Granger causes Y and Y also Granger causes X, it would be said that there is bi-directional causality between these two variables (Brooks 2002).

When we conduct Granger causality tests, two cases should be considered depending on whether the variables are cointegrated or not.

(a) If the variables are not cointegrated, the following VAR estimation equations in the first differences are tested.

$$\Delta Y_t = \sum_{j=1}^{n} b_j \Delta X_{t-j} + \sum_{j=1}^{n} c_j \Delta Y_{t-j} + \varepsilon_{t-1} \quad (5.1)$$

$$\Delta X_t = \sum_{j=1}^{n} b_j^* \Delta Y_{t-j} + \sum_{j=1}^{n} c_j^* \Delta X_{t-j} + \varepsilon_{t-1}^* \quad (5.2)$$

(b) If the variables are cointegrated, the following error correction models (ECM) are tested.

$$\Delta Y_t = \sum_{j=1}^{n} b_j \Delta X_{t-j} + \sum_{j=1}^{n} c_j \Delta Y_{t-j} + \varphi e_{t-1} + w_t \quad (5.3)$$

$$\Delta X_t = \sum_{j=1}^{n} b_j^* \Delta X_{t-j} + \sum_{j=1}^{n} c_j^* \Delta Y_{t-j} + \varphi e_{t-1}^* + w_t \quad (5.4)$$

Let ΔY_t and ΔX_t denote the stock returns of country x and country y, respectively. $e_{t-1}$and e_{t-1}^*, are the lagged residuals from two equations in case (a).The null hypothesis for the Granger test in the above equations is 'X does not cause Y' (all b_j=0), the alternative hypothesis is 'X causes Y' (at least one $b_j \neq 0$ and all b_j^*=0). If the null hypothesis is rejected, the conclusion that X Granger- causes Y is obtained (Roca, 1999). The reason to use ECM to test the causality between cointegrated variables is that regressing on the first difference cointegrated variables could lead to misspecification error.

It should be noted that Granger-causality really represents only a correlation between the current value of one variable and the previous values of others. It does not mean that movements of one variable cause movements of another (Brooks 2002). Moreover, although causality in VAR examines whether the current value of variable X can be explained by the past values of variable Y, it still does not explain the sign of the relationship or how long these effects last.

5.4.1 GARCH (1,1)-BEKK Model

According to Chong and Miffre (2008), the strategic decision on a well-diversified portfolio is not based solely on the temporal risk-return characteristics of the contracts. But the decision also depends on how an asset, say, commodity futures correlate with the rest of the portfolio over time. Therefore, to study the volatility spillover between the variables, the present study uses the Generalized Autoregressive Conditional Heteroscedasticity of BEKK Model (named after Baba, Engle, Kraft and Kroner, 1990). It is explained in the following.

In conventional econometrics models, the variance of the error terms is assumed to be constant (homoskedasticity) over time. But it is unlikely in the context of the financial time series. Many financial time series have exhibited the property of long-memory, i.e., the presence of statistically significant correlations between observations that are a large distance apart (Harris and Sollis, 2003). Another distinguishing feature of the financial time series is known as volatility clustering, i.e., large (small) volatility followed by large (small) volatility. In other words, the current level of the volatility is positive with its level during the immediately preceding periods (Brooks, 2002).

Engle (1982) developed the ARCH (Autoregressive Conditional Heteroscedasticity) model that allows for the conditional variance to be time-varying. However there are some limitations for ARCH (q) model. Bollerslev (1986) extended the ARCH model to a more general one – GARCH (Generalized Autoregressive Conditional Heteroscedasticity), which allows for the conditional variance to be dependent upon previous own lags.

However, some researchers are interested in quantifying the interactions between the volatility of *N* different financial time series. In this context, the multivariate GARCH models are utilized instead of univariate counterparts. In multivariate GARCH models, considering a stochastic vector series rt with a dimension of (N×1), the conditional mean of rt is an (N×1) vector μt and the conditional covariance of rt is an (N×N) matrix Ht. Let It−1 denotes the information set generated by the past information until time t-1 and θ is a finite vector of parameters (Bauwens et al. 2006).

A traditional approach to testing volatility spillovers is to estimate a GARCH model and to test the significance of the parameter estimates. A popular type of multivariate GARCH model used to examine volatility spillover effects is the BEKK model, which ensures the positive semi-definite property of the variance-covariance matrix. The purpose of estimating a BEKK-GARCH model using futures price returns is to compare our results from the VAR model with those from the traditionally used method. A BEKK model can be written as the following:

$$[r_t] = \mu_t(\theta) + \varepsilon_t \tag{5.5}$$

where, $\mu_t(\theta)$ is the conditional mean vector and

$$\varepsilon_t = H_t^{1/2}(\theta) Z_t \tag{5.6}$$

where, $H_t^{1/2}(\theta)$ is positive definitive matrix and Z_t is aasumed to be I.I.D vector Nx1,

$$\text{with } E(Z_t) = 0 \; and \; Var(Z_t) = I_N \tag{5.7}$$

Depending on the formulation of Ht, several different multivariate GARCH models have been developed. In the BEKK model, the H_t matrix is C′C+Ai′εt−1′εt−1Ai+Bi′Ht−1Bi, which can be written as,

$$H_t = C'C + A_i'\varepsilon_{t-1}'\varepsilon_{t-1}A_i + B_i'H_{t-1}B_i \tag{5.8}$$

where C is N×N upper triangular matrix of constants, while Ai and Bi are N×N matrices of parameters. We focus on a GARCH (1,1) specification since it is considered to be a parsimonious representation of conditional variance that can adequately fit many econometric time series (Tim Robert et al., 1988). In the case of two variables (N=2) and p=q=1, the above equation can be written out in the following.

$$\begin{bmatrix} h_{11,t} & h_{12,t} \\ h_{21,t} & h_{22,t} \end{bmatrix} =$$

$$\begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix}\begin{bmatrix} c_{11} & 0 \\ c_{12} & c_{22} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}\begin{bmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{1,t-1} \\ \varepsilon_{1,t-1}\varepsilon_{1,t-1} & \varepsilon_{1,t-1}^2 \end{bmatrix}\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} +$$

$$\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}\begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix}\begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \tag{5.9}$$

The symmetric matrix A captures the ARCH effects, the elements aij of the symmetric matrix A measure the degree of innovation from market *i* to market *j*. While the matrix B focus on the GARCH effects, the elements bij in matrix B represent the persistence in conditional volatility between market *i* and market *j* (Worthington and Higgs, 2004). In other words, the diagonal parameters in matrices A_i and B_i– a_{11} ,a_{22} and b_{11} ,b_{22} capture the effects of own past shocks and volatility on its current conditional variance. The off-diagonal parameters in matrices Ai and Bi, a_{ij} and b_{ij}, measure the cross-market influences on the conditional variances and covariances, which is also known as ‘volatility spillover ‘effects.

Under the assumption of conditional normality, the parameters of the multivariate GARCH model can be estimated by maximizing the log likelihood function.

$$L(\vartheta) = -\frac{TN}{2} log 2\pi - \frac{1}{2}\sum_{i=1}^{t}[\log(H_t) + \varepsilon_t' H_t^{-1}\varepsilon_t] \tag{5.10}$$

where, θ denotes all the unknown parameters to be estimated. N is the number of the series in the system and T is the number of the observations. This log likelihood function is maximized by using the BHHH (Berndt, Hall and Hausman, 1974) algorithm.

5.5 Analysis of Estimated Results

5.5.1. Unconditional Correlation and Volatility

In relation to the analysis of the estimated results, we can quote the UNCTAD Trade and Development Report (2008, p.67). This report mentioned that "the positive correlation between commodity and equity prices during the period from 2005 to 2008 suggests that financial investors may have had a strong influence on commodity prices".

The other existing literature viewed that the commodity futures markets provide an excellent asset allocation forum, where traders in futures market could easily switch investment funds from stock to commodity to take advantage when market has short-term and long-term moving trends. For example, traders take position in stock market when those financial markets are outperforming the commodity market. Alternatively, they take positions in commodity futures market when the financial markets start to slip, and commodity market begins to outperform them. Generally, during the period of high inflation or any financial turbulence, traders take position in the commodity market and vice versa.

In Table-5.1, we have reported the descriptive statistics of commodity price indices and also the stock price index for the three periods, i.e., (i) full sample period, from January 2001 to June 2012, (ii) pre-crisis period from January 2001 to September 2008, and (iii) post-crisis period from November 2008 to June 2012. Data (in block I) show that stock price provides higher average return (5.61%) than the commodity price indices but stock price provides the highest variation/volatility (11.34%) during the full period. Among the commodity index prices, energy price has the highest average return (4.82%) with the highest volatility (5.22%). Similarly, food index price has the lowest average return (4.72) with the lowest price variation/volatility (3.89%). The skewness and kurtosis result in the full sample period show that IAC, IAGRI and IMETAL price indices are positively skewed, whereas the IENERGY price index and stock price index are negatively skewed.

In the pre-crisis period also (block II in Table 5.1), stock price index gave the highest average return (5.33%), followed by the IENERGY price (4.72%). Similarly, during this period also, the IAGRI provides less return (4.60% with less variation/volatility (1.77%) compared to other price indices. The skewness results indicate that all are positively skewed but IAGRI is more leptokurtic than the normal distribution.

In the post-crisis period (shown in block III of Table 5.1), stock price index provided more average return (2.68%) and also more price variation/volatility (3.63%) compared to all commodity price indices. Among the commodity price indices, IENERGY price was the most volatile (3.03%). The IAGRI price index gave more average price return (2.20%) with less volatility (2.60%). The skewness and kurtosis results indicate that IAC, IMETAL and stock price indices are negatively skewed, whereas IAGRI and IENERGY price are positively skewed in the study period.

In Table-5.2 (block I to III), we have reported the unconditional return correlations between commodity index prices with stock index price. As existing studies have said that stock returns have a very low correlation with commodity return, here we find that high correlations between commodity index prices and stock price index in India. Estimated results in Table-5.2 indicate that there is positive correlation between commodity prices and stock prices.

5.5.2 Analysis of Unit Root Test

Table-5.3a and Table-5.3b have reported the Unit Root test of Augmented Dickey Fuller test (ADF) and Phillips Perron Test (PP). Table 5.3a show the results of ADF at their level values as well as first difference values of only intercept and intercept with trend for the three periods. It can be seen that the values of intercept and intercept with trend in the three periods are non-stationary but at the first difference, all selected variables are stationary at intercept and also intercept with trend in the three periods.

In the same way, Table-5.3b shows the Unit Root test of PP test. Table-5.1b reports the results of PP test at their level values as well as first difference values of only intercept and intercept with trend for the three periods. It can be seen that the values of intercept and intercept with trend in the three periods are non-stationary but at the first difference, all the selected variables are stationary at intercept and also intercept with trend in the three periods. Therefore, it can be said that the selected study variables are non-stationary at their level values in the three periods but they are stationary in the first difference.

Table 5.1: Descriptive Statistics of Selected Variables

I: 2001M01 - 20012M06	Mean	Std. Dev.	CV	Skewness	Kurtosis
IAC	4.77	0.21	4.40	0.23	2.02
IAGRI	4.72	0.18	3.89	0.61	2.16
IENERGY	4.82	0.25	5.22	-0.05	1.99
IMETAL	4.82	0.21	4.39	0.38	2.16
STOCK	5.61	0.64	11.34	-0.38	1.62
II: 2001M01 - 2008M09					
IAC	4.66	0.14	2.91	0.10	1.79
IAGRI	4.60	0.08	1.77	0.01	2.22
IENERGY	4.70	0.20	4.19	0.06	1.69
IMETAL	4.72	0.16	3.30	0.46	1.53
STOCK	5.33	0.59	11.06	0.20	1.63
III: 2008M10 - 2012M06					
IAC	2.15	0.04	2.05	-0.38	-1.28
IFOOD	2.20	0.06	2.60	0.15	-1.20
IAGRI	2.18	0.07	3.03	0.38	-1.67
IMETAL	2.18	0.05	2.25	-0.12	-1.46
STOCK	2.68	0.10	3.63	-1.54	1.28

Source: Author's Estimation

Table 5.2: Correlation between Commodity Prices with Stock Price

I: 2001M01 - 20012M06					
Variable	IAC	IAGRI	IENERGY	IMETAL	STOCK
IAC	1.00				0.91
IAGRI		1.00			0.84
IENERGY			1.00		0.93
IMETAL				1.00	0.90
STOCK	0.91	0.84	0.93	0.90	1.00
II: 2001M01 - 2008M09					
IAC	1.00				0.95
IAGRI	0.97	1.00			0.91
IENERGY	0.99		1.00		0.94
IMETAL				1.00	0.96
STOCK	0.95	0.91	0.94	0.96	1.00
III: 2008M10 - 2012M06					
IAC	1.00				0.67
IAGRI		1.00			0.80
IENERGY			1.00		0.54
IMETAL				1.00	0.41
STOCK	0.67	0.80	0.54	0.41	1.00

Source: Author's Estimation

After examining the unit root test, we have estimated the Johansen cointegration test for the selected variables. Results are reported in Appendix A.5.2a to A.5.3c. It is found that there is no long-term relationship between the selected variables. Therefore, to know the short-run relationship between these variables, we have estimated the causality test and analysis results are given in the following section.

Table 5.3a: Augmented Dickey Fuller Unit Root Test Results

	2005M06-2012M12				2005M06-2008M07				2008M07-2012M06			
	Int		Int with Trend		Int		Int with		Int		Int with Trend	
Variable	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff
SComdex	-1.33	-7.70*	-2.97	-7.66*	-1.08	-6.22*	-2.51	-6.11*	-1.61	-5.92*	-3.23	-5.95*
SAGRI	-0.080	-8.78*	-1.51	-8.77*	-2.23	-6.12*	-1.27	-4.85*	0.14	-6.58*	-2.10	-6.80*
SENERGY	-3.21	-7.43*	-3.24	-7.38*	-0.44	-5.16*	-1.15	-5.21*	-3.29	-5.60*	-3.37	-5.60*
SMETAL	-1.47	-8.91*	-2.24	-8.89*	-2.01	-5.40*	-1.97	-5.87*	-0.43	-7.48*	-2.03	-4.26*
FComdex	-1.57	-7.44*	-3.48	-7.40*	-1.32	-1.98*	-2.56	-1.96*	-0.85	-5.64*	-1.70	-5.65*
FAGRI	-1.24	-10.60*	-2.63	-10.54*	-2.26	-6.77*	-1.66	-4.97*	-1.01	-8.53*	-3.54	-8.47*
FENERGY	-2.85	-6.49*	-3.24	-6.45*	-0.63	-5.15*	-1.30	-5.15*	-2.89	-4.58*	-3.11	-4.55*
FMETAL	-1.58	-8.86*	-2.36	-8.85*	-2.92	-5.95*	-2.18	-6.50*	-0.39	-7.53*	-2.12	-5.07*

Source: Author's Estimation

Notes: a. Critical values for unit root test (ADF & PP) are: -3.49 and -4.10 (without trend) and -4.04, -4.10 (with trend) respectively at 1% level and 5% levels

b. * and ** represent significant at 1% and 5% levels respectively.

Table 5.3b: Phillips Perron Unit Root Test Results

	2005M06-2012M12				2005M06-2008M07				2008M07-2012M06			
	Int		Int with Trend		Int		Int with		Int		Int with Trend	
Variable	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff
SComdex	-1.57	-7.81*	-2.68	-7.76*	-1.05	-6.22*	-2.03	-6.11*	-1.21	-6.04*	-2.13	-6.01*
SAGRI	-0.08	-8.77*	-1.56	-8.77*	-2.23	-6.12*	-1.06	-8.03*	0.141	-6.69*	-3.15	-6.88*
SENERGY	-2.75	-7.48*	-3.00	-7.44*	-0.52	-5.15*	-1.23	-5.08*	-2.15	-5.56*	-2.22	-5.57*
SMETAL	-1.47	-8.91*	-2.34	-8.89*	-2.15	-5.80*	-1.88	-6.03*	-0.52	-7.47*	-2.12	-7.54*
FComdex	-1.63	-7.43*	-2.75	-7.39*	-1.20	-6.15*	-2.4	-6.00*	-1.23	-5.69*	-2.15	-5.66*
FAGRI	-1.09	-10.85*	-2.58	-10.77*	-2.19	-7.00*	-1.4	-12.7*	-0.92	-8.50*	-3.43	-8.43*
FENERGY	-2.68	-6.47*	-2.98	-6.44*	-0.63	-5.04*	-1.3	-4.97*	-2.21	-4.58*	-2.28	-4.55*
FMETAL	-1.58	-8.86*	-2.39	-8.84*	-2.70	-5.85*	-1.96	-6.31*	-0.47	-7.51*	-2.19	-7.59*

Source and Notes: Same as in Table 5.3a

5.5.3 Analysis of Pair wise Causality Tests

Since the main aim of this chapter is to look whether there is any financialization of commodity markets in India, therefore, to examine this we have estimated the Granger causality test between commodity price indices and the stock price index. Estimated results are reported in Table 5.4 (block I to III).

In Table-5.4 (block I), there are two null hypotheses: first one is that ‘stock index price does not cause IAC index price’, whereas the alternative hypothesis is ‘stock index price causes IAC index price’. The second null hypothesis is ‘IAC index price does not cause stock index price', whereas the alternative hypothesis is 'IAC index price causes stock index price' and similarly for other three variables. If we look at the estimated results, the null hypothesis, i.e., the stock index price does not cause IAC index price is rejected at 10% significance level but the second null hypothesis cannot be rejected. Therefore, there exists only one way causality from stock price to IAC price. In case of IAGRI price index, both the null hypotheses cannot be rejected which means that there is no relationship between stock price and the IAGRI price, which suggests that the price changes are not related with each other. Similarly, the first null hypothesis of IENERGY index price is rejected at 1% significance but the second hypothesis cannot be rejected. Therefore, there is one way causality, i.e., from stock price to IENERGY price. In the case of IMETAL, the first null hypothesis is rejected at 5% significance level, whereas the second hypothesis cannot be rejected. Therefore, there is only one-way causality from the stock price to IMETAL price in India.

In Table-5.4 (block II), the first null hypothesis, i.e., stock index price does not causes IAC can not rejected but the second null hypothesis, i.e., IAC does not cause stock price is rejected at 1% significance level. Therefore, it can be said that IAC index price causes stock price in the period from January 2001 to September 2008. In the case of IAGRI, the first null hypothesis, stock price does not cause IAGRI price, is not rejected but the second null hypothesis i.e. IAGRI price does not cause stock price is rejected at 5% significance level. This means that there is causality from IAGRI price to stock price in India. Likewise, the null hypothesis of stock price does not cause IENERGY price is not rejected but the second hypothesis is rejected at 5% significance level. It suggests that, there is causality IENERGY price to stock price. In the case of IMETAL price index, the null hypothesis of stock price does not cause IMETAL, is rejected but the null hypothesis of IMETAL does not cause stock price, cannot be rejected. Hence, there exists only one-way causality from stock price to IMETAL price in India.

In Table-5.4 (block III), we have reported the Granger causality test for the post-crisis period, i.e., for the period from November 2008 to June 2012. The first null hypothesis, i.e., stock index price does not cause IAC price, is rejected at 1% significance level. But the second hypothesis is not rejected. Therefore, it can be said that stock price causes IAC index price in the post-crisis period i.e. from September 2008 to June 2012. Similarly, the null hypothesis of stock price does not cause IAGRI price is not rejected but the null hypothesis of IAGRI price does not cause stock price is rejected at 1%

significance level. Hence, there is causality from IAGRI to stock price in the period from July 2008 to June 2012. The null hypothesis, i.e., stock price does not cause IENERGY index price is rejected at 10% significance level. Therefore, there is one-directional causality between IENERGY with stock price, i.e., from stock price to IENERGY price in the period from July 2008 to June 2012. But, the null hypothesis of stock price does not cause IMETAL price is rejected at 1% significance level. Hence, there is only one directional causality, i.e., from stock to IMETAL in the period from January 2001 to July 2008.

Table 5.4: Granger Causality Test

I : 2001M01 - 2012M06			
Null/Alternative Hypothesis	Chi-sq	Prob.	YES/NO
Stock Index price does not cause IAC Index Price	3.34	0.07	YES
IAC Index price does not cause Stock price	0.53	0.47	NO
Stock Index price does not cause IAGRI Index Price	1.06	0.30	NO
IFOOD Index price does not cause Stock price	0.72	0.40	NO
Stock Index price does not cause IENERGY Index Price	9.62	0.01	YES
IENERGY Index price does not cause Stock price	0.95	0.62	NO
Stock Index price does not cause IMETAL Index Price	8.32	0.04	YES
IMETAL Index price does not cause Stock price	0.41	0.94	NO
II : 2001M01 - 2008M09			
Stock Index price does not cause IAC Index Price	0.39	0.82	NO
IAC Index price does not cause Stock price	13.66	0.00	YES
Stock Index price does not cause IAGRI Index Price	1.44	0.82	NO
IFOOD Index price does not cause Stock price	13.66	0.00	YES
Stock Index price does not cause IENERGY Index Price	0.31	0.32	NO
IENERGY Index price does not cause Stock price	8.51	0.00	YES
Stock Index price does not cause IMETAL Index Price	9.99	0.02	YES
IMETAL Index price does not cause Stock price	3.62	0.21	NO
III : 2008M10 - 2012M06			
Stock Index price does not cause IAC Index Price	7.49	0.01	YES
IAC Index price does not cause Stock price	0.00	0.97	NO
Stock Index price does not cause IAGRI Index Price	1.48	0.22	NO
IFOOD Index price does not cause Stock price	3.37	0.07	NO
Stock Index price does not cause IENERGY Index Price	28.80	0.00	YES
IENERGY Index price does not cause Stock price	1.29	0.26	NO
Stock Index price does not cause IMETAL Index Price	14.42	0.00	YES
IMETAL Index price does not cause Stock price	0.05	0.82	NO

Source: Author's Estimation

5.5.4 Volatility Spillover Analysis

Volatility spillovers between cross markets, i.e., commodities and stock markets may improve the chances for speculators to shift their investments from one market to another. Therefore, in this section, we have used bivariate GARCH (1, 1)-BEKK model to effectively capture the own and cross-market volatility spillovers between stock markets and commodity markets in India. We have reported the BEKK results for three periods, i.e., (i) full sample period from January 2001 to June 2012, (ii) first sub-sample period from January 2001 to September 2008 and (ii) second sub-sample period from October 2008 to June 2012. These results are reported in the Tables-5.5 to 5.8. The estimated BEKK results are categorized into two types: mean equations where mean co-efficient results are only reported. Secondly, we have reported the variance equations coefficients, where, the own-volatility spillover effects as well as cross-volatility spillover effects are reported.

In Table-5.5 (block I to III), we have reported the BEKK results of IAC with stock price for the three periods. Table-5.5a shows that the two mean coefficients (0.557 and 1.292) are significant at 1% and 10% significance level respectively. But in GARCH-BEKK model estimation results, it is very important to analyze the variance equation coefficients because these coefficients value talk about the volatility spillover between variables. So, in Table-5.5a, variance coefficients have three types of co-efficients - constant coefficients, own-volatility coefficients and cross market volatility.

The constant co-efficient C(2,1) is significant at 1% significance level. Unfortunately, the own-volatility spillover effect, namely A (1, 2), is insignificant at 10% significant level. But if we look at the cross market volatility spillovers between commodity and stock price, B(2,1) is significant at 1% significance level, which means that there is volatility spillover from the stock market to the IAC but the reverse, i.e., B(1,2), is not significant. Therefore, there is only one way volatility spillover effect from the stock market to the IAC market for the period from January 2001 to June 2012.

If we look at the mean coefficients for the pre-crisis period, i.e., from January 2001 to September 2008 (Table5.5, block II), the mean1 and mean2 coefficients (0.413 and 1.652) are significant at 1% significance level. The own volatility coefficients A(2,1) and A(2,2 values (0.026 and 0.283) are significant at 5% significance level. The cross-market volatility coefficients B(1,2), B(2,1) values (-8.559 and 0.101) are significant at 1%

significance level. This means that there exists bi-directional cross market volatility between stock market with IAC in the period from January 2001 to September 2008.

In the same manner, if we look in Table-5.5 (block III), the mean1 coefficient is significant at 1% significance level. The own volatility spillover effects A (2, 1) and A (2, 2) are insignificant at 1% significance level. The cross market volatility coefficients B(1,1), B(1,2), B(2,1) and B(2,2) are significant at 1% significance level. This means that there are cross market volatility between stock market to IAC and IAC to the stock market in the pre-crisis period, i.e., from November 2008 to June 2012.

In Table-5.6 (block I), we have reported the BEKK-GARCH (1,1) results for IAGRI with stock price. At first, we have reported the mean coefficients and it shows that mean1 is significant at 1% significance level. The constant coefficients C(1,1) is significant at 1% significance level. The own volatility spillover coefficients A(1,1), A(1,2), A(2,1) and A(2,2) are not significant. The cross market volatility spillovers between commodity and stock price B(1,2) and B(2,1) are not significant, which means that there is no cross market volatility spillover between stock market and the IAGRI market for the period from January 2001 to June 2012.

By the by, if we look at the Table-5.6 (block II), the mean coefficients (0.287 and 2.231) are significant at 1% significance level. In the variance equation coefficients, the constant coefficient (C(2,1) is significant at 1% significance level for the period from January 2001 to July 2008. The own-volatility coefficients A(1,1), A(1,2) and A(2,2) values are insignificant at 1% and 5% significance level. The cross market volatility coefficients B(1,2) and B(2,1) are not significant which means that there is no cross market volatility between IAGRI and stock price in the period from January 2001 to September 2008. This means that financial investors are not interested to invest in the food items.

Similarly, in Table-5.6 (block III), we have reported the BEKK-GARCH(1,1) coefficients for the post-crisis period, i.e., for the period from November 2008 to June 2012. The mean1 coefficient value 0.63 is significant at 10% significance level. In the variance equations, the constant coefficient C(1,1) and C(2,2) are significant at 1% and 10% significance level respectively. The variance coefficients for the period from November 2008 to June 2012, the own volatility spillover effects A (2, 2) is insignificant at 1% level but the co-variance of A (1, 2) coefficient values is not significant. the cross market volatility coefficients B(1,2) coefficient value (2.244) are significant at 1% level but B(2,1) coefficient value is insignificant which means that there is volatility spillovers from IAGRI to stock market but opposite is not possible for the period from November 2008 to June 2012.

In the case of IENERGY (Table-5.7, block I), for the period from January 2001 to June 2012, mean co-efficient (0.584 and 1.510 are significant at 1% significance level. The own-volatility coefficient A(1,1) is significant at 1% significance level but A(2,2) is also significant, which means that there is own price volatility spillover. The cross market volatility coefficients B(1,2) and B(2,1) values (-1.676 and -0.087) are significant at 1% significance level which means that there are bi-directional cross market volatility spillovers from stock market to IENERGY market and vice versa.

If we look at Table-5.7 (block II), the mean co-efficients 0.728 and 1.278 are significant at 1% and 5% significance level respectively. In the variance coefficient, the constant coefficients C(1,1), C(2,1) and C(2,2) are significant at 1% and 5% significance level respectively. The own-volatility spillovers A(1, 1), A(1,2), A(2,1) and A(2,2) values are insignificant. The cross market volatility coefficients B(1,2) are insignificant and B(2,1) are significant at 1% level. This means that there is cross market volatility from stock market IENERGY but not from IENERGY to stock price for the period from January 2001 to September 2008.

If we look at the variance coefficients for the period from November 2008 to June 2012 (Table-5.7, block III), mean coefficients 0.437 and 2.715 are significant at 1% significance level. The own volatility spillover effects A (1, 1) is (-0.597) significant at 1% significance level but the co-variance of A (2,1) is (0.17) also significant. The cross market volatility coefficients B(1,1) and B(2,1) values (0.449 and 0.058) are significant at 1% significance level which means that there is cross volatility spillovers from stock market to IENERGY market but it is not from IENERGY to stock market for the period from August 2008 to June 2012.

In Table-5.8 (block I), the mean1 coefficient 0.374 is significant at 1% significance level. Constant coefficients C(1,1), C(2,1) values (0.15) and (-7.089) are significant at 5% and 1% significance level. The own-volatility coefficients A(1,1) is significant at 1% level. The cross market volatility coefficients B(2,1) value (0.093) is significant at 1% significance level. This means that there is cross market volatility spillover between stock market and the IMETAL market for the period from January 2001 to June 2012.

If we look at the Table-5.8 (block II), the mean1 coefficient value 0.371 is significant at 1% significance level. The own-volatility spillover coefficient A(1,1) and A

(2,2) coefficient values are significant at 1% significance level. The cross market volatility coefficients B(1,2) and B(2,1) values (2.829 and 0.071) are statistically significant at 10% and 1% significance level which means that there is cross market volatility existing between stock market with IMETAL market for the period from January 2001 to July 2008.

Similarly, If we look at the variance coefficients for the period from August 2008 to June 2012 (Table-5.8, block II), the own-volatility spillover effects A(1,1) is insignificant at 1% level but the own-variance of A (2, 2) coefficient values is not significant. The cross market volatility coefficients B (1, 2) and B (2, 1) values (-3.031 and 0.035) are significant at 1% and 10% significance level. This suggests that there are bi-directional volatility spillovers existing between stock market and IMETAL Market for the period from August 2008 to June 2012.

Table 5.5: GARCH-BEKK Estimation between IAC with Stock Prices

	Variable	Coeff.	Std Error	t-Stat.	Signif.
I: 2001M01 - 2012M06					
Mean Coff.	Mean(1)	0.557	0.105	5.299	0.000
	Mean(2)	1.292	0.727	1.777	0.075
Var. Coff.	C(1,1)	0.275	0.238	1.156	0.248
	C(2,1)	7.178	0.441	16.294	0.000
	C(2,2)	0.000	61.625	0.000	0.962
	A(1,1)	0.078	0.123	0.637	0.524
	A(1,2)	0.497	0.793	0.627	0.531
	A(2,1)	0.031	0.017	1.831	0.067
	A(2,2)	0.226	0.194	1.162	0.245
	B(1,1)	0.325	0.261	1.244	0.214
	B(1,2)	-0.699	1.355	-0.516	0.606
	B(2,1)	0.144	0.028	5.168	0.000
	B(2,2)	-0.302	0.090	-3.335	0.001
II: 2001M01 - 2008M09					
Mean Coff.	Mean(1)	0.413	0.083	4.994	0.000
	Mean(2)	1.652	0.707	2.338	0.019
Var. Coff.	C(1,1)	0.000	0.184	0.000	0.983
	C(2,1)	0.000	3.415	0.000	0.968
	C(2,2)	0.001	3.598	0.000	0.975
	A(1,1)	0.001	0.097	0.013	0.990
	A(1,2)	-1.357	0.819	-1.658	0.097
	A(2,1)	0.026	0.011	2.297	0.022
	A(2,2)	0.283	0.094	2.999	0.003
	B(1,1)	-0.081	0.104	-0.773	0.439
	B(1,2)	-8.559	0.838	-10.212	0.000
	B(2,1)	0.101	0.010	9.735	0.000
	B(2,2)	-0.552	0.096	-5.756	0.000
III: 2008M10 - 2012M06					
Mean Coff.	Mean(1)	0.518	0.180	2.874	0.004
	Mean(2)	0.085	0.895	0.095	0.925
Var. Coff.	C(1,1)	0.000	0.135	0.000	0.951
	C(2,1)	0.000	0.860	0.000	0.963
	C(2,2)	0.000	0.865	0.000	0.964
	A(1,1)	0.009	0.049	0.186	0.853
	A(1,2)	-0.266	0.350	-0.759	0.448
	A(2,1)	0.052	0.013	4.005	0.000
	A(2,2)	0.186	0.079	2.365	0.018
	B(1,1)	0.603	0.092	6.575	0.000
	B(1,2)	-5.126	0.610	-8.397	0.000
	B(2,1)	0.124	0.015	8.533	0.000
	B(2,2)	0.485	0.096	5.054	0.000

Note: Estimations using the equation (5.8)

Source: Author's Estimation

Table 5.6: GARCH-BEKK Estimation between IFood with Stock Prices

	Variable	Coeff.	Std Error	t-Stat.	Signif.
I: 2001M01 - 2012M06					
Mean Coff.	Mean(1)	0.467	0.172	2.714	0.007
	Mean(2)	0.945	0.653	1.447	0.148
Var. Coff.	C(1,1)	1.713	0.382	4.489	0.000
	C(2,1)	0.565	1.934	0.292	0.770
	C(2,2)	0.000	5.713	0.000	0.979
	A(1,1)	0.162	0.154	1.048	0.295
	A(1,2)	-0.003	0.334	-0.009	0.993
	A(2,1)	-0.013	0.021	-0.617	0.537
	A(2,2)	-0.247	0.103	-2.388	0.017
	B(1,1)	0.399	0.445	0.896	0.370
	B(1,2)	-1.606	1.142	-1.406	0.160
	B(2,1)	-0.020	0.080	-0.253	0.800
	B(2,2)	-0.882	0.111	-7.937	0.000
II: 2001M01 - 2008M09					
Mean Coff.	Mean(1)	0.287	0.067	4.301	0.000
	Mean(2)	2.231	0.653	3.416	0.001
Var. Coff.	C(1,1)	0.115	0.133	0.861	0.389
	C(2,1)	5.644	0.979	5.764	0.000
	C(2,2)	0.000	9.535	0.000	1.000
	A(1,1)	-0.017	0.109	-0.154	0.878
	A(1,2)	-4.824	1.535	-3.143	0.002
	A(2,1)	0.053	0.015	3.463	0.001
	A(2,2)	-0.234	0.142	-1.656	0.098
	B(1,1)	0.833	0.079	10.601	0.000
	B(1,2)	-3.092	1.949	-1.586	0.113
	B(2,1)	0.015	0.022	0.674	0.501
	B(2,2)	0.316	0.318	0.992	0.321
III: 2008M10 - 2012M06					
Mean Coff.	Mean(1)	0.630	0.356	1.771	0.077
	Mean(2)	0.569	0.788	0.721	0.471
Var. Coff.	C(1,1)	2.396	0.383	6.264	0.000
	C(2,1)	2.018	1.630	1.238	0.216
	C(2,2)	1.784	0.976	1.827	0.068
	A(1,1)	-0.153	0.129	-1.186	0.236
	A(1,2)	0.054	0.421	0.128	0.898
	A(2,1)	0.026	0.049	0.521	0.602
	A(2,2)	0.759	0.182	4.172	0.000
	B(1,1)	-0.363	0.316	-1.150	0.250
	B(1,2)	2.244	0.235	9.552	0.000
	B(2,1)	0.006	0.061	0.101	0.920
	B(2,2)	-0.016	0.540	-0.030	0.976

Source and Note: Same as in Table 5.5

Table 5.7: GARCH-BEKK Estimation between IEnergy with Stock Prices

	Variable	Coeff.	Std Error	t-Stat.	Signif.
I: 2001M01 - 2012M06					
Mean Coff.	Mean(1)	0.584	0.124	4.699	0.000
	Mean(2)	1.510	0.562	2.687	0.007
Var. Coff.	C(1,1)	0.164	0.213	0.769	0.442
	C(2,1)	-3.354	0.906	-3.704	0.000
	C(2,2)	0.000	4.835	0.000	937.000
	A(1,1)	-0.461	0.099	-4.650	0.000
	A(1,2)	0.356	0.369	0.966	0.334
	A(2,1)	0.097	0.015	6.333	0.000
	A(2,2)	0.001	0.063	0.014	0.989
	B(1,1)	-0.728	0.058	-12.548	0.000
	B(1,2)	-1.676	0.408	-4.113	0.000
	B(2,1)	-0.087	0.031	-2.848	0.004
	B(2,2)	0.783	0.041	19.070	0.000
II: 2001M01 - 2008M09					
Mean Coff.	Mean(1)	0.728	0.182	4.005	0.000
	Mean(2)	1.278	0.672	1.903	0.057
Var. Coff.	C(1,1)	1.663	0.187	8.886	0.000
	C(2,1)	-1.802	0.859	-2.097	0.036
	C(2,2)	7.175	0.750	9.566	0.000
	A(1,1)	0.000	0.199	0.000	0.953
	A(1,2)	0.000	1.620	0.000	0.935
	A(2,1)	0.000	0.058	0.000	0.989
	A(2,2)	0.000	0.177	0.000	0.950
	B(1,1)	-0.009	0.937	-0.010	0.992
	B(1,2)	0.410	1.834	0.223	0.823
	B(2,1)	0.088	0.037	2.403	0.016
	B(2,2)	-0.005	0.324	-0.014	0.989
III: 2008M10 - 2012M06					
Mean Coff.	Mean(1)	0.437	0.168	2.602	0.009
	Mean(2)	2.715	0.822	3.305	0.001
Var. Coff.	C(1,1)	0.303	0.269	1.126	0.260
	C(2,1)	-3.279	0.731	-4.484	0.000
	C(2,2)	0.000	3.544	0.000	0.954
	A(1,1)	-0.597	0.192	-3.106	0.002
	A(1,2)	1.286	0.949	1.356	0.175
	A(2,1)	0.170	0.026	6.479	0.000
	A(2,2)	-0.090	0.153	-0.588	0.557
	B(1,1)	0.449	0.160	2.810	0.005
	B(1,2)	-0.924	0.794	-1.164	0.244
	B(2,1)	0.058	0.014	4.206	0.000
	B(2,2)	0.805	0.057	14.132	0.000

Source and Note: Same as in Table 5.5

Table 5.8: GARCH-BEKK Estimation between IMetal with Stock Prices

I: 2001M01 - 2012M06					
	Variable	Coeff.	Std Error	t-Stat.	Signif.
Mean Coff.	Mean(1)	0.374	0.090	4.141	0.000
	Mean(2)	0.916	0.642	1.426	0.154
Var. Coff.	C(1,1)	0.150	0.071	2.097	0.036
	C(2,1)	-7.089	0.466	-15.221	0.000
	C(2,2)	0.001	18.466	0.000	0.967
	A(1,1)	0.503	0.096	5.243	0.000
	A(1,2)	0.808	0.729	1.109	0.268
	A(2,1)	0.027	0.017	1.557	0.119
	A(2,2)	-0.219	0.132	-1.659	0.097
	B(1,1)	0.445	0.172	2.591	0.010
	B(1,2)	-1.695	1.317	-1.287	0.198
	B(2,1)	0.093	0.009	9.876	0.000
	B(2,2)	0.278	0.020	13.610	0.000
II: 2001M01 - 2008M09					
Mean Coff.	Mean(1)	0.257	0.092	2.810	0.005
	Mean(2)	-0.182	0.775	-0.235	0.814
Var. Coff.	C(1,1)	0.000	0.343	-0.001	0.999
	C(2,1)	-0.378	1.052	-0.359	0.719
	C(2,2)	6.691	0.741	9.029	0.000
	A(1,1)	0.489	0.157	3.107	0.002
	A(1,2)	3.758	1.369	2.745	0.006
	A(2,1)	0.064	0.014	4.535	0.000
	A(2,2)	-0.203	0.126	-1.612	0.107
	B(1,1)	0.091	0.234	0.387	0.699
	B(1,2)	2.358	2.149	1.097	0.273
	B(2,1)	0.071	0.013	5.539	0.000
	B(2,2)	-0.121	0.125	-0.967	0.333
III: 2008M10 - 2012M06					
Mean Coff.	Mean(1)	0.268	0.147	1.824	0.068
	Mean(2)	0.799	0.943	0.847	0.397
Var. Coff.	C(1,1)	0.842	0.140	5.994	0.000
	C(2,1)	-0.999	1.194	-0.837	0.403
	C(2,2)	0.000	2.472	0.000	0.974
	A(1,1)	0.593	0.142	4.179	0.000
	A(1,2)	0.660	0.593	1.113	0.266
	A(2,1)	0.006	0.022	0.288	0.773
	A(2,2)	-0.492	0.141	-3.487	0.000
	B(1,1)	0.379	0.240	1.578	0.114
	B(1,2)	-0.957	0.874	-1.095	0.274
	B(2,1)	0.017	0.016	1.019	0.308
	B(2,2)	0.863	0.060	14.273	0.000

Source and Note: Same as in Table 5.5

5.6 Relationship between Commodity Futures and Spot Prices

Over the last one decade in India, commodity prices have undergone large fluctuations as a result of economic, political and financial issues. But most financialization of commodity market becomes eyewitness to policy makers to make them understand the rise of commodity prices in all over world markets. In fact, it is well known that derivatives particularly futures market provides economic benefits, such as information dissemination, price discovery and efficient allocation of resources (Chan 1992, Schwarz, Szakmary,1994). The tightened cross market linkages that result from futures trading also fuel a common public and regulatory perception in India This leads to generate or exacerbate volatility in the underlying asset markets, since that represents not only an important tool for managing risk exposure, but also an opportunity for trading and speculation, which leads to commodity prices rise may vary excessively, with destabilizing effects in the markets. Holding a long commodity position differs from holding a stock in that commodity future as it has expiration dates and one must buy or “roll” into a new contract when their existing contract expires. Contango is the “normal” or “cost of carry” upward curve shape of futures prices rising with time to maturity. Backwardation is the downward curve shape when prices fall with time to maturity.

Under an efficient market, no one can consistently make abnormal profits and futures eliminate the possibility of guaranteed profits. An efficient market would provide reliable forecasts of spot prices in future. This would, as pointed out by Raizada and Sahi (2006), help in better risk management for market participants. According to Working (1949), futures price of a commodity depends on the futures events that could affect the demand and supply of traded commodities. So, based on the market information, a highly organized commodity exchange is needed for better functioning of the commodity futures market. If the information is biased, there will be the possibility of random or mean reversal of commodity futures price. Nowadays, all commodity exchanges are trying to avoid noise trading and the rational agents are permitted to trade in commodity exchanges. Thus, it is necessary to test efficiency of commodity market before doing any empirical study. If the market is efficient, the need for government intervention will be minimal.

There are several techniques to measure the market efficiency. Some of the time series techniques for determination of spot and futures prices (and thus, testing the market efficiency) include techniques such as ‘cointegration’ developed by Engle and Granger (1987) and cointegration vectors developed by Johansen (1990). Most of the existing studies have used the time series techniques such as Granger causality test, Engle-Granger cointegration, Johansen cointegration test and vector error correction model to test the commodity futures market efficiency. For example, Liang et al. (2008), Kumar (1992), Raizada and Sahi (2006), Prada and Bhatt (2008), McKenzie and Holt (2002), He and Holt

(2004) investigated the efficiency of futures and spot markets of various commodities using the Johansen co integration test. These researchers (except He and Holt, 2004)) found that there was long term cointegration between the futures and spot prices of commodities. On the other hand, some studies like Kaminsky and Kumar (1990), Eswaran and Ramasundaram (2008), Carnella and Pollard (1987)] found that two markets were not integrated and hence not efficient. Granger (1986) found that if two variables were cointegrated, the causality must exist at least in one direction.

Though, the main objective of this chapter is to find out how financial speculators could influence prices, yet there are four possible outcomes of these tests and each of them with different implications (Alexander et al., 2011):

- If change in one commodity futures price led to change of spot price of same commodity, it suggests that there is price discovery in the futures market. This means that the futures market tends to absorb news about changes to fundamentals more quickly than the spot market, that leads to speculative developments in futures prices that are distorting spot prices (at least temporarily).
- If changes in spot prices are found to Granger-cause changes in futures prices, this suggests that price discovery is occurring in the spot market. In such a case, any speculation-driven changes in futures prices are unlikely to distort spot prices.
- If there is an evidence of bi-directional Granger causality (i.e., changes in futures prices Grange-cause changes in spot prices and changes in spot prices Granger-cause changes in futures prices), it indicates that spot and futures prices are jointly determined. This could indicate either that there are large numbers of participants who have access to both markets (such that perceived news is simultaneously reflected in both the futures and spot markets) or that there are institutional factors which enforce a close mechanical relationship between the two markets.
- Lastly, if no Granger-causal relationships are detected, this may suggest that spot and futures markets are sufficiently segmented to prevent arbitrage from occurring, and therefore, that developments in one market are unlikely to affect the other. Alternatively, arbitrage may still hold, with the Granger-causal relationships existing only on an intraday basis or adjustment occurring primarily through changes in other variables (e.g., through storage costs or the convenience yield).

These are the four possible outcomes of the Granger causality test between futures and spot price. Therefore, to examine the relationship between future and spot price, we have used the Granger causality test.

Before estimating the Granger causality test, we have checked whether the selected commodities for spot and future prices are stationary or not. Therefore, we have tested the stationarity of the variables by applying the Unit root test of Augmented dickey fuller and Phillips Perron test, and the estimated results are reported in the Appendix Table-A.5.3a and A.5.3b. Results in appendix Table-A.5.3a and A.5.3b indicate that all selected commodities for spot and futures prices are non-stationary at their level value and all are stationary at the first difference in both ADF and PP test.

In Table-5.9 (block I), we have reported the causality test. In Table-5.9 (block I), there are two null hypotheses - first, Comdex spot price does not cause Comdex future price, whereas the alternative hypotheses is Comdex spot causes Comdex future price. The second null hypothesis is that Comdex future price does not cause Comdex spot price, whereas the alternative hypothesis is that Comdex future price has caused Comdex spot price and similarly for other three variables. If we look at Table-5.9 (block I), the estimated results show that there is bi-directional granger causality between the Comdex spot and futures price, where there is no causality from the futures prices to Food spot but there is causality from the food spot price to food futures price. In the case of energy, the hypothesis energy futures doesn't cause energy spot price can be rejected. That means that there is no causality from energy futures to its spot price. But the reverse is possible, which means that there is causality from energy spot to energy futures price. In case of metal, there is causality from metal futures to metal spot price but reverse is not possible.

Table-5.9 (block II) indicates that there is bidirectional causality between Comdex spot price and futures price. Similar to Table-5.9 (block I), Table-5.9 (block II) shows that there is no causality between either Food spot price and its futures price or from food futures price to spot price in pre-crisis period, i.e., from the period of June 2005 to September 2008. In the case of energy, there is no causality from energy futures to the spot price but there is reverse causality, i.e., from the energy spot price to energy futures price. It indicates that if there is change in energy spot price, then it will cause changes in the energy futures price in India. Similarly, in the case of metal, the null hypothesis is rejected at 1% significance level, which means that there are bi-directional causality existing between these two prices.

Table 5.9: Granger Causality Test

I : 2005M04 - 2012M03			
Null/Alternative Hypothesis	Chi-sq	Prob.	YES/NO
Comdex future price does not cause Comdex spot price	6.78	0.08	YES
Comdex spot price does not cause Comdex future price	8.10	0.04	YES
Food future price does not cause Food spot price	1.30	0.25	NO
Food future price does not cause Food spot price	6.84	0.01	YES
Energy future price does not cause Energy spot price	8.66	0.01	NO
Energy spot price does not cause Energy future price	3.96	0.14	YES
Metal future price does not cause Metal spot price	9.11	0.03	YES
Metal spot price does not cause Metal future price	3.92	0.27	NO
II : 2005M04 - 2008M09			
Comdex future price does not cause Comdex spot price	12.69	0.01	YES
Comdex spot price does not cause Comdex future price	17.14	0.00	YES
Food future price does not cause Food spot price	0.22	0.64	NO
Food future price does not cause Food spot price	0.10	0.75	NO
Energy future price does not cause Energy spot price	0.18	0.67	NO
Energy spot price does not cause Energy future price	3.43	0.67	YES
Metal future price does not cause Metal spot price	12.42	0.01	YES
Metal spot price does not cause Metal future price	12.95	0.00	YES
III : 2008M10 - 2012M03			
Comdex future price does not cause Comdex spot price	11.16	0.01	YES
Comdex spot price does not cause Comdex future price	5.46	0.14	NO
Food future price does not cause Food spot price	0.99	0.32	NO
Food future price does not cause Food spot price	5.43	0.14	YES
Energy future price does not cause Energy spot price	15.53	0.00	YES
Energy spot price does not cause Energy future price	0.03	0.99	NO
Metal future price does not cause Metal spot price	8.57	0.04	YES
Metal spot price does not cause Metal future price	4.39	0.22	NO

Source: Author's Estimation

In Table-5.9 (block III), we have reported the Granger causality results for both futures and spot prices of the selected commodities. It is seen that the null hypothesis of Comdex future price does not cause Comdex spot price is rejected at 10% significance level. Therefore, it is said that Comdex future price causes Comdex spot price in the period from October 2008 to June 2012. The second null hypothesis is that Comdex spot price does not cause Comdex future price cannot be rejected. Therefore, there is only one way causality that is from the Comdex futures price to the Comdex spot price. In the case of food, there is also one way causality existing that is from Food spot price to futures price. In the case of energy, the null hypothesis Energy future price does not cause Energy spot price is rejected but the second hypothesis, i.e., Energy spot price does not cause future price cannot be rejected. Hence, it can be said that there is one-way causality existing from the Energy futures to the Energy spot price. Lastly, the causality test results for metal shows that there is no causality between these two prices. This means that the change in price is caused by other price but not by some other factors.

5.7 Analysis of BEKK Model for the Commodity Spot and Futures Prices

As stated earlier, volatility spillovers between cross markets, i.e., commodities spot and futures prices may improve the chances for speculators to shift their investments from one market to another. But, Granger causality could not explain properly the way of volatility spillover between the study variables. Thus, we have used bivariate GARCH (1, 1)-BEKK model to effectively capture the own and cross market volatility spillovers between spot and futures commodity prices in India. In the following Table-5.10 to 5.13, we have reported the BEKK results for three periods, i.e., full sample period, pre-crisis period and post crisis period for the four selected commodities. The same with the earlier BEKK model analysis, here we also have estimated BEKK model's mean equations where only mean co-efficient results are reported. Secondly, we have reported the variance equation coefficients, where the own-volatility spillover effects as well as cross volatility spillover effects are reported.

In Table-5.10 (block I to III), we have reported the BEKK results of spot and futures price of Comdex. The Table-5.10 (block I) shows that the two mean coefficients (0.975 and 0.874) are significant at 1% and 10% significance level. The variance constant co-efficient i.e. C(1,1) and C(2,1) values (1.806 and 1.967) are significant at 1% significance level. Unfortunately, the own-volatility spillover effects of Comdex spot price A(1,1) value (-0.169) is not significant but the futures price coefficient A(2,2) value (0.497) is significant at 1% significance level. But if we look at the cross market volatility spillovers between Comdex spot and futures price, the coefficient B(1,2) is not significant but the coefficient B(2,1) value (1.492) is significant at 1% significance level, which means that there is volatility spillover from the Comdex futures to the spot price for the period from June 2005 to June 2012.

In Table-5.10 (block II), we have reported the BEKK results for the period from June 2005 to July 2008. The two mean coefficient values (1.577 and 1.523) are significant at 1% significance level. In the variance equations, the constant coefficients C (1, 1) and C (2, 1) are significant at 1% significance level. The Comdex futures price own-volatility spillover coefficient A(2,2) is only significant at 1% significance level. The cross market volatility spillover coefficients B(1,2) and B(2,1) values (0.731 and -1.094) are significant at 1% significance level. This means that there are cross market volatility between Comdex spot and futures prices for the period from June 2005 to July 2008.

Similarly, if we look at the Table-5.10 (block III), the mean coefficients are not significant but the constant coefficients C(1,1) and C(2,1) are significant at 1% significance level. The own-volatility spillover effects coefficients are not significant. But the cross market volatility coefficients B(1,2) and B(2,1) values (1.387 and -1.675) are significant at 1% significance level that means there are cross market volatility between Comdex spot and futures prices and vice versa for the period, August 2008 - June 2012.

Table 5.10: Descriptive Statistics of Selected Variables

I: 2005M06 - 20012M06					
	Mean	Std. Dev.	CV	Skewness	Kurtosis
SAC	7.835	0.246	3.134	0.172	2.095
SFOOD	7.585	0.299	3.946	0.530	2.156
SENERGY	7.875	0.209	2.653	0.089	3.246
SMETAL	7.987	0.315	3.942	0.022	2.485
FAC	7.848	0.240	3.054	0.190	2.095
FFOOD	7.571	0.274	3.621	0.506	2.177
FENERGY	7.892	0.197	2.498	0.238	3.058
FMETAL	7.997	0.317	3.962	0.001	2.539
II: 2005M06 - 2008M09					
SAC	7.702	0.167	2.169	0.187	2.702
SFOOD	7.354	0.110	1.498	-0.308	2.225
SENERGY	7.860	0.210	2.677	1.150	3.497
SMETAL	7.781	0.206	2.648	-1.136	3.227
FAC	7.711	0.163	2.119	0.106	2.848
FFOOD	7.358	0.104	1.413	-0.271	2.038
FENERGY	7.868	0.200	2.547	1.261	3.873
FMETAL	7.786	0.210	2.700	-1.166	3.221
III: 2008M10 - 2012M06					
SAC	7.953	0.245	3.078	-0.475	2.295
SFOOD	7.790	0.263	3.375	-0.300	2.410
SENERGY	7.889	0.209	2.648	-0.865	3.570
SMETAL	8.171	0.280	3.425	-0.376	1.924
FAC	7.969	0.233	2.918	-0.397	2.086
FFOOD	7.760	0.237	3.051	-0.291	2.549
FENERGY	7.913	0.194	2.451	-0.729	3.170
FMETAL	8.185	0.276	3.373	-0.325	1.826

Source: Author's Estimation

In Table-5.11 (block I to III), we have reported the BEKK results of spot and futures price of Food. Table-5.11 (block I) shows that the mean coefficient 1.385 is significant at 1% significance level. In the variance equation, the constant coefficient C(2,1) is -1,017 is significant at 10% significance level. The own-volatility spillover coefficients A(1,2), A(2,1) and A(2,2) are significant at 1% and 5% significance level respectively. The cross market volatility spillovers shows that all the coefficients between Comdex spot and futures price, B(1,1), B(2,1) and B(2,2) are significant at 1% and 5% level of significance respectively, which means that there exists cross volatility spillover that is from the food futures to spot price for the period from June 2005 to June 2012.

In Table-5.11 (block II), we have reported the BEKK results for food spot and futures prices for the period from June 2005 to September 2008. The two mean coefficients values (0.621 and 0.279) are insignificant. In the variance equations, only the constant coefficient C (2, 2) is significant at 1% significance level. The food spot and futures price's own-volatility spillover coefficients A(1,1), A(1,2), A(2,1) and A(2,2) are significant at 1% significance level. This means that there is own volatility spillover in these two prices. The cross market volatility spillover coefficients B(1,1) and B(1,2) are only significant, which means that there is volatility spillovers that is from the food spot price to the futures market of food for the period from June 2005 to September 2008.

In Table-5.11 (block III), the two mean coefficients are significant and the constant coefficients in the variance equation C (1, 1) and C (2, 1) are significant at 1% significance level. The own-volatility spillover effects coefficients A (1, 1 and A (2, 1) are significant at 1% significance level, which suggests that there is own volatility spillovers. The cross market volatility coefficients B(1,1), B(1,2), B(2,1) and B(2,2) are significant at 1% and 5% significance level respectively that means there exists cross market volatility spillover between food spot price and futures prices for the period from October 2008 to June 2012.

In Table-5.12 (block I to III), we have reported the BEKK results of energy spot and futures prices for three periods. Table-5.12 (block I) shows that the two mean coefficients are significant at 5% and 10% significance level respectively. In the variance coefficients, the constant coefficients, i.e., C(1,1) and C(2,1) values are also significant at 1% significance level. The own-volatility spillover coefficients A(1,1), A(1,2), a(2,1) and A(2,2) are significant at 1% significance level. The cross market volatility spillovers between energy spot and futures price, all the coefficients B(1,1), B(1,2), B(2,1) and B(2,2) are significant at 1% significance level, which means that there exists bidirectional volatility spillover between the energy spot and futures prices for the period from June 2005 to June 2012.

Table-5.12 (block II) shows that two mean coefficients are insignificant. In the variance equations, the constant coefficient C(2,1) is significant at 1% significance level.

The energy spot and futures price's own-volatility spillover coefficient A(1,1), A(1,2) and A(2,1) are all significant at 1% significance level. The cross market volatility spillover coefficient B(1,1,), B(1,2), B(2,1) and B(2,2) are significant at 5% and 10% significance level. This indicates that there exists directional volatility spillover effect between energy future and spot spot price for the period from June 2005 to September 2008.

If we look at Table-5.12 (block III), the constant coefficient C(1,1) is significant at 1% significance level. The own-volatility spillover effects coefficients A(1,1) and A(2,1) are significant at 1% significance level. The cross market volatility coefficients are insignificant that means that there is no cross market volatility spillovers between energy spot and futures price for the period from October 2008 to June 2012.

In Table-5.13 (block I to III), we have reported the BEKK results of metal spot and futures price. Table-5.13 (block) shows that the constant co-efficients C(1,1) and C(2,1) are significant at 1% significance level. The own-volatility spillover coefficients A(1,1), A(1,2), A(2,1) and A(2,2) are insignificant that means there is no own price volatility spillover. The cross market volatility spillovers coefficients B(1,1) and B(2,1) are significant at 5% and 1% significance level. This means that there is volatility spillover from metal future price to spot price for the period from June 2005 to June 2012.

In Table-5.13 (block II), we have reported the GARCH(1,1)-BEKK results for metal spot and future price for the pre-crisis period. It shows that the metal spot and futures price's own-volatility spillover coefficient A(1,1), A(1,2), A(2,1) and A(2,2) are all significant at 1% significance level. The cross market volatility spillover coefficient B(1,1), B(1,2), B(2,1) and B(2,2) are all significant at 1% significance level, which means that there is bi-directional volatility spillover effect existing between metal spot and futures price for the period from June 2005 to September 2008. But, if we look at the Table-5.13 (block III), the mean coefficients are significant at 1% significance level. The own-volatility spillover effect coefficient A(1,1) and A(2,1) are significant at 1% significance level. The cross market volatility coefficients are all insignificant, which means that there is no cross market volatility between metal spot price and futures prices for the period from October 2008 to June 2012.

Table 5.11: GARCH-BEKK Estimation between SFood with FFood Prices

I: 2005M06 - 2012M06	Variable	Coeff.	Std Error	t-Stat.	Signif.
Mean Coff.	Mean(1)	1.385	0.352	3.939	0.000
	Mean(2)	0.409	0.541	0.755	0.450
Var. Coff.	C(1,1)	0.437	1.674	0.261	0.794
	C(2,1)	-1.017	0.552	-1.842	0.065
	C(2,2)	2.973	0.695	4.277	0.000
	A(1,1)	-0.646	0.442	-1.461	0.144
	A(1,2)	-1.392	0.485	-2.869	0.004
	A(2,1)	0.503	0.287	1.753	0.080
	A(2,2)	1.594	0.442	3.608	0.000
	B(1,1)	0.756	0.296	2.552	0.011
	B(1,2)	0.586	0.362	1.621	0.105
	B(2,1)	-0.756	0.185	-4.096	0.000
	B(2,2)	-0.572	0.222	-2.577	0.010
II: 2005M06 - 2008M09	Variable				
Mean Coff.	Mean(1)	0.621	0.435	1.426	0.154
	Mean(2)	0.279	0.574	0.486	0.627
Var. Coff.	C(1,1)	0.247	0.639	0.387	0.699
	C(2,1)	-1.082	0.691	-1.566	0.117
	C(2,2)	1.614	0.403	4.001	0.000
	A(1,1)	-1.410	0.273	-5.167	0.000
	A(1,2)	-1.312	0.387	-3.386	0.001
	A(2,1)	1.472	0.205	7.180	0.000
	A(2,2)	1.353	0.267	5.064	0.000
	B(1,1)	0.801	0.261	3.065	0.002
	B(1,2)	0.955	0.324	2.948	0.003
	B(2,1)	-0.177	0.252	-0.703	0.482
	B(2,2)	-0.144	0.366	-0.393	0.695
III: 2008M10 - 2012M06	Variable				
Mean Coff.	Mean(1)	1.131	0.350	3.237	0.001
	Mean(2)	0.781	0.362	2.159	0.031
Var. Coff.	C(1,1)	-2.226	0.819	-2.719	0.007
	C(2,1)	-3.133	1.389	-2.256	0.024
	C(2,2)	0.000	1.057	0.000	0.988
	A(1,1)	-0.763	0.283	-2.697	0.007
	A(1,2)	-0.222	0.291	-0.761	0.447
	A(2,1)	1.152	0.250	4.613	0.000
	A(2,2)	0.368	0.253	1.454	0.146
	B(1,1)	0.926	0.359	2.580	0.010
	B(1,2)	1.027	0.532	1.933	0.053
	B(2,1)	-0.867	0.422	-2.056	0.040
	B(2,2)	-1.207	0.579	-2.082	0.037

Source: Same as in Table 5.10

Table 5.12: GARCH-BEKK Estimation between SEnergy with FEnergy Prices

I: 2005M06 - 2012M06	Variable	Coeff.	Std Error	t-Stat.	Signif.
Mean Coff.	Mean(1)	1.333	0.512	2.601	0.009
	Mean(2)	1.187	0.524	2.267	0.023
Var. Coff.	C(1,1)	1.766	0.487	3.627	0.000
	C(2,1)	2.755	0.391	7.037	0.000
	C(2,2)	0.000	2.464	0.000	0.949
	A(1,1)	-0.706	0.094	-7.528	0.000
	A(1,2)	-0.266	0.074	-3.600	0.000
	A(2,1)	0.703	0.053	13.204	0.000
	A(2,2)	0.594	0.046	12.880	0.000
	B(1,1)	-0.751	0.156	-4.809	0.000
	B(1,2)	-0.320	0.080	-4.010	0.000
	B(2,1)	1.647	0.127	12.938	0.000
	B(2,2)	1.167	0.076	15.362	0.000
II: 2005M06 - 2008M09	Variable				
Mean Coff.	Mean(1)	0.692	1.272	0.544	0.587
	Mean(2)	0.638	1.324	0.482	0.630
Var. Coff.	C(1,1)	4.304	3.197	1.346	0.178
	C(2,1)	5.797	1.994	2.907	0.004
	C(2,2)	0.000	6.070	0.000	1.000
	A(1,1)	2.016	0.704	2.863	0.004
	A(1,2)	1.530	0.649	2.359	0.018
	A(2,1)	-1.598	0.704	-2.269	0.023
	A(2,2)	-1.005	0.682	-1.474	0.140
	B(1,1)	-1.199	0.709	-1.692	0.091
	B(1,2)	-1.253	0.697	-1.798	0.072
	B(2,1)	1.664	0.739	2.250	0.024
	B(2,2)	1.526	0.708	2.154	0.031
III: 2008M10 - 2012M06	Variable				
Mean Coff.	Mean(1)	0.465	1.058	0.439	0.661
	Mean(2)	0.558	1.050	0.532	0.595
Var. Coff.	C(1,1)	3.921	1.907	2.056	0.040
	C(2,1)	2.883	2.076	1.389	0.165
	C(2,2)	0.001	2.057	0.000	0.970
	A(1,1)	-1.096	0.338	-3.239	0.001
	A(1,2)	-0.019	0.277	-0.069	0.945
	A(2,1)	1.240	0.334	3.711	0.000
	A(2,2)	0.208	0.259	0.800	0.423
	B(1,1)	-0.214	0.448	-0.477	0.633
	B(1,2)	-0.129	0.397	-0.326	0.745
	B(2,1)	-0.558	0.663	-0.842	0.400
	B(2,2)	-0.718	0.544	-1.321	0.187

Source: Same as in Table 5.10

Table 5.13: GARCH-BEKK Estimation between SMetal with FMetal Prices					
I: 2005M06 - 2012M06	Variable	Coeff.	Std Error	t-Stat.	Signif.
Mean Coff.	Mean(1)	0.491	0.427	1.151	0.250
	Mean(2)	0.598	0.419	1.429	0.153
Var. Coff.	C(1,1)	4.905	0.597	8.219	0.000
	C(2,1)	4.961	0.537	9.230	0.000
	C(2,2)	0.000	0.275	0.000	0.988
	A(1,1)	0.397	0.432	0.919	0.358
	A(1,2)	0.581	0.369	1.573	0.116
	A(2,1)	-0.132	0.440	-0.299	0.765
	A(2,2)	-0.027	0.378	-0.072	0.943
	B(1,1)	-0.780	0.352	-2.218	0.027
	B(1,2)	-0.017	0.359	-0.049	0.961
	B(2,1)	0.972	0.320	3.043	0.002
	B(2,2)	0.212	0.340	0.623	0.533
II: 2005M06 - 2008M09	Variable				
Mean Coff.	Mean(1)	0.425	0.470	0.905	0.365
	Mean(2)	0.313	0.404	0.774	0.439
Var. Coff.	C(1,1)	4.375	0.682	6.419	0.000
	C(2,1)	4.263	0.870	4.901	0.000
	C(2,2)	-0.003	0.492	-0.006	0.995
	A(1,1)	1.084	0.061	17.680	0.000
	A(1,2)	1.058	0.084	12.579	0.000
	A(2,1)	-0.781	0.082	-9.474	0.000
	A(2,2)	-0.511	0.046	-10.987	0.000
	B(1,1)	0.375	0.083	4.494	0.000
	B(1,2)	-0.440	0.046	-9.509	0.000
	B(2,1)	-0.127	0.043	-2.968	0.003
	B(2,2)	0.696	0.045	15.354	0.000
III: 2008M10 - 2012M06	Variable				
Mean Coff.	Mean(1)	2.127	0.566	3.760	0.000
	Mean(2)	2.197	0.570	3.857	0.000
Var. Coff.	C(1,1)	0.788	0.839	0.939	0.348
	C(2,1)	2.010	0.929	2.163	0.031
	C(2,2)	0.000	4.115	0.000	0.951
	A(1,1)	0.726	0.312	2.326	0.020
	A(1,2)	-0.145	0.344	-0.422	0.673
	A(2,1)	-1.278	0.364	-3.511	0.000
	A(2,2)	-0.328	0.370	-0.886	0.375
	B(1,1)	0.079	0.456	0.173	0.862
	B(1,2)	0.062	0.468	0.132	0.895
	B(2,1)	0.620	0.393	1.577	0.115
	B(2,2)	0.724	0.436	1.661	0.097

Source: Same as in Table 5.10

5.8 Summary

In Chapter 5, we have empirically examined the financialization of commodity markets in India in two ways. First, we have examined the relationship between stock price and commodity spot price. Second, we have examined the relationship between commodity spot and futures prices using the commodity futures price index, spot price index and equity index or stock price index for India over the period from June 2005 to June 2011. The study has used the time series techniques of cointegration test, causality test and the volatility spillover tests. Some important findings of the chapter are given below.

From the relationship of stock price with commodity price, it is found that average stock price return was more than the commodity price return but compared to the commodity price volatility, stock price was more volatile than commodity price. Among the commodity price indices, energy price index provided more price return with the highest volatility, whereas food price had the least return with less volatility in three periods. From the unconditional correlation, it is found that commodity price indices were highly correlated with the stock prices in three periods. From the Johansen cointegration test, it was found that food price index was not related with the stock price in all the three periods. That might be the reason why it provided less liquidity. Similarly, for other commodities also, it was found that there was no relationship between stock price and the commodity price in the long-run.

From the Granger causality test for the full sample period, it was found that there existed only one way causality from stock price to IAC price. In case of IAGRI price index, there was no relationship between stock price and the IAGRI price. There existed one way causality, i.e., from stock price to IENERGY price. In the case of IMETAL, there was only one way causality from the stock price to IMETAL price in India.

In the pre-crisis period, IAC index price caused stock price in the period from January 2001 to September 2008. In the case of IAGRI, there was causality from IAGRI price to stock price. There was causality from IENERGY price to stock price. In the case of IMETAL price index, there existed only one way causality from stock price to IMETAL price in India.

The Granger causality test for the post-crisis period, i.e., from the period November 2008 to June 2012 showed that stock price causes IAC index price in the post-crisis period. There was causality from IAGRI to stock price and also there existed one-directional causality between IENERGY stock price, i.e, from stock price to IENERGY price in the period from July 2008 to June 2012. There was only one directional causality, i.e., from stock to IMETAL in the period from January 2001 to July 2008.

Next we analysed the volatility spillover results. From the full sample period of IAC, we found that there was volatility spillover from the stock market to the IAC. In the pre-crisis period, there existed a bi-directional cross market volatility between stock market and IAC, and IAC and stock price in the period from January 2001 to September 2008. Similarly, in the post-crisis period, it was found that there existed cross market volatility between stock market to IAC and IAC to the stock market in the pre-crisis period, i.e., from November 2008 to June 2012.

In the case of IAGRI, there was no cross market volatility spillover between stock market and the IAGRI market for the period January 2001 to June 2012. There was also no cross market volatility between IAGRI and stock price in the period from January 2001 to September 2008. That means in the pre-crisis period, while commodity prices were booming, that time financial investors were not interested to invest on food items. Similarly, in the post-crisis period, there was volatility spillover from IAGRI to stock market but opposite was not possible.

In the case of IENERGY, there were bi-directional cross market volatility spillovers from stock market to IENERGY market and vice versa in the full sample period. While looking at the pre-crisis period, we found volatility spillovers from stock market IENERGY but not from IENERGY to stock price for the period from January 2001 to September 2008. In the post-crisis period, we found that there was cross volatility spillover from stock market to IENERGY market but it was not from IENERGY to stock market for the period from August 2008 to June 2012.

In the case of metal, there was cross market volatility spillover between stock market and the IMETAL market for the period from January 2001 to June 2012. There was also cross market volatility between stock market and IMETAL market for the period from January 2001 to September 2008. There were also bi-directional volatility spillovers between stock market and IMETAL Market for the period from October 2008 to June 2012.

In the second part of the analysis of financilisation of commodity markets, we analyzed the relationship between commodity spot and future price. Before estimating the Granger causality test and volatility spillover models, we checked the stationarity condition by applying the unit root tests such as ADF and PP test. From the unit root test, we found that all spot and future commodity price indices were non-stationary at their significance level. But in the first difference, all variables were significant at 1% significance level. Next, we analysed the Granger causality test and from this test we found that in the full sample period, there were bi-directional granger causality between the Comdex spot and futures price, whereas there was no causality from the food futures prices to Food spot. But there was causality from the food spot price to food futures price. In case of energy, there was no causality from energy futures to its spot price. But the reverse was possible, which means that there was causality from energy spot to energy futures price. In the case of metal, there was causality from metal futures to metal spot price but reverse was not.

In the pre-crisis period, there was bidirectional causality between Comdex spot price and futures price. There was no causality between either Food spot price and its futures price or from food futures price to spot price in pre-crisis period, i.e., from the period of June 2005 to September 2008. In the case of energy, there was no causality from energy futures to the spot price but there is reverse causality, i.e., from the energy spot price to energy futures price. It indicates that if there was change in energy spot price, then it would cause to change in the energy futures price in India. Similarly, in the case of metal, there was a bi-directional causality existing between these two prices.

In the post-crisis period, Comdex future price caused Comdex spot price in the period from October 2008 to June 2012. There was only one way causality, that is, from the Comdex futures price to the Comdex spot price. In the case of food, there was also one way causality, that is, from Food spot price to futures price. In the case of energy, there was one way causality existing from the Energy futures to the Energy spot price. Lastly, the causality test results for metal showed that there was no causality between these two prices. It means that the change in price was caused by some other factors.

Subsequently, we analysed the volatility spillover estimation model [i.e., GARCH(1,1)-BEKK model]. In the full-sample period, it was found that there was volatility spillover from the Comdex futures to the spot price for the period from June 2005 to June 2012. In the pre-crisis period, there existed cross market volatility between Comdex spot and futures prices for the period from June 2005 to September 2008. In the same way, in the post-crisis period there was cross market volatility spillover between Comdex spot and futures prices and vice versa for the period from August 2008 to June 2012.

In the case of food in the full-sample period, we found that there existed cross volatility spillover, that is, from the food futures to spot price and food spot price to food future for the period from June 2005 to June 2012. In the pre-crisis period, it was found that there was a volatility spillover, that is, from the food spot price to the futures market of food for the period from June 2005 to September 2008. In the post-crisis period, there existed cross market volatility spillover between food spot price and futures prices for the period from October 2008 to June 2012.

In the case of energy in the full-sample period, there existed bidirectional volatility spillover between the energy spot and futures prices for the period from June 2005 to June 2012. Similarly, in the pre-crisis period, there also existed bi-directional volatility spillover effect between energy future and spot spot price for the period from June 2005 to September 2008. In the post-crisis period, there was no cross market volatility spillovers between energy spot and futures price for the period from October 2008 to June 2012.

In the case of metal in the full-sample period, it was found that there was volatility spillover from metal future price to spot price for the period from June 2005 to June 2012. In the pre-crisis period, there was bi-directional volatility spillover effect existing between metal spot and futures price for the period from June 2005 to September 2008. But, in the post-crisis period, there was no cross market volatility between metal spot price and futures prices for the period from October 2008 to June 2012. Therefore, it can be concluded that there was no clarity on whether there was financialisation of commodity markets in India or not. Hence, the answer is in-conclusive.

In the present chapter 5, we found no strong evidence on the financialisation of commodity markets in India. This result is quite similar with the report of the Reserve Bank of India (RBI, 2009-10). The RBI annual report (2009-10) mentioned that commodity prices in India seemed 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. However, studies like UNCTAD TDR (2009, 2010 and 2011), Troester (2013) and Tang and Xiong (2012) found the evidence of financialisation of commodity markets in respective countries. And this led to large increase in the price volatility of commodities around the year 2008. Thus, the main finding of the present study is contrary to those studies.

Appendix-5

In appendix Table-A.5.1, we have reported the composition of commodities and their weights in the MCX COMDEX of the year 2009. The MCX Indices based on futures prices are on a real time basis with the change in last traded price in MCX. The MCX COMDEX is the simple weighted average of the three group indices, i.e., MCX Agri, MCX Metal and MCX Energy. The group indices are computed through geometric mean. MCX Agri index includes six different commodities (i.e., Ref. Soy Oil, Potato, Chana, Crude Palm Oil, Kapaskhalli and Mentha Oil) and it is weighted 20.0% in the total weights in MCX COMDEX. Similarly, MCX Energy Index has only two commodities (Crude Oil and Natural Gas) in the Index but it is weighted 40.0% in the total weight of MCX COMDEX. MCX Metal Index includes 7 different commodities (i.e., gold, silver, copper, zinc, alminium, nickel and lead). The MCX Metal Index is weighted 40.0% in total MCX COMDEX weight. It can be seen that both metals and energy commodities have more weights than that of agricultural commodities in MCX Comdex

Appendix A.5.1: Composition of Commodities and their weights in the MCX COMDEX, 2009

MCX Comdex	Commodity	Weight	Group Adjusted Weights
MCX Agri Index	Ref. Soya Oil	3.91%	20.00%
	Potato	4.76%	
	Chana	4.14%	
	Crude Palm Oil	3.19%	
	Kapaskhali	2.00%	
	Mentha Oil	2.00%	
MCX Metal Index	Gold	15.21%	40.00%
	Silver	9.66%	
	Cooper	7.13%	
	Zinc	2.00%	
	Aluminium	2.00%	
	Nickel	2.00%	
	Lead	2.00%	
MCX Energy Index	Crude Oil	35.41%	40.00%
	Natural Gas	4.76%	

Source: MCX Commodity Index, www.mcxindia.com

Appendix A.5.2a: Results of Johansen Cointegration Test for 2001M01 to 2012M06

	Commodity	Null hypothesis		Alternative Hypothesis	Eigen Value	Statistics	Critical Values 5%	Prob.
ISTOCK	IAC	λ_{trace} tests	r = 0	r > 0	0.030	4.166	15.495	0.890
			r ≤ 1	r > 1	0.000	0.000	3.841	0.997
		λ_{max} test	r = 0	r = 1	0.030	4.166	14.265	0.841
			r = 1	r = 2	0.000	0.000	3.841	0.997
ISTOCK	IFood	λ_{trace} tests	r = 0	r > 0	0.018	2.525	15.495	0.984
			r ≤ 1	r > 1	0.000	0.025	3.841	0.874
		λ_{max} test	r = 0	r = 1	0.018	2.500	14.265	0.974
			r = 1	r = 2	0.000	0.025	3.841	0.874
ISTOCK	IEnergy	λ_{trace} tests	r = 0	r > 0	0.034	5.331	15.495	0.773
			r ≤ 1	r > 1	0.005	0.643	3.841	0.423
		λ_{max} test	r = 0	r = 1	0.034	4.688	14.265	0.781
			r = 1	r = 2	0.005	0.643	3.841	0.423
ISTOCK	IMetal	λ_{trace} tests	r = 0	r > 0	0.037	5.138	15.495	0.794
			r ≤ 1	r > 1	0.001	0.148	3.841	0.701
		λ_{max} test	r = 0	r = 1	0.037	4.990	14.265	0.743
			r = 1	r = 2	0.001	0.148	3.841	0.701

Source: Author's Calculation

Note: r denotes the cointegration vector

Appendix A.5.2b: Results of Johansen Cointegration Test for 2001M01 to 2008M09

	Commodity	Null hypothesis		Alternative Hypothesis	Eigen Value	Statistics	Critical Values 5%	Prob.
ISTOCK	IAC	λ_{trace} tests	r = 0	r > 0	0.068	7.727	15.495	0.495
			r ≤ 1	r > 1	0.012	1.146	3.841	0.284
		λ_{max} test	r = 0	r = 1	0.068	6.581	14.265	0.540
			r = 1	r = 2	0.012	1.146	3.841	0.284
ISTOCK	IFood	λ_{trace} tests	r = 0	r > 0	0.021	2.048	15.495	0.994
			r ≤ 1	r > 1	0.001	0.116	3.841	0.733
		λ_{max} test	r = 0	r = 1	0.021	1.931	14.265	0.992
			r = 1	r = 2	0.001	0.116	3.841	0.733
ISTOCK	IEnergy	λ_{trace} tests	r = 0	r > 0	0.082	9.233	15.495	0.344
			r ≤ 1	r > 1	0.014	1.307	3.841	0.253
		λ_{max} test	r = 0	r = 1	0.082	7.926	14.265	0.386
			r = 1	r = 2	0.014	1.307	3.841	0.253
ISTOCK	IMetal	λ_{trace} tests	r = 0	r > 0	0.104	11.182	15.495	0.201
			r ≤ 1	r > 1	0.011	0.990	3.841	0.320
		λ_{max} test	r = 0	r = 1	0.104	10.191	14.265	0.200
			r = 1	r = 2	0.011	0.990	3.841	0.320

Source: as in Table A.5.2a.

Appendix A.5.2c: Results of Johansen Cointegration Test for 2008M10 to 2012M06

	Commodity	Null hypothesis		Alternative Hypothesis	Eigen Value	Statistics	Critical Values 5%	Prob.
ISTOCK	IAC	λ_{trace} tests	r = 0	r > 0	0.186	7.781	15.495	0.489
			r ≤ 1	r > 1	0.022	0.772	3.841	0.380
		λ_{max} test	r = 0	r = 1	0.186	7.009	14.265	0.488
			r = 1	r = 2	0.022	0.772	3.841	0.380
ISTOCK	IFood	λ_{trace} tests	r = 0	r > 0	0.242	13.258	15.495	0.106
			r ≤ 1	r > 1	0.107	3.849	3.841	0.050
		λ_{max} test	r = 0	r = 1	0.242	9.409	14.265	0.254
			r = 1	r = 2	0.107	3.849	3.841	0.050
ISTOCK	IEnergy	λ_{trace} tests	r = 0	r > 0	0.181	6.829	15.495	0.598
			r ≤ 1	r > 1	0.001	0.045	3.841	0.832
		λ_{max} test	r = 0	r = 1	0.181	6.784	14.265	0.515
			r = 1	r = 2	0.001	0.045	3.841	0.832
ISTOCK	IMetal	λ_{trace} tests	r = 0	r > 0	0.321	14.208	15.495	0.077
			r ≤ 1	r > 1	0.030	1.027	3.841	0.311
		λ_{max} test	r = 0	r = 1	0.321	13.181	14.265	0.074
			r = 1	r = 2	0.030	1.027	3.841	0.311

Source: as in Table A.5.2a.

Appendix A.5.3a: Augmented Dickey Fuller Unit Root Test Results

	2005M06-2012M06				2005M06-2008M09				2008M10-2012M06			
	Int		Int with Trend		Int		Int with		Int		Int with Trend	
Variable	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff
SComdex	-1.33	-7.70	-2.97	-7.66	-1.73	-5.78	-3.25	-5.78	-0.86	-6.45	-2.38	-6.42
SFOOD	-0.08	-8.78	-1.51	-8.77	-2.20	-6.36	-1.23	-6.87	-1.38	-6.31	-2.42	-6.37
SENERGY	-2.21	-7.43	-2.77	-7.38	-1.12	-5.16	-1.62	-5.09	-1.34	-6.29	-3.31	-6.20
SMETAL	-1.47	-8.91	-2.24	-8.89	-1.81	-5.98	-3.24	-5.93	-1.28	-7.55	-1.82	-7.94
FComdex	-1.57	-7.44	-3.48	-7.40	-1.81	-5.98	-3.24	-5.93	-0.86	-6.19	-2.15	-6.25
FFOOD	-0.08	-8.78	-1.51	-8.77	-2.22	-7.01	-1.63	-7.41	-2.14	-7.75	-3.35	-8.04
FENERGY	-2.85	-6.49	-3.24	-6.45	-1.17	-5.27	-1.71	-5.21	-1.05	-5.34	-3.25	-5.22
FMETAL	-1.58	-8.86	-2.36	-8.85	-2.21	-5.98	-2.10	-6.78	-1.21	-8.03	-1.94	-7.10

Source: Author's Calculation

Notes: a. Critical values for unit root test (ADF & PP) are: -3.49 and -4.10 (without trend) and -4.04, -4.10 (with trend) respectively at 1% level and 5% levels

Appendix A.5.3b: Phillips Perron Unit Root Test Results

	2005M06-2012M06				2005M06-2008M09				2008M10-2012M06			
	Int		Int with Trend		Int		Int with		Int		Int with Trend	
Variable	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff
SComdex	-1.57	-7.81	-2.68	-7.76	-1.73	-5.78	-2.28	-5.78	-0.86	-6.51	-2.64	-6.54
SFOOD	-0.08	-8.77	-1.56	-8.77	-2.20	-6.36	-0.92	-9.40	-1.37	-6.31	-2.55	-6.39
SENERGY	-2.75	-7.48	-3.00	-7.44	-1.24	-5.15	-1.75	-5.05	-1.45	-6.87	-3.42	-6.93
SMETAL	-1.47	-8.91	-2.34	-8.89	-2.49	-5.77	-1.71	-6.22	-1.31	-7.76	-1.65	-7.70
FComdex	-1.63	-7.43	-2.75	-7.39	-1.79	-5.98	-2.58	-5.90	-0.86	-6.20	-2.51	-6.49
FFOOD	-0.08	-8.77	-1.56	-8.77	-2.17	-7.22	-1.27	-13.87	-2.27	-7.86	-2.75	-8.38
FENERGY	-2.68	-6.47	-2.98	-6.44	-1.17	-5.20	-1.71	-5.12	-1.25	-6.25	-3.76	-7.50
FMETAL	-1.58	-8.86	-2.39	-8.84	-3.16	-5.80	-1.70	-6.71	-1.24	-8.27	-1.78	-8.90

Source and Note: Same as in Appendix A.5.3a

CHAPTER 6

Commodity Market Integration and Price Transmission in India

6.1 Introduction

In the era of globalization, each and every country is connected, particularly markets are connected with each other with the aim of not only to compete local products with international product to increase economic stand, but also to help other countries by providing their required products. Therefore, in the 21st century, it has been seen that markets are more vibrant and transparent in integration with each other. Therefore, over the last couple of years, it has been noticed that prices of food items have increased and remained highly volatile in international markets. It has been observed that the commodity prices in international market surged since 2002 reflecting the significant changes in demand-supply imbalances, increase in biofuels demand, rise in oil prices and also due to speculative transactions in markets for commodity derivatives persisting in the global market (UNCTAD, 2010). The rise and fall in international prices tend to get transmitted from the international market to the domestic markets in an open trade environment (Rajmal and Mishra, 2009). For example, when commodity prices rise in the international markets, domestic countries, which are net exporters of commodities, will be benefited from improved terms-of-trade. But some of them will miss out the benefits of those countries that have banned exports to protect domestic consumers. Similarly, net importer of commodities could face the challenges of meeting consumption demand and maintaining price stability.

The economy of India is largely integrated with the world economy as globalization is progressing. Though India is now one of the major emerging economies in the world, yet only some sectors in India are integrated with the world markets. On the other hand, in certain sectors, particularly agriculture, this may not be entirely true. This is not only due to more restrictions on world trade of agricultural commodities but also restriction in trade among the regions within the country. Therefore, food inflation is different in different regions within the country. In a world with no transaction costs, the way to measure such integration is the difference in the prices of similar commodities in different regions/countries. The more integrated a market, the less would be this gap. For example, if in country A, commodities are more expensive than in the neighbouring country, say B, the free flow of commodities will encourage producers in B to sell in A and consumers from country A to buy from country B. This movement will continue till prices are equated in the two regions. But in the real world, there are various transaction costs that prevent this from happening. Therefore, another way of measuring the degree of integration is to see how these prices have moved over time.

When we talk about greater integration of Indian economy with the world economy, it is also important to remember that India is a very small player in the global trade scenario. According to World Trade Organization (WTO), India's share in world's total exports was 1.32 percent, while its share in total imports was 2.02 percent in 2009, where agricultural product contributed 10.2 percent to the economy's total exports and 5.6 percent of agricultural products were imported. The share of manufacturing sector in total merchandise exports declined marginally from 62.9 per cent in 2010-11 to 61.3 per cent in 2011-12. However, the respective share of petroleum products and primary products increased during that period. Exports of petroleum products grew by 34% during 2011-12 as against 47.1% during 2010-2011.

Oil imports of India during December-2012 were valued at US$ 14429.7 million which was 23.56 per cent higher than oil imports valued at US$ 11678.7 million in the corresponding previous year. Oil imports during April-December, 2012-13 were valued at US$ 124520.8 million which was 12.18 per cent higher than the oil imports of US$ 111002.9 million in the corresponding previous year. Non-oil imports during December, 2012 were estimated at US$ 28119.8 million which was 0.87 per cent lower than non-oil imports of US$ 28365.4 million in December, 2011. Non-oil imports during April-December, 2012-13 were valued at US$ 236751.1 million which was 6.37 per cent lower than the level of such imports valued at US$ 252864.9 million in April-December, 2011-12. As per the available data on commodity-wise imports for 2011-12, petroleum and petroleum products continued to be a major item of India's imports, followed by capital goods and gold and silver. Petroleum, petroleum products and related material, accounting for nearly 31.7 per cent of India's total merchandise imports, grew by 46.2 per cent during 2011-12 as compared with 21.6 per cent during 2010-11. Import of gold & silver showed a marginally higher growth of 44.4 per cent as compared with 43.5 per cent in 2010-11, reflecting the higher demand for gold despite the rise in international gold prices in 2011-12. Higher growth in imports of gold in value terms (44.4 percent) than that in international prices (27.2 per cent) during 2011-12 reflected the contribution of price as well as quantum factors in increasing the imports of gold. However, non-oil imports during

2011-12 at US$ 334.5 billion witnessed a growth of 26.8 per cent as against 31.1 per cent during 2010-11 (MCX Commodity Year Book, 2011).

Therefore, Rajmal and Mishra (2009) stated that with the gradual opening up of the economy, international prices have started to play a key role in impacting domestic inflation in India. The extent to which the international price movements are reflected in domestic prices has long been a matter of interest in international economics. Hence, against the above backdrop, this chapter attempts to explore the nature and extent of impact of international prices on the domestic prices in India. The reminder of the chapter is organized as follows. In section-6.2 we have described the commodity market integration and in this section we also have analysed the sources of market integration. Price transmission is analysed in the section-6.3. In section-6.4, we have analysed various constraints of commodity price transmission. Section-6.5 gives the review of literature both for India and other countries. The methodology and data are analysed in the section-6.6. In section-6.7 we have analysed the trends in international commodity prices. The construction of commodity price index is reported in section-6.8. In section-6.9, we have analysed the movements in commodity prices. In section-6.10, we have analysed the absolute commodity price. The correlation results are analysed in the section-6.11 whereas the section-6.12 gives the volatility in domestic and international commodity prices. In the section-6.14, we have analysed the cointegration results and the VECM results are explained in the section-6.15. The last section-6.16 reports the causality test results, followed by the summary in section 6.17.

6.2 Commodity Market Integration[1]

The term 'market integration' has been variously used in different fields of research. Market integration is defined as the degree of price transmission between two, either vertically or spatially, related markets. The operational definition of market integration is known as the law of one price (LOOP) - identical products are sold at a uniform price across different markets. Homogeneous commodities follow the law of one price (Monke and Petzel, 1984). The assumption required for the LOOP to hold is of profit maximization and priceless transportation, distribution and resale. If the LOOP holds for a product in all the markets, then it would be characterized as an integrated market. In the domestic economy, if LOOP holds, then domestic market integration exists (Bradford and

[1] This is mainly drawn from Acharya et al. (2012), Ghafoor & Aslami (2012) and Jha et al. (2005).

Lawrence, 2004). In the period of globalization, commodity markets around the world have been integrated within as well as across boundaries. At the same time, deregulation in market has led to removal of trade restrictions, which is one of the pre-requisites for market integration. Commodities are now more mobile across national boundaries, with the development of technologies and communication systems.

Lack of integration is referred to as 'segmentation'. A market is geographically segmented if the location of the buyer and seller influences the terms of transaction in a substantial way (that is, by more than marginal cost of physically moving the goods from one location to another). A perfectly competitive market should be fully integrated (Knetter and Goldberey 1996). The premise of full price transmission and market integration corresponds to those of the standard competition model. In a frictionless undistorted world, the LOOP is supposed to regulate spatial price relations (Conforti, 2004). According to Stigler (1969), a market is in the law of one price (LOOP) when "the area within the price of a commodity tends to uniformity, allowance being made for transportation costs". Based on this definition, there exists a large volume of empirical literature investigating market integration by analyzing price relationships.

Thus, the law of one price (LOOP) states that for a given commodity, a representative price, adjusted by exchange rates and allowance for transportation costs, will prevail across all countries. For example, if p_{i1} and p_{i2} are prices in domestic and international markets of commodity "i" respectively, then according to the LOOP, the two will be equally adjusted for the exchange rate. Therefore, the LOOP suggests that similar commodity markets across all countries should be integrated as a single market, which is warranted by the efficient international commodity arbitrage. But either in practice or in real world, the assumptions of costless transportation and resale (such as tariff barriers) do not hold in practice. Hence, these frictions should give rise to a stable price differential across two markets. This is the weaker or relative version of the LOOP. The two prices, then, differ by some constant α.

Like financial markets, commodity market integration has vital importance due to several reasons. If two regions are integrated, then it is more profitable for producers to sell in the region where goods are more expensive. The movement will continue till prices equate across regions. If price of good "i" in the international market is higher than that in the domestic market, then it is more profitable for domestic producers to sell in the international market as they get higher returns for their product. The export will take place till prices in the domestic market rise and the gap between the two markets is no longer there. In that situation, it will not be profitable to sell domestic commodities in the international market and vice versa. These situations will arise when there are no trade restrictions. When there will be either export or import restrictions, then the prices in the national market might not move with those in the international markets.

Sources of Market Integration: Geographically, separated markets are spatially integrated if goods and information flow freely among them and, as a result, the effects of price changes in one market are transmitted to another market's price. Theoretically, under the assumption of perfect competition, when two regions are in trade, the product price change in import region equals to the price in the export region plus transaction costs. Therefore, the price change in the export region induces a price change in the import region in the same direction and the same degree. If this is the case, both the markets are completely integrated as a single market. The extent and the speed with which shocks are passed through, and the strength of the interdependence among prices are the indicators of the degree of integration and the global efficiency of markets' performance.

Measurement of market integration can be viewed as basic data for developing an understanding of how specific markets work (Ravallion, 1986). Integrated markets do not necessarily imply efficient spatial allocations (Knetter and Slaughter, 1999). It is worth considering what price dispersion actually reveals about integration. Which factors make arbitrage costlier and thus enable price discrimination. In order to understand long run market segmentation we need to study price details market wise; product by product. Deviation in the LOOP is not merely because of product differentiation. Palaskas and Barbara (1993) attempt to answer the question of how markets work, by evaluating the behaviour of prices of staple foods and then by explaining the price behaviour with reference to market institutions. In making inferences about market efficiency from the data on prices, the concept of integration has been central. In the domestic market, laws regulating the distribution and resale of commodities, information, transportation cost and other transaction cost can result in price differentiation (Knelter and Goldberey, 1996).

In the case of differentiated products if prices differ but have a high degree of substitutability in production or consumption, shocks from changes in supply and demand of one product are transmitted to other products in the commodity group (Monke and Petzel, 1984). This mechanism leads to price linkages across the differentiated products can be identified statistically. Integrated markets are defined as markets in which prices of differentiated products do not behave independently.

6.3 Price Transmission[2]

Broadly, the commodity market integration can be categorized into three dimensions - nationally, regionally and globally. From an alternative perspective, commodity market integration could take place horizontally and vertically. In the horizontal integration, inter-linkages occur among domestic commodity market segments, while vertical integration occurs between domestic markets and international/regional commodity markets (USID, 1998). Domestic market integration entails horizontal linkages of various regional markets.

The issue of price transmission has a long history in the economic literature, surveyed by Meyer and Cramon-Taubadel (2004). In simple terms, price transmission is a change in one price that causes another price change. Price transmission refers to the effect of prices in one market on prices in another market. Generally, it is measured in terms of the transmission elasticity, defined as the percentage change in the price in one market given a 1% change in the price in another market. To understand the price transmission, we have given an example here. Assume that crude oil is in global, it is in upstream, and petroleum is local or domestic, it is in downstream. Market for petroleum is small compared to the market for crude oil in terms of quantity sold/bought, so that downstream prices cannot drive the upstream prices.

In the short-run, only crude oil prices drive petroleum prices, where prices of other inputs are assumed to be constant and no substitutes are available to petroleum. Given this, one may expect that increases or decreases in crude oil prices trigger appropriate changes in downstream, resulting changes are symmetric in terms of absolute size/timing. Such behaviour is predicted by all standard market pricing models (perfect competition, monopoly) which is called the symmetric price transmission.

However, asymmetric price transmission exists when the adjustment of prices is not homogeneous with respect to characteristics, external or internal to the system. For example, increase in crude oil prices leads to immediate increase in petroleum prices, but decreases in crude oil prices take time to be passed down to petroleum prices. This asymmetry is referred to as time asymmetry. There is also size asymmetry, i.e., a situation when increases in crude oil prices lead to bigger changes (in absolute values) in petroleum prices than decreases but this size asymmetry cannot occur on its own. If that had been the case then the upstream prices and downstream prices would drift apart. Though we assumed that downstream prices and upstream prices were related to each other, this could

[2] This section draws on Rajmal and Mishra (2009), McNew (1996), Sanogo (2008) and Goodwin (2006).

not be the case. Accordingly, size asymmetry can occur only together with time asymmetry and only when the long-run relationship between prices is restored after the impulse shock to upstream prices.

In the economic literature, asymmetric price transmission caught attention because of two reasons. First, its presence is not in line with predictions of the canonical economics theory (e.g., perfect competition and monopoly), which expects that under some regularity assumptions (such as non-kinked), convex/concave demand function) downstream responses to upstream changes should be asymmetric in terms of absolute size and timing. Secondly, asymmetric price transmission is important from the welfare point of view, that means, welfare redistribution from agents downstream to agents upstream and it has serious political and social consequences (Wlazlowski, 2003, vol.11, p.1-25).

Broadly, the price transmissions are categorized into three – vertical, spatial and cross-commodity integration. A brief description of each category is given below.

(i) *Vertical Price Transmission*: Vertical price transmission means an interaction between prices at different stages. Vertical price interactions can be characterized by degree (of completeness of pass through of price change), speed, and type of price adjustments through the supply chain. Such changes are usually represented as responses to shocks at some points in the chain. For example: for products at different points in the supply chain (e.g., wheat and bread), we focus on the case of markets for the same commodity in two locations.

From the existing studies on vertical integration, it is found that there are three aspects of vertical price transmission that have been of particular importance – (a) the extent of adjustment (i.e., how big a response triggered by a shock of a given size?), (b) the timing of the adjustment (i.e., are there significant lags in adjustment?), and (c) the extent to which adjustments are asymmetric (i.e., do positive shocks trigger different adjustments than negative shocks?). Most of the researches which are conducted on vertical price transmission are mainly motivated by concerns about market power and the potential effects that increased market concentration may have on the price adjustment process. For example, price of wheat → price of flour. If wheat price changes, it transfers to flour price. Such price transmission is called the vertical price transmission.

(ii) *Spatial Price Transmission*: According to Fackler and Goodwin (2001, p.973, an economic market is the spatial area 'within which the price of a good tends towards uniformity, allowance being made for transportation costs'. Therefore, when spatially separated markets are considered, price transmission analysis plays a crucial role in trying to assess how efficiently integrated they are, i.e., to which extent rational arbitrage operates. Under the spatial integration, most of the studies concentrate on the LOOP. That is, homogeneous goods in spatially separated locations will have a unique price, when expressed in the same currency, net of transport costs. For example: price of maize in South Africa → price of maize in Mozambique. Assume, South Africa is an exporting country and Mozambique is an importing country of maize. If South Africa changes the price of maize, definitely it will transfer to the maize price in Mozambique. Such a price transmission is called the spatial price transmission.

(iii) *Cross Commodity Price Transmission:* Cross commodity price transmission is the price transmission from one commodity to another commodity. For example, assume there are two commodities, say, maize and rice. If the change in price of rice leads to change in the price of maize, it is known as the cross commodity price transmission. Example: price of maize → price of rice. In this case, both commodities are different but closely related and also substitute commodities. Therefore, when there is a change in price of maize, it transfers to rice price.

6.3.1 Law of one Price (LOOP)

In this sub-section, we give a brief description on the LOOP. In the dictionaries and encyclopedias of economics, it is generally stated that for the spatial price transmission, arbitrage is the main mechanism behind the LOOP. In the Penguin Dictionary of Economics, the LOOP is defined as "some studies make the link between the LOOP and arbitrage explicit". The LOOP is mainly based on international commodity arbitrage. Isard (1997, p.942) said that in the assumed absence of transport costs and trade restrictions, perfect commodity arbitrage insures that each good is uniformly priced (in common currency units), throughought the world, the LOOP prevails. Of course, arbitrage is not the only mechanism that causes prices to converge but even without arbitrage, competition normally limits the divergence between prices of even similar goods. Asche et al. (1999) note that the LOOP is closely related to the composite commodity theorem of Hicks and Leontief. For both conditions to hold, in fact, prices must move proportionally over time.

Most of the studies on the LOOP in commodity markets at least implicitly appear to attribute the LOOP to arbitrage. But some studies find the link between the LOOP and arbitrage explicitly. The basic notion is the spatial arbitrage condition, which can be written as:

$$P_j - P_i \leq R_{ij} \tag{6.1}$$

where, P is the prices in the two spatially separated locations i to j, and R_{ij} is the cost of moving the good under consideration from i to j. The spatial arbitrage condition implies that the difference between prices in different locations will never exceed transport cost[3], or otherwise the profiting opportunities would be immediately exploited by arbitrageurs. That is, they would buy the goods in the markets where price is lower, and sell them where price is higher. Other things remaining equal, the prices would go up in the first market due to the increased demand, and price will go down in the second market due to increase of supply, thus leading towards the equilibrium. In the short-run, actual prices may diverge from the spatial arbitrage condition, but in the long-run, moving the price spread toward the transport cost.

The LOOP is categorized into two forms - weak and strong versions. The weak form is the same as the arbitrage condition, while the strong form is the relation of equation (6.1) taken with an equality sign. Goodwin et al. (1999) give a comprehensive definition of the LOOP. The economic agent is assumed to have the opportunity to sell in two different markets[4], and to aim at maximizing his profit, V, which is given by:

$$V_{q_{1t},q_{2t}} = \sum_t \left\{\delta^t \left[P_{1t+k} q_{1t} + P_{2t+j} q_{2t} - C(Q_t) - \tau_1 q_{1t} - \tau_2 q_{2t}\right]\right\} \tag{6.2}$$

where, q_{1t} is the quantity sold in market i (i = 1, 2) at time t, $P_{i,t+k}$ is the price received upon delivery in market i (at k and j periods after t), C(.) is a general arbitrage cost function, Q_t is the total traded quantity ($Q_t = q_{1t} + q_{2t}$), δ is the real discount factor, and τ_{it} is the per unit transaction cost. For all s > t, the first order conditions are given by:

$$E_{t+s} = \{\delta^s [\delta^k P_{1t+k+s} - C'(Q_{t+s}) - \tau_{1t+s}]\} = 0 \tag{6.3}$$

$$E_{t+s} = \left\{\delta^s \left[\delta^j P_{2t+j+s} - C'(Q_{t+s}) - \tau_{2t+s}\right]\right\} = 0 \tag{6.4}$$

These can be arranged to yield the following:

$$E_t = \left\{\delta^k P_{1t} - \tau_{1t} - \delta^j P_{2t+j} + \tau_{2t}\right\} = 0 \tag{6.5}$$

Supposing there are no delivery lags (i.e., k = j = 0), this relation implies the following:

$$P_{1t} = P_{2t} + (\tau_{1t} - \tau_{2t}) \tag{6.6}$$

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[3] The term transport cost is meant to include all costs of arranging transactions between spatially different locations.

[4] Storage is not explicitly considered, but may be added to the model, without loss of generality; additional arbitrage conditions would exist among expected prices, storage costs, and transportations costs.

This is the LOOP according to Goodwin et al. (1999)[5].

To hold the LOOP in commodity market, another basic concept is the competitive market equilibrium, that is, a condition in which extra ordinary profits are exhausted by competitive pressures, regardless of whether this results in physical trade flows between markets (Barrett and Li, 2002)[6]. Analogously, the spatial market efficiency can be taken as synonymous with the spatial arbitrage condition. For the concept of spatial market integration, instead, Barrett and Li (2002) explicitly make it clear that it just reflects the tradability of products between spatially distinct markets, irrespective of the presence or absence of spatial market equilibrium and efficiency. In other words, market integration is a quantity based indicator of tradability, while, as explained, efficiency is a price-based indicators, based on economic concepts of equilibrium (Thompson and Bohl, 2002). Frackler and Goodwin (2001) reported that there is no satisfactory definition of spatial market integration. Indeed, in general, the degree of co-movement is shown by prices in different locations, and also, the degree at which price shocks are transmitted among spatially separated markets (Goodwin and Piggott, 2001). In this respect, Frackler and Goodwin (2001) propose the following indicator:

$$RA_{AB} = \frac{\delta P_B}{\delta \varepsilon_A} / \frac{\delta P_A}{\delta \varepsilon_A} \qquad (6.7)$$

Where ε_A is a shock occurring on market A, and RA_{AB} is the price transmission ratio between region A and region B. If the two markets are perfectly integrated, it should show a value of 1. This ratio, which could not be symmetric between the two regions, allows studying how shocks are transmitted from one market to the other. Finally, since the LOOP can hold even if the price transmission ratio between two regions is less than one[7], the following hierarchy holds for the concepts defined so far, where the notion of market integration refers to the equation (6.7).

$$\text{Perfect Market Integration} \Rightarrow \text{LOOP strong} \Rightarrow \text{LOOP weak} \qquad (6.8)$$

[5] If transaction costs are a constant proportion of price ($\tau_{1t} = \lambda_{1t} P_{1t}$), then the first order conditions imply $P_{1t} = (1 - \lambda_2 / 1 - \lambda_1) P_{2t} = \beta_0 P_{2t}$ which as explained in the following paragraph, is a multiplicative version of the LOOP which can be put in a linear form by taking the logarithms of the prices.

[6] Markets may maintain spatial linkages even when direct trade doesn't occur between them. This happens if selling agents from both markets compete in a third one and perfect competition holds in all three markets. Even in the absence of trade, spatial market linkages might be disciplined under the threat of competition; prices differences are kept between the cost bands (Goodwin et al., 1999).

[7] This might happen also for unrelated commodities. Pindyck and Rotemberg (1990), cited by Tomek and Myers (1993), note that the co-movement of prices has three explanations – (a) supply and demand shocks in one market may spill over into other markets, (b) macroeconomic shocks can affect all prices together and (c) speculators overreact to new information, and this causes spillovers between commodity markets.

The LOOP is expected to regulate spatial price relations in a frictionless undistorted world. The premises of full price transmission and market integration correspond to those of the standard competition model (Conforti, 2004).

6.4 Constraints of Commodity Price Transmission

Miljkovic (1999) and Conforti (2004) stated that some major groups of factors that prevent prices from convergence could be identified[8]. Some of these are described briefly below.

(a) Transaction Costs: High transportation costs play a crucial role while investigating the market efficiency. It is very important especially for agricultural commodities (Fackler and Goodwin, 2001). Unless certain assumptions are made, their treatment is not easy, and, even if the LOOP is satisfied, if transaction costs are large and volatile, prices don't move together. Transaction costs have many components like transport costs (freight rate, i.e., per unit of transportation costs), variable transport costs (insurance costs, financing, hedging, contracting, technical barriers to trade), exogenous cost (underwriting fees, testing charges), unit average duties, and other immeasurable transaction costs (such as search costs and exchange rate variability (Barrett, 2001). Apart from these, all other information, negotiation, monitoring and enforcement costs are also included with this cost. Conforti (2004) and Miljkovic (1999, p.135) state that the effect of distance on trade consists of three components - transportation costs, time element (perishability, adaptability to market conditions, irregularities in supply in addition to interest costs), and 'psychic' distance, i.e., familiarity with laws, institutions and habits.

(b) Domestic Policies: Government of a domestic country adopts several commodity price policies like variable levies, export subsidies, non-tariff barriers, quotas, prohibitive tariffs, ad valorem tax, etc. to prevent domestic price from changes/volatility in world prices. Therefore, due to such policies, LOOP cannot exist.

(iii) Market Power: Market power exists in production chains, where some agents may behave as price makers, while some others are price takers. Due to the presence of increasing returns to scale in production, it leads to the origin of market power. Miljkovic (1999) said that export demand elasticities varied over countries. This provided the impetus for the differential pricing of exports as opposed to price taking. Prices were not

[8] In general, the conditions necessary for adherence to factor price equalization are even stronger than those required for output markets and evidence supporting factor market integration is weak (Fackler and Goodwin, 2001).

expected to converge also if product homogeneity and differentiation influence the substitutability in consumption.

(iv) Exchange Rate: Generally, when commodities are traded from domestic to international market, exchange rates are passed-through on output prices. Therefore, exchange rate risks do have an effect on export prices (Miljkovic, 1999).

(v) Market Information: The imperfect flows of market information can also raise the cost of arbitraging. If consumer has to pay some money to get information on the price and products, cost in general becomes higher.

However, market integration affects economic growth, induces structural change and alters the location of economic activities (Vollrath and Hallahan, 2006, p.56). In the recent year, international price transmission is an issue which has received considerable attention to understand the behavior of commodity prices in an emerging economy like India.

6.5 Review of Literature on Market Integration and Price Transmission

The literature on the market integration and international price transmission is vast. It has many dimensions also in terms of commodities involved, types of integration and techniques adopted.

There is a large number of research works on market integration and price transmission, both spatially and vertically. Most of studies on the price transmission are examining within the context of the LOOP (cited by Baffes, 1991). For example, Esfahani (2006) examined the impact of LOOP in the Chinese wholesale food markets. Various integration models were used to evaluate pricing efficiency in a number of major wholesale food markets in Beijing, Nanjing, Shanghai, and Shenzhen over the period of 1993-1999. He found that the LOOP did not prevail in most of these markets. Kaabia et al. (2002) examined the non-linear adjustments of prices along the lamb sector in Spain using the multivariate approach to specify and estimate a threshold autoregressive model. They found that in the long-run, price transmission was perfect and any supply or demand shocks were fully transmitted to all prices in the system. In the short run, the analyses suggested that the higher degree of horizontal concentration among retailers allowed them to have market power. Some of the studies in the context of market integration include Ravallion (1986), Sexton et al. (1991), Palaskas and Harris (1993), Zanias (1993), Gardner and Brooks (1994) and Blauch (1997).

Spatial and vertical integration: While examining the spatial market integration, many studies examine specific country with respect to international market. This is because it is easy to examine the relationships of one country's commodity prices with international prices and vice-versa. Even within a single country also, there are studies examining the market integration of several markets of various regions. Dawson and Dey (2002), Choi et al. (2008), Ghosh (2003), Badiane and Shively (2003), Zahid et al. (2007) etc. are some studies examining the spatial market integration. Dawson and Dey (2002) studied the spatial market integration among major rice markets in Bangladesh. An integrated empirical framework tested long-run spatial market integration between price pairs using a dynamic vector autoregressive model and cointegration. They found that rice markets in Bangladesh were perfectly integrated with each other. The results of the causality analysis showed that Dhaka market dominated nearby markets but was itself dominated by more distant markets. In a similar way, Choi et al. (2008) assessed the marketing channel, distributed marketing margins and spatial market price transmission to evaluate the performance of pulses in Myanmar markets. The analysis of the two markets' integration to know that degree of co-movement of prices in spatially separated markets. The assumption was that Mandalay current wholesale price depended upon the Yangon current wholesale price and taking one to five lag weekly wholesale prices of both Yangon and Mandalay markets. The results concluded that there was a long-run relationship existing between chick pea and green gram within the Yangon and Mandalay markets. Ghosh (2003), using the maximum likelihood method of cointegration, empirically evaluates intra-state and inter-state spatial integration of wheat markets in India. The cointegration tests provide strong evidence in favour of spatial integration of the regional wheat markets. Even though the regional markets are geographically dispersed, the prices across different market centres within and across the selected states have exhibited long-run spatial linkages, suggesting that all the exchange locations are integrated and the prices provide relevant market signals. Badiane and Shively (1997) investigated respective role of spatial integration and transport costs in explaining price changes in Ghana. They found that reductions in local prices and local price variance following the introduction of economic reforms in 1983 could be traced to both local and central market forces. But those differences in the degree of market integration had important implications for long-run changes in transport costs and the evolution of prices in outlying markets.

Zahid et al. (2007) analyzed long-run market integration for wheat between central market (Lahore) and five feeder markets (Faisalabad, Sargodha, Gujranwala, Gujrat and

Sialkot) in Pakistan. The results from the analysis showed that market couples of Lahore-Gujranwala and Lahore-Faisalabad were perfectly integrated with each other in the long-run. The rationale behind those integrated markets was better and direct road and rail links, common socio-economic cultures, better flow of information between those markets. The pairs of Lahore-Gujrat, Lahore-Sargodha, and Lahore-Sialkot markets were partially integrated. The reasons behind those partially integrated markets were having somewhat a long distance, different socioeconomic cultures and minor information flow. Those market pairs did not have any direct road and rail link for transportation of commodities. The study revealed that Government should develop infrastructure among major markets, especially roads and rails and should improve flow of information.

Few studies in the context of vertical integration include Bakucs et al. (2013) for milk, and Goetz et al (2008) of citrus export. Bakucs et. al. (2013) focussed on the vertical price transmission on the Hungarian milk market. They used the Gregory–Hansen methodology to simultaneously search for a break point and a cointegrating relationship between the logs of producer and retail prices of milk. They found that price transmission is asymmetric on both long and short-run, and after November 2000, the marketing margin had increased. They presented a number of events that possibly explained the structural break. Goetz et al.(2008) studied vertical price transmission between Israel and the EU in the imperfectly competitive Israeli citrus export sector, which emerged after the former parastatal marketing board was liberalised in 1991. They found the evidence of positive asymmetry in price transmission, implying that Israeli exporters' profits increased at the expense of grapefruit growers, and they argued that this was the evidence that Israeli citrus exporters exerted market power vis-à-vis Israeli citrus growers. This study was unique in investigating vertical price transmission in the international supply chain for fresh fruits and vegetables (FFV). International FFV trade is especially susceptible to the abuse of market power since transparency regarding the determination of the grower price is often very low. The analysis found that exporters transmitted changes in EU import prices to Israeli growers asymmetrically in the volatile phase directly after liberalization, but symmetrically in the calm phase thereafter. They also suggested that the measured asymmetry in price transmission was economically significant. In a nutshell, their study showed that liberalization improved the efficiency of Israel's international citrus marketing channel, although this took time and was probably accelerated by government market intervention.

In theory, spatial price determination models suggest that, if two markets are linked by trade in a free market regime, excessive demand or supply shocks in one market will have an equal impact on price in both the markets. The implementation of import tariffs, in general, will allow international price changes to be fully transmitted to domestic markets in relative terms. Thus, a proportional increase in the international price will result in an equal proportional increase in the domestic price, at all points in time provided that tariff levels remain unchanged. However, if the tariff level is prohibitively high, changes in the international price would be only partly if at all transmitted to the domestic market. As domestic prices may be close to the autarky price level, thus, obliterating opportunities for spatial arbitrage and resulting in the two prices moving independently of each other, as if an import ban was implemented. Other policy instruments such as tariff rate quotas may result in international price changes. But not being at all points of time proportionately transmitted to domestic prices, as changes in the domestic price level will depend on two different tariff rates that are applied according to whether the volume of imports falls within or outside the quota level.

Apart from policies, domestic markets can also be partly insulated by large marketing margins that arise due to high transfer costs. Especially in developing countries, poor infrastructure, transport and communication services give rise to large marketing margins due to high costs of delivering the locally produced commodity to the border for export or the imported commodity to the domestic market for consumption. High transfer costs and marketing margins hinder the transmission of price signals, as they may prohibit arbitrage (Sexton et al. 1991; Badiane and Shively, 1998). As a result, changes in world market prices are not fully transmitted to domestic prices, resulting in economic agents adjusting (if at all) partly to shifts in world supply and demand.

Non-competitive behaviour such as that is considered in pricing-to-market models (Dornbush, 1987; Froot and Klempeter, 1989; Krugman, 1986) can hinder market integration. Pricing-to-market models postulate that firms may absorb part of exchange rate movements by altering export prices measured in home currency in order to retain their market share. Alternatively, oligopolistic behavior and collusion among domestic traders may retain price differences between international and domestic prices in levels higher than those determined by transfer costs.

Tools and Techniques: Majority of the studies on price transmission and market integration applied different time-series econometric techniques. The development of these techniques (such as cointegration and error correction models), has become the standard tool for analyzing spatial market relationships, replacing earlier empirical tools (such as the bivariate correlation coefficient and regressions). Nevertheless, time series analysis has also been criticized to be unreliable (Blauch, 1997; Barrett and Li, 2002) with recent research works focusing on switching regime models that incorporate data on prices, volumes traded and transactions costs. The debate on the application methodology for testing for market integration and price transmission has a relatively long history starting with Harriss (1979). Blauch (1997) provides a review of the debates and examines the statistical performance of econometric tests for market integration. In brief, linear tests for market integration and price transmission are regarded of as crude and inappropriate (Blauch, 1997; McNew, 1996; McNew and Fackler, 1997; Fackler and Goodwin, 2002 and Barrett and Li, 2002). Non linearities in market relationships that arise from arbitrage conditions, unsynchronized price cycles, discontinuous trade and non stationary transfer costs are regarded as rendering linear representations and models not useful and inaccurate.

Although there are some merits in the above criticisms, especially as far as non stationary transfer costs are concerned, time series analysis can provide useful insights into the issue of market integration and price transmission, if an appropriate testing framework is employed and the results are interpreted correctly. Market integration is formally testable, if one adheres to the definition implied by the standard spatial equilibrium model. However, the *extent* of price transmission is an inherently ambiguous concept. Cointegration and error correction models provide an analytical tool that can focus beyond the case of market integration or complete price transmission, in testing notions such as completeness, speed, and asymmetry of the relationship between prices. For example, discontinuities in trade, within a time series modeling framework, correspond to slow speed of convergence to a long run relationship, whilst non-linearities may be modeled as asymmetric responses to price changes. Time series models have small data requirements as compared to other methodologies, relying on price series only, which are more easily available in developing countries. In addition, time series applications play a useful role in signaling potential failures in markets and in contributing to the assessment of the direction, magnitude and distribution of welfare effects of trade policy reforms. However, it is important to note that, in general, time series applications may also creator while attempting to achieve an unattainable goal that of giving a universal measure of the extent of price transmission in terms of a single parameter or test (Ghosh, 2012).

Determinants: Several determinants or factors are responsible for the extent, degree and directions of price transmission and market integration. Many studies have highlighted several factors that impede the pass-through of price signals. Distortions introduced by governments in the form of policies, either along the border, or as price support mechanisms weaken the link between the international and domestic markets. Agricultural policy instruments such as, import tariffs, tariff rate quotas, and export subsidies or taxes, intervention mechanisms, as well as exchange rate policies insulate the domestic markets and hinder the full transmission of international price signals by affecting the excessive demand or supply schedules of domestic commodity markets (Gardner, 1975; Mundlak and Larson, 1992; Quiroz and Soto, 1996; Baffes and Ajwad, 2001; Abdulai, 2000; Sharma, 2002).

Goletti et al.(1995) investigated how different measures of market integration can be used to derive conclusions about the structural determinants of market integration. They assumed that marketing infrastructure, volatility of government intervention, and the degree of self-sufficiency in production are the major determinants of market integration. They found that the degree of market integration in Bangladesh was rather moderate. The weak congruence of the effect of various structural factors suggested that market integration was affected negatively by the distance between markets and by the number of strikes, whereas it was positively affected by the number of production shocks.

World Bank (2008) points out that the pass-through of rising global prices doesn't translate into an immediate and proportionate rise in domestic price levels, due to various factors such as a weakening dollar, domestic infrastructure and price stabilization policies. On the other hand, FAO (2008) indicates that large increases in food and fuel prices threaten macroeconomic stability and overall growth, especially low-income, net-importing countries. However, it implies that government policies designed to avoid large domestic price shocks and the depreciation of the US dollar against many currencies tend to reduce transmission of world market prices to domestic prices. In this regard, it sets the case of Bangladesh as a successful example in mitigating the effect of international price on domestic prices and indicates that Bangladesh uses variable rice tariffs to stabilize domestic prices.

Commodity specific and commodity groups: Most of the studies on price transmission and market integration are commodity specific (rice, wheat, milk, agricultural products etc.) as shown in Table 6.1. For example, studies like Moghaddasi (2009), Bakhshoodeh and Sahraeiyan(2006) examined the price transmission in agricultural markets for Iran. Moghaddasi (2009) found that that price transmission according to Houck approach in pistachio market is asymmetric. In other words, price increases are transmitted more completely than its decreases. Error Correction model in the date market showed that farm price increases were more rapid and fully transmitted than price decreases. This revealed the asymmetry in price transmission. Bakhshoodeh and Sahraeiyan (2006) investigated Iranian domestic agricultural markets integration and probability of Iran's markets integration with world agricultural markets. They found that long-run market integration among local markets of products such as rice and wheat whereas Iran's major agricultural product markets were not found integrating with world markets in the long run. Government intervention was recognized as the major impediment to domestic and world market integrations.

Studies like Rajmal and Mishra (2009) for India examined the present topic for food products. They examined the nature and extent of impact of international prices on the domestic food prices in India. They considered that the pass-through from the world food prices reflects only a part of the rise in domestic food prices. They examined various factors such as domestic demand and supply conditions, exchange rates, and imports and exports of concerned commodities. They found that while domestic and international food prices had moved in the same direction, particularly in the current decade, the food prices in India had remained lower than international prices in terms of absolute levels, percentage variations as well as volatility. There was also evidence of limited pass-through from international food prices to domestic food prices in India. They pointed out that the reason for limited pass-through lied in the fact that food prices in India were predominantly driven by the domestic factors.

The issue of price transmission and market integration with respect to rice was also examined [see Sonogo (2008) of Nepal with India, Weber and Lee (2006) for US and Mixico, Dawson and Dey (2002) for Bangladesh, Jha et al. (2005) of India]. Sanogo (2008) studied the integration of rice markets in the mid-west and far-west districts of Nepal. He found that the rice markets of the hinterland were poorly integrated with the regional market of Nepalgunj. In contrast, price fluctuations were transmitted, both in the short and medium run, across the India-Nepal border between Nepalgunj and the Indian border districts of Rupedia and Jogbani. Large price differentials relative to transport costs indicated market inefficiencies in the mid-west and far-west districts of Nepal. Moreover, the poor road infrastructure determines the price differentials. Poor infrastructure impedes price correlation and convergence between these districts. Given its open-door policy with

India and the ongoing efforts to further align trade policies with the World Trade Organization, the findings suggested that Nepal would maintain its partnership with India and build an effective market surveillance system that covers the Indian border markets as well, to ensure food security in the short run. However, substantial investment in transportation infrastructure is required to improve market integration and accessibility in the long run, especially in the hilly and mountainous areas.

Weber and Lee (2006) examined the spatial market integration in the U.S. and Mexican rice markets using the multivariate cointegration test. They found that it seemed that long-run equilibrating relationships bound most Mexican markets - the exceptions being Aguascalientes, Leon and Irapuato - to the U.S. markets, and that the U.S. markets were integrated with continuity. The small size and lack of proximity of the three smaller Mexican markets to transport hubs and milling centers tended to isolate them (like other such regional markets in Mexico) from the informational flows of the larger marketplace. They also found some conflicting results. The disintegration of American markets in the second subsample was an isolated supply shock, such as a weather phenomenon, could have a substantial impact on whether markets were integrated. The third subsample showed that the imposition of a large tariff did in fact alter the relationships between the affected markets, though ongoing trade might have upset the divisive effects of the tariff.

Jha et al. (2005) examined the market integration in 55 wholesale rice markets in India using monthly data over the period of January 1970 – December 1999. The technique of Gonzalez-Rivera and Helfand (2001) was used to identify common factors across various markets. It was discovered that market integration was far from complete in India and a major reason behind this was the excessive interference in rice markets by government agencies. As a result, it was hard for scarcity conditions in isolated markets to be picked up by markets with abundance in supply.

While many studies examined only one commodity, some studies also exist examining two of more commodities simultaneously. For example, Baffes and Gardner (2003) examined the degree to which world price signals had been transmitted into domestic prices for eight countries and ten commodities, out of a total of 31 country/commodity pairs. The main characteristic of these countries was that they all undertook substantial policy reforms during the mid-1980s to early 1990s. The paper investigated the effect of reforms on the speed at which signals were transmitted to domestic markets and on the extent of price transmission. They found that Chile, Mexico, and Argentina were the only countries whose domestic commodity markets were integrated with world markets. For the remaining cases (Ghana, Madagascar, Indonesia, Egypt, and Colombia), only a few country/commodity pairs was there some pass-through of world price changes. In terms of the effects of policy reforms, in the majority of the cases the hypothesis of a structural break following the reform year was rejected. In a similar way, Acharya et al. (2012) examined the transmission of prices of rice and wheat from the world markets to the domestic markets, especially to the farmgate during the world food crisis of 2007-08. The paper reviewed the domestic policies related to marketing of rice and wheat, including holding of public stocks, assessed the integration of domestic markets, analyzed the congruence between international and domestic prices and finally assessed the impact of high global prices on the farm gate prices. Using both econometric tools and policy analysis approaches, the study found that there was no cointegration between domestic and international rice prices. Delhi wholesale wheat prices appeared to be cointegrating with international wheat prices. There was long-run equilibrium relationship between international and domestic wheat prices at different levels of markets. The long-run elasticity of price transmission from international to wheat wholesale and retail prices was higher than that of farmgate prices. The transmission from international prices to farmgate prices was asymmetric, which showed that farmgate prices responded differently in rising and falling phases of international prices. The price transmission was symmetric in the case of wholesale prices of wheat. Interestingly, the short-run shocks in international prices did not have any significant influence on domestic prices at any level of wheat supply chain. The main factors that impacted the transmission of abnormal increase in global prices to Indian markets were timely and effective government intervention in rice and wheat markets, and almost complete insulation of domestic fertilizer prices from increase in international crude oil and fertilizer prices.

It is observed from the above literature review that several studies exist on the market integration and price transmission, both spatial and vertical. However, majority of studies have concentrated on agricultural commodities (as seen in Table 6.1). But there are very few such studies which have examined a group of commodities like the combination of agriculture, metals and energy prices. Moreover, a very less number of studies available in an emerging country like India on the present topic. Therefore, in this chapter we are empirically investigating the market integration and price transmission from international market to domestic market in India.

Table 6.1: Few commodity specific studies on market integration and price transmission

Commodity/Commodity Groups	Some studies with country names
Agricultural commodities	Maghaddasi(2009) of Iran, Bakhshoodeh and Sahraeiyan(2006) of Iran
Food products	Esfahani (2006) of China, Rajmal and Mishra (2009) of India
Rice	Sonogo(2008) of Nepal with India, Weber and Lee (2006) for US and Mixico, Dawson and Dey(2002) for Bangladesh, Jha et al. (2005) of India
Wheat	Zahid et al. (2007) of Pakistan, Ghosh(2003) of India
Rice and Wheat	Acharya et al. (2012) of India
Milk	Bakucs et al (2013) of Hungary
Pulses	Choi et al.(2008) of Myanmar

Source: Author's classification

6.6 Methodology and Data

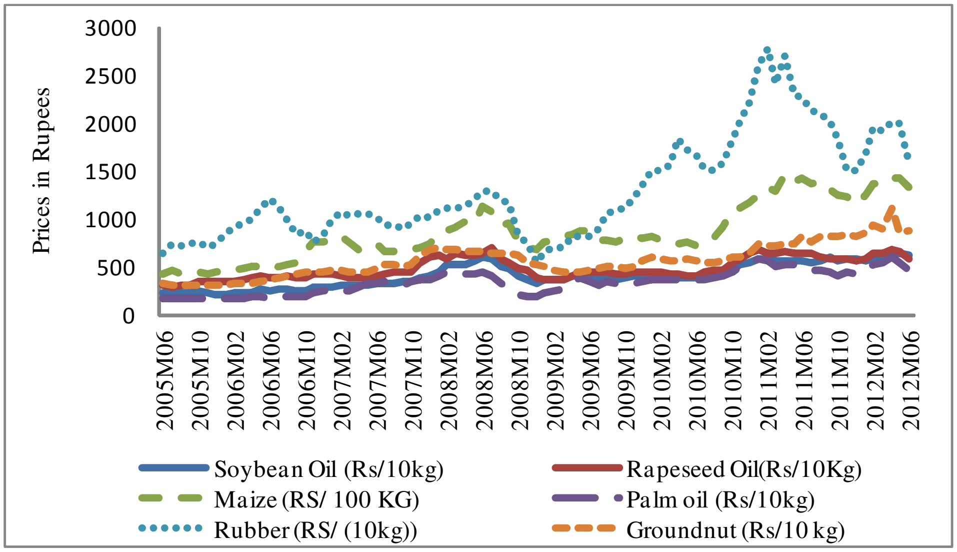
From the above existing literature, it is found that there were various econometric techniques which are used to examine the spatial market integration. Some of such econometrics techniques include the ratio of percentage changes between two time periods, correlation coefficients, co-integration analysis, VECM, causality, dynamic regression models based on a point location model, regime switching models and rational expectation models, etc. In this chapter, to examine the spatial price transmission, we have used the techniques of caulsality, cointegration and VEC models. These techniques were already explained in the chapter-3.

6.7 Trends in International Commodity Prices

(i) International Food Price: As stated in earlier chapter, in this study, the selected commodities are broadly categorized into three - agriculture, metal and energy commodities. In this section, we are analyzing price trends of these three groups in international market.

Since the beginning of 21st century, it has been seen that there had been increasing the prices of food in international market. If we look at Figure 6.1, we can see that there had been continuous rises in the food prices in the international market but the rise in prices was particularly sharp during 2007 through mid-2008, reflected higher demand with lower stocks. Though the international prices decelerated since second half of 2008 but they still continued to remain higher than the levels that prevailed during 2000-03.

Figure 6.1: Trends of International Food Prices from 2005 to 2012



Source: IMF online data base

According to the Food and Agriculture Organization (FAO) Report (2009), the survey data of 58 developing countries show that the latest prices are higher than a year earlier in 78 per cent of the cases, and are higher than 3 months earlier in 43 per cent of the cases. High level of prices was prevailing mostly in sub-Saharan African countries. So far as prices of specific commodities are concerned, in case of the cereals, the most important staple food in developing countries, the situation is quite similar with the latest nominal domestic price quotations considerably higher than 12 months earlier in about 80 per cent of the countries and higher than 3 months earlier in 35 to 65 per cent of the countries, depending on the type of cereal. In 10 to 30 per cent of the countries, latest food prices by late March 2009 as secured the highest on record. Food prices also remain at high levels in some other regions, particularly in Asia for rice and in Central and South America for maize and wheat. It can also be seen from Figure 6.1 that there has been continuous price rise since the mid-2008.

(ii) International Metal Prices: International metal price trends are shown in Figure 6.2. It can be seen that there has been continuous rises in the metal prices since 2005 to the mid-2008. It can also be noticed that international prices of aluminum rose from Rs. 7536.54 per quintal in June 2005 to Rs. 10927.68 per quintal in June 2007 and it reached the highest price of Rs. 13032.10 per quintal in July 2008. Thereafter, the prices of aluminum declined and resumed rising in the beginning of 2009 up to 2012. Similarly, the price of copper started rising from Rs. 15359.62 per quintal in June 2005 to Rs. 35717.22 per quintal in 2008 and thereafter it started declining. Again in the beginning of 2009, it started growing and in June 2012, it became Rs. 41827.96 per quintal.

The international price of gold has seen tremendous changes in the last couple of years. In June 2005, the international price of gold was only Rs. 6025.74 per 10 gram. It was continuously rising and became Rs. 15380.60 per 10 grm in February 2009. Then it slightly reduced and again it started rising till June 2009 and it reached Rs 28946.81 per 10 grm in June 2012. It can be seen that during the global financial crisis, while other metals prices were declining, gold price was rising due to heavy consumption or world-wide investment on gold because, investors believed that the metal was the most secure investment asset. Therefore, the price of this metal scored so high in a very short period of time setting a record in the history of the prices of metals.

Like gold, investors prefer to invest on silver as it is considered as the second precious metal in the world. Hence, it can be seen that the silver price which was only Rs. 10228.82 per kg in June 2005, rose to Rs. 24635.70 per kg in July 2008, slightly reduced and again it started rising since December 2008 and it reached Rs. 50666.51 per kg in June 2012. So, among the metals, gold and silver prices have seen tremendous changes in a very short period of time.

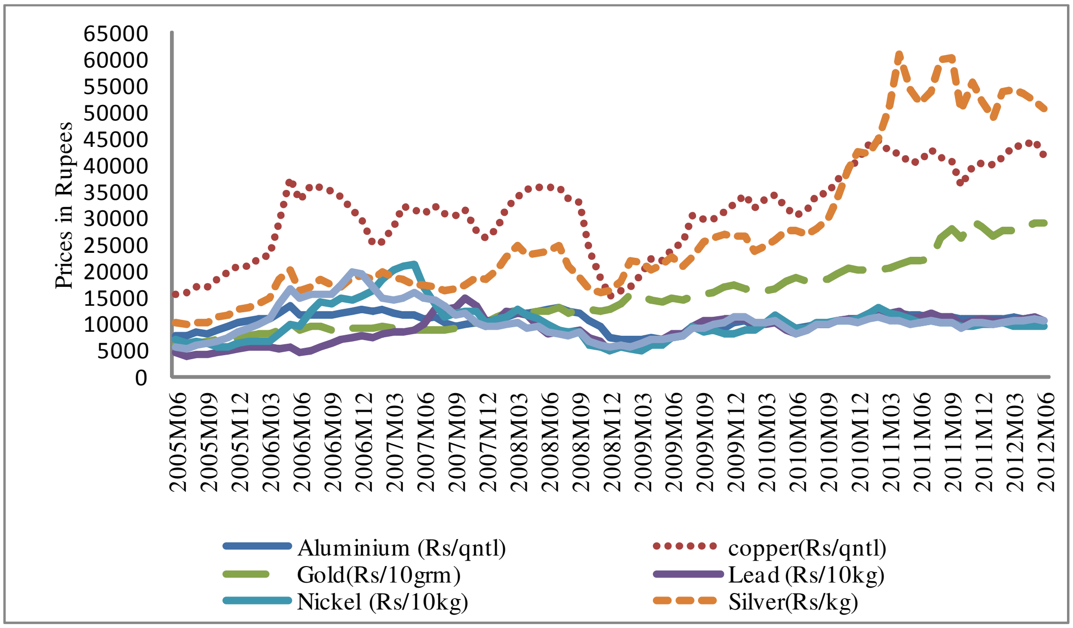
Lead price was only Rs. 4276 per 10 kg in June 2005 and it rose to Rs. 14637.30 per 10 kg in October 2007, after that it started declining and reached Rs. 6851.87 in May 2009. Thereafter, it had been continuously rising until it reached Rs. 10422.57 per 10 kg.

Nickel price also shot up from Rs. 7011.65 per 10 kg in June 2005 to Rs. 21093.94 per 10 kg in May 2007, Thereafter, it started declining. It can be seen that there had been continuous decline of prices of nickel and it reached at Rs. 9349.37 per 10 kg in June 2012. Similarly, international zinc price was Rs. 5539.98 per quintal in June 2005 and it reached the highest price of Rs. 19598.66 in November 2006. Thereafter the international price of zinc started declining and it reached at Rs. 10450.56 in June 2012.

(iii) International Energy Prices: The international energy price trends are shown in Figure-6.3. It can be seen that there has been continuous rise in the energy prices since 2005 to the mid-2008. It can also noticed that international prices of crude oil rose from Rs. 2453.81 per barrel in June 2005 and it reached the highest price of Rs. 5752.29 per barrel in June 2008. Owing to the global financial turmoil, there has been sharp decline in the demand for crude oil. Therefore, the price of crude oil has declined and it reached Rs.

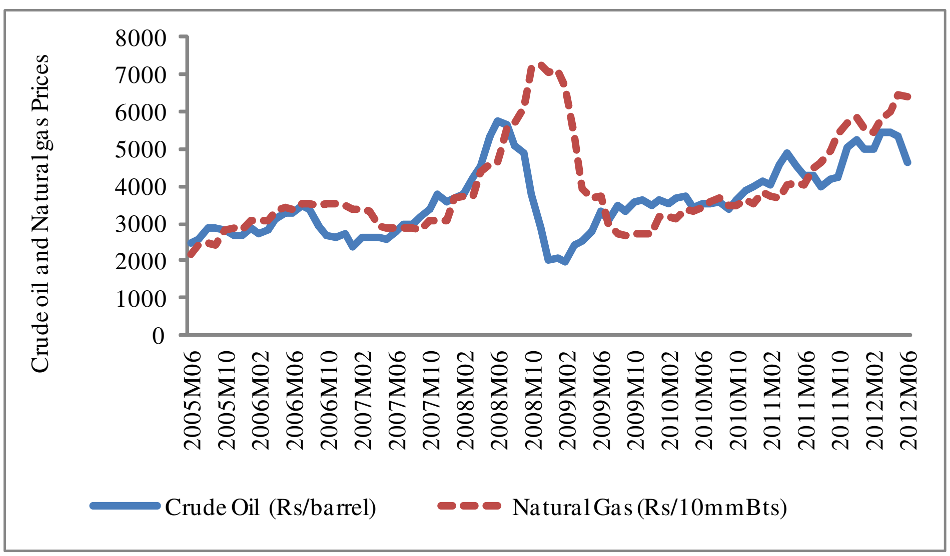
1985.88 per barrel in February 2009. Again it started rising from the March 2009 and it reached at Rs. 4637.61 per barrel in June 2012.

Figure 6.2: Trends of International Metal Prices from 2005 to 2012



Source: IMF online data base

Figure 6.3: International Energy Prices from 2005 to 2012



Source: IMF online data base

In the 21st century, there is a great demand for natural gas everywhere. Therefore, the international price of natural gas has seen dramatic changes in the last couple of years.

In June 2005, the international price of natural gas was Rs. 2175.31 per 10 mmBts. There has been a continuous rise in the price of natural gas and it became Rs. 3533.46 per 10 mmBts in October 2006. Thereafter, the natural gas price declined and it reached Rs. 28.8.29 per 10 mmBts in September 2007. Again it started rising since October 2007 and it reached at Rs. 7125.43 per 10 mmBts in January 2009. Thereafter, there has been a decline in the international natural gas price and it became Rs. 6416.50 in June 2012.

6.8 Construction of Commodity Price Index

In this section, we have reported the construction of an India-specific commodity price index to assess the impact of fundamental factors on commodity prices in India. While constructing the index, we have captured the relative importance of the commodity for India using the weight of the commodity in the WPI basket (base 2004-05**).** In appendix Table A.3.1 in chapter 3, we have reported the commodity price weight in WPI (2004-05). Though, it is necessary that the aggregate weights of commodities should be equal to 100, we have reweighted to each commodity by distributing 100 and the new (i.e, re-weights) weights of commodities are used to construct the commodity index using the spot prices of 14 commodities. We have normalized the component prices to a common scale, so that the weights are not distorted by the difference in values of different components. For this purpose, we have constructed the commodity index by anchored 100 for January 2009. The values for all other periods are divided by the average value for January 2009 to obtain the component value before combining the individual components into a combined index. The formation of commodity price index is followed by the Laspeyres price index. The Laspeyres price index formula is:

$$L_t = \frac{\sum_{j=1}^{n} p_{jt} q_{j0}}{\sum_{j=1}^{n} p_{jo} q_{j0}} \times 100 \qquad (6.9)$$

where, the subscript "j_0" refers to the base month value for good j, and, t refers to the current month. By using this formula, we have estimated four commodity indices - agricultural commodity index, metal index, energy index and all commodity index.

6.9 Analysis of Movements in Commodity Prices (Percentage Variation)

International prices of all selected food commodities have risen in the recent times due to tight supply and increase in demand. In Table 6.2, we have reported the percentage variation in nominal prices of commodities index prices both for international and India markets. It can be noticed that food index prices in India have generally been moving in tandem with the international prices, but at a significantly lower pace when compared with international food prices, thus, reflecting at less than complete pass-through. International soyabean price rose from 23.96% in 2006 to 50.49% in 2008, whereas India's food prices rose from -5.02% in 2006 to 40.42% 2008. While world food price have shown a sharp fall in 2009, domestic food price has also fallen but at lesser rate. Again in 2010 and 2011 international food price was increasing from 7.21% to 50.87 but its growth rate became negative in 2012. But India's food prices were continuously rising up positively since 2010 to 2012. The international price of metal was positive growth rate in 2006 and 2007 but in the year 2008 and 2009, the metal index price became negative growth rate from -13.29% to 25.26 and after that international metal index price has positive growth rate. India's metal price was also moving par with the international prices. The domestic metal index price was 190.04 in 2006 and it became 10.55% in 2007. The metal price in India became negative growth in 2008 and 2009 but thereafter there has been a positive growth rate. The international energy price index shows that in the year 2006, energy price positive growth rate (35.94%), it became negative in the year 2007 (-5.38). Again it has positive growth rate in 2008 (74.46%) but in the year 2009 it became negative (-37.70%). Thereafter, there is positive growth of international energy price. In case of India, there is a positive growth rate energy price since 2006 to 2008. Due to financial crisis, energy prices became negative in 2009 (-43.20), and after that there has been positive growth rate in domestic energy prices in India.

Table 6.2: Growth Rates of Domestic and International Prices of Selected Commodities

Index/Year	2006	2007	2008	2009	2010	2011	2012
IMF Food Index	23.96	26.14	50.49	-28.94	7.21	50.87	-5.22
India Food Index	-5.02	29.99	40.42	-28.28	14.30	27.35	18.21
IMF Metal Index	52.90	24.73	-13.29	-25.26	23.21	20.86	3.38
India Metal Index	190.04	10.55	-4.95	-23.79	19.96	22.06	2.52
IMF Energy Index	34.87	-15.78	105.04	-40.60	4.12	22.35	11.54
India Energy Index	36.61	-1.37	110.98	-47.33	5.18	17.04	10.10
IMF Com Index	35.94	-5.38	74.46	-37.70	6.75	26.16	7.68
India Com Index	41.01	4.08	81.85	-43.20	8.16	19.20	10.39

Note: Growth rates are percentage changes compared to the previous year
Source: Author's estimations from IMF and RBI database

6.10 Analysis of Absolute Commodity Prices

In Table-6.3 to 6.5, we have reported the growth rates of prices of selected commodities for both domestic and international. Table-6.3 reports the food commodity price growth rates for selected study commodities for domestic and international. It can be seen that, the domestic food prices are moving on par with the international food prices. The growth rates of international prices of soybean oil, rapeseed oil, maize and groundnut have positive growth rate from 2006 to 2009. But due to the global financial crisis in 2008, the growth rate of these prices became negative in 2009 Palm oil and groundnut, soybean oil, rapeseed oil and maize price have a negative growth rate in 2009 and 2010. After that, there has been a positive growth rate in 2011 and 2012. Similarly, in the case of India, the growth rates of food commodities follow the international price but in lower rate.

It is observed that the domestic and international soyabean oil price growth rate increased over periods. In 2006, the soyabean oil price growth rate was 9.98% but it increased to 90.39% in 2008 both in the domestic and international markets. But due to the downfall of demand due to crisis in the world, the growth rate declined to -34.46% in 2009 and became -3.94% in 2010. After that, there was positive growth rate in soyabean oil price in both domestic and international markets. Similarly, the other edible oil (rapeseed, palm oil and groundnut) price growth rates had also the similar trends. These edible oils growth rates increased from 2006 to 2008 and after that, there was negative growth in 2009 both in the domestic and international markets. After that, there were positive growth rates in edible oils. There were also similar trends in maize and groundnut price growth rates for both domestic and international markets.

In Table-6.4 we have reported the growth rates of domestic and international prices of metals. It is seen that both aluminium and copper have the similar trends in growth rates in both domestic and international markets. There have been increased the aluminium and copper price in 2006 to 2008 and declined in the year 2009 in domestic and international markets. After that there have upward trends in growth rate in both domestic and international markets. But, gold price has positive growth rate in the selected years except the year 2007 in both domestic and international markets. Except the year 2009, in all other years silver price has positive growth rate. The other metals like lead, nickel and zinc have the similar growth rate trends. At first there have increased in the growth rates and declined in the year 2008 and 2009. After that there have been positive growth rates.

In Table 6.5, we have reported the growth rates of domestic and international prices of energy commodities. If we look at the growth rate of crude oil price, it has been seen that in 2006, there were positive growth rates in both domestic and international markets. There were negative growth rates in 2007 in both domestic and international markets. In the year 2008, there had positive growth rates and became negative in 2009. After that, it has been positive growth rates in both domestic and international markets. In a similar manner, natural gas had the similar trends like crude oil in both domestic and international markets. Except the year 2007 and 2009, there had positive growth rates in both domestic and international markets.

Table 6.3: Growth of Domestic and International Prices of Selected Agriculture Commodities (in %)

Commodity/Year		2006	2007	2008	2009	2010	2011	2012
Soybean Oil	International	9.98	25.86	90.39	-34.46	-3.94	46.17	10.57
	India	8.49	22.92	43.20	-32.99	-6.30	44.79	18.46
Rapeseed Oil	International	32.10	1.92	61.83	-30.89	-8.98	58.84	-8.98
	India	1.94	25.46	48.60	-32.83	2.27	27.70	29.29
Maize	International	13.25	50.52	55.65	-22.49	-19.14	101.25	-6.98
	India	11.91	24.27	23.62	-5.88	11.32	21.74	3.05
Palm oil	International	5.37	94.27	30.64	-21.59	4.74	39.38	-6.82
	India	-46.98	64.52	78.10	-34.40	8.61	31.48	18.14
Rubber	International	88.50	-16.72	27.48	-36.12	102.70	37.12	-29.94
	India	76.07	-30.16	75.80	-24.03	81.26	16.19	-10.93
Groundnut	International	11.32	36.76	34.35	-27.77	17.45	48.04	7.47
	India	-2.62	60.12	-7.90	-18.83	32.90	18.18	34.62

Note: Growth rates are percentage changes from the previous year

Source: Author's calculations from IMF and RBI database

Table 6.4: Growth of Domestic and International Prices of Selected Metal Commodities (in %)

Commodity/Year		2006	2007	2008	2009	2010	2011	2012
Aluminium	International	52.32	-4.81	16.65	-40.41	18.35	27.26	-7.19
	India	NA	-6.85	20.65	-41.42	15.90	25.15	-7.93
copper	International	116.71	-8.00	16.29	-32.60	26.19	33.88	3.15
	India	123.92	-9.94	18.10	-32.93	21.67	45.84	-0.64
Gold	International	46.60	-2.74	42.97	18.52	26.86	19.08	31.61
	India	43.75	-4.12	50.42	12.54	29.17	16.68	34.87
Lead	International	3.85	123.62	-19.53	-0.05	-0.41	41.98	-7.71
	India	NA	145.11	-30.88	11.07	-4.89	48.89	-13.77
Nickel	International	35.30	78.50	-42.78	-26.08	26.24	10.88	-6.77
	India	60.55	42.39	-36.27	-17.70	18.15	14.17	-10.26
Silver	International	56.41	7.67	36.05	-3.73	22.54	86.20	-1.57
	India	52.40	6.25	44.15	-8.64	31.54	75.64	0.43
Zinc	International	166.00	0.36	-44.64	-9.03	9.26	22.82	4.57
	India	NA	-10.45	-40.22	-7.34	9.40	26.56	0.58

Note and Source: Same as in Table 6.2

Table 6.5: Growth of Domestic and International Prices of Selected Energy Commodities (in %)

Commodity/Year		2006	2007	2008	2009	2010	2011	2012
Crude Oil	International	33.21	-15.85	109.13	-42.08	5.37	22.62	7.73
	India	36.61	-15.47	112.05	-44.28	4.58	19.67	12.33
Natural Gas	International	56.46	-14.93	60.16	-19.44	-8.80	19.10	58.13
	India	NA	NA	104.60	-66.34	11.31	-8.36	-18.00

Note and Source: Same as in Table 6.3

6.11 Correlations between Domestic (Indian) and International Commodity Prices

To examine further the extent of relationship between international and domestic prices, the correlation coefficient analysis is carried out. The correlation coefficient between domestic and international prices both in index prices and absolute prices are reported in Table-6.6. It shows that during the study period 2001 to 2012, all three index prices between international and domestic prices are positive and highly correlated. It means both international and domestic prices are moving together. If we look at the correlation between the absolute prices of commodities, it can be seen that there are positive correlations between all commodities except the natural gas price. It means both international and domestic prices for the selected study variables except the natural gas prices are moving positively.

Table 6.6: Correlations between Domestic (India) and International Prices

Food Index	Metal Index	Energy Index	All Commodity Index		
0.96	0.96	0.95	0.97		
Food	Correlation	Metal	Correlation	Energy	Correlation
Groundnut	0.89	Aluminium	0.97	Crude Oil	0.98
Maiz	0.89	Copper	0.97	Natural Gas	-0.08
Palm Oil	0.95	Gold	0.996		
Rapseed Oil	0.82	Lead	0.97		
Rubber	0.95	Nickel	0.98		
Soya Oil	0.95	Silver	0.99		
		Zinc	0.98		

Source: Author's calculation

6.12 Volatility in Domestic (Indian) and International Commodity Prices

The volatility in prices between commodities is measured in this study by the coefficient of variation (C.V.) and the results for the study period 2001 to 2012 are reported in Table 6.7. It is observed that the domestic food price index (25.71%) was less volatile than the international food index price (30.33%). But India's metal and energy index prices (24.81% and 25.17%) were more than the international metal and energy index prices (20.22% and 24.93%). If we look at the all commodity price indices, they are more volatile in India compared to the international one.

Table 6.7: Coefficient of Variation of Prices of Selected Commodities

Index		Mean	S.D.	CV
Food Index	International	109.85	33.31	30.33
	India	111.41	28.64	25.71
Metal Index	International	129.21	26.12	20.22
	India	123.57	30.66	24.81
Energy	International	107.73	26.85	24.93
	India	106.56	26.82	25.17
All Commodity Index	International	110.49	25.69	23.25
	India	109.19	25.48	23.33
Food				
Groundnut	International	563.48	174.74	31.01
	India	696.87	190.35	27.31
Maiz	International	858.51	300.21	34.97
	India	865.05	211.55	24.46
Palm Oil	International	338.95	123.07	36.31
	India	359.39	128.61	35.79
Rapseed Oil	International	479.57	113.54	23.67
	India	537.46	119.66	22.26
Rubber	International	1292.21	539.00	41.71
	India	1283.93	527.82	41.11
Soya Oil	International	405.92	129.35	31.87
	India	516.63	111.86	21.65
Metal		**Mean**	**S.D.**	**CV**
Aluminium	International	10356.16	1573.61	15.19
	India	10512.19	1559.22	14.83
Copper	International	31313.56	8082.69	25.81
	India	31486.69	8184.96	25.99
Gold	International	14807.87	6595.55	44.54
	India	15090.20	6687.73	44.32
Lead	International	8817.37	2649.06	30.04
	India	9437.40	2341.59	24.81
Nickel	International	10090.12	3457.48	34.27
	India	10117.75	3532.42	34.91
Silver	International	27253.69	14558.69	53.42
	India	28578.72	15363.59	53.76
Zinc	International	10358.93	3191.06	30.80
	India	10742.73	3251.52	30.27
Energy				
Crude Oil	International	3594.35	931.13	25.91
	India	3628.60	922.54	25.42
Natural Gas	International	3960.94	1278.02	32.27
	India	2477.77	911.54	36.79

Source: Author's calculations from IMF and RBI database

If we look at the C.V. of individual commodities, we get to know that prices of international food items, (i.e. soybean oil, palm oil, maize, groundnut, rapeseed oil and rubber prices) were more volatile than the domestic prices. In case of metals, copper, nickel and silver prices (26%, 34.91% and 53.76%) were more volatile than their international prices (25.81%, 34.27% and 53.42%). But, the international prices of aluminium, gold, lead and zinc (15.19%, 44.54%, 30.04% and 30.80%) were more volatile than the domestic prices (14.83%, 44.32%, 24.81% and 30.27%). In energy, international crude oil price was more volatile than the domestic price, but the domestic natural gas price was more volatile than the international price.

6.13 Analysis of Market Integration and Price Transmission

Economists or researchers generally examine the market integration and price transmission by using the techniques like correlation, regression and co-integration tests etc. In this study also, we have used those tools to examine the market integration and price transmission. Therefore, before examining these tests, at first, we have checked whether the commodity index price series were stationary or not. Table-6.8a and 6.8b report the Unit root test of ADF and PP tests. In Table 6.8a, we have reported the ADF test for the level and first difference value for intercept and intercept with trend for three periods, i.e., for 2001M01 to 2012M06, second period from 2001M01 to 2008M07 and third period from 2008M08 to 2012M06. It is seen that all variables are non-stationary at their level values both in intercept and intercept with trend in all three periods but in the first difference, all variables are significant for these three periods.

Similarly, in Table 6.8b, we have reported the Phillips Peron Test (PP) results for all selected variables for the three periods. It is observed that all variables are non-stationary at their level values both in intercept and intercept with trend in all the three periods. But in the first difference values, all variables are statistically significant for the three periods and hence all variables are I(1).

Table 6.8a: Augmented Dickey Fuller Unit Root Test Results

Variable	2001M01-2012M06				2001M01-2008M09				2008M10-2012M06			
	Int		Int with Trend		Int		Int with		Int		Int with Trend	
	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff
IAC	0.81	-9.72*	-2.77	-9.76*	1.26	-7.80*	-2.73	-7.91*	0.16	-6.23*	-3.39	-6.11*
IFOOD	0.14	-11.84*	-2.28	-11.84*	-0.11	-8.13*	-2.11	-8.07*	-1.47	-6.72*	-2.21	-6.69*
IENERGY	-0.18	-8.35*	-2.77	-8.34*	0.69	-8.37*	-2.04	-8.48*	0.61	-5.39*	-3.41	-4.94*
IMETAL	0.35	-4.09*	-2.02	-4.26*	-0.37	-3.33*	-2.08	-4.32*	-0.01	-3.99*	-2.33	-4.16*
WAC	-1.01	-7.84*	-3.36	-7.80*	0.28	-6.68*	-2.92	-6.78*	-0.61	-5.82*	-2.91	-5.61*
WFOOD	-0.95	-7.90*	-3.03	-7.86*	-0.03	-5.65*	-2.34	-5.70*	-0.68	-5.34*	-1.89	-5.23*
WENERGY	-1.35	-8.40*	-3.41	-8.36*	0.43	-7.52*	-3.18	-7.59*	-1.09	-5.66*	-3.48	-5.45*
WMETAL	0.36	-11.72*	-2.97	-11.73*	0.10	-9.75*	-2.46	-9.74*	-0.47	-7.39*	-3.09	-7.29*

Source: Author's Calculation

Notes: a. Critical values for unit root test (ADF & PP) are: -3.49 and -4.10 (without trend) and -4.04, -4.10 (with trend) respectively at 1% level and 5% levels

b. * and ** denotes significant at 1 percent and 5 percent respectively.

Table 6.8b: Phillips Perron Unit Root Test Results

Variable	2001M01-2012M06				2001M01-2008M09				2008M10-2012M06			
	Int		Int with Trend		Int		Int with		Int		Int with Trend	
	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff	Level	First Diff
IAC	0.63	-9.70*	-2.31	-9.73*	1.12	-7.78*	-2.41	-7.85*	0.10	-6.70*	-3.36	-6.47*
IFOOD	0.64	-12.50*	-2.09	-12.81*	0.59	-8.17*	-1.90	-8.07*	-1.36	-7.15*	-2.27	-7.46*
IENERGY	-0.19	-8.36*	-2.52	-8.35*	0.65	-8.34*	-2.16	-8.42*	0.01	-6.27*	-3.13	-5.46*
IMETAL	0.73	-6.33*	-1.66	-6.57*	-0.01	-6.34*	-1.89	-6.40*	0.38	-3.90*	-2.11	-4.10*
WAC	-0.81	-7.77*	-3.41	-7.74*	0.73	-6.63*	-2.46	-6.70*	-0.76	-5.82*	-3.24	-5.61*
WFOOD	-0.70	-7.83*	-3.29	-7.79*	0.55	-5.52*	-1.81	-5.57*	-0.86	-5.34*	-2.32	-5.22*
WENERGY	-1.19	-8.44*	-3.17	-8.41*	0.28	-7.38*	-2.70	-7.41*	-1.34	-5.78*	-2.73	-5.51*
WMETAL	0.37	-11.72*	-3.13	-11.73*	0.12	-9.74*	-2.59	-9.74*	-0.15	-8.77*	-3.09	-8.90*

Source and Notes: Same as in Table 6.8a

6.14 Analysis of Co-integration Test Results

The long-term relationship of commodity prices in India with the international prices is measured using the Johansen cointegration tests and the results are reported in Table-6.9a to Table-6.9c. Table 6.9a reports the cointegration results for the period from January 2001 to June 2012, i.e., the full sample period. If we look at the cointegration between IAC and WAC, the trace statistics and the maximum statistics values (24.98 and 16.89) are statistically significant at the one cointegrating vector. This suggests that there exists a long run equilibrium relationship between IAC and WAC from the period January 2001 to

June 2012. The cointegration between IFOOD and WFOOD indicates that the trace statistics and the maximum eigen statistics (11.22 and 11.02) are insignificant, which suggests that there is no long-run relationship between IFOOD and WFOOD. If we look at the cointegration between IENERGY and WENERGY, the trace statistics (25.53) is statistically significant at 1% significance level. The maximum statistics (16.21) is also significant at 5% significance level. That means, there is log-run equilibrium relationship between IENERGY price and WENERGY price. In case of IMETAL and WMETAL, the trace statistics (23.20) and the maximum statistics (17.84) are significant at 5% level of significance. That means, there is long-run relationship between IMETAL and WMETAL in the full-sample period.

Table 6.9b reports the cointegration results for the pre-crisis period from January 2001 to September 2008. If we look at the cointegration between IAC and WAC, the trace statistics and the maximum statistics values (30.74 and 20.98) are statistically significant at one cointegrating

Table 6.9a: Results of Johansen Cointegration Test for 2001M1 to 2012M6

Variables		Null hypothesis		Eigen Value	Stat	Critical Values 5%	Prob.
WAC	IAC	λ_{trace} tests	r = 0	0.117	24.983	20.262	0.010
			r < 1	0.058	8.087	9.165	0.080
		λ_{max} test	r = 0	0.117	16.896	15.892	0.035
			r = 1	0.058	8.087	9.165	0.080
WAGRI	IAGRI	λ_{trace} tests	r = 0	0.080	11.223	15.495	0.198
			r ≤ 1	0.002	0.205	3.841	0.651
		λ_{max} test	r = 0	0.080	11.018	14.265	0.153
			r = 1	0.002	0.205	3.841	0.651
WENERGY	IEnergy	λ_{trace} tests	r = 0	0.113	25.533	20.262	0.009
			r ≤ 1	0.067	9.321	9.165	0.047
		λ_{max} test	r = 0	0.113	16.212	15.892	0.045
			r = 1	0.067	9.321	9.165	0.047
WMETAL	IMetal	λ_{trace} tests	r = 0	0.117	24.983	20.262	0.010
			r ≤ 1	0.058	8.087	9.165	0.080
		λ_{max} test	r = 0	0.117	16.896	15.892	0.035
			r = 1	0.058	8.087	9.165	0.080

Note: r denotes the cointegration vector
Source: Author's estimations from IMF and RBI database

Table 6.9b: Results of Johansen Cointegration Test for 2001M1 to 2008M09

Variables		Null hypothesis		Eigen Value	Statistics	Critical Values 5%	Prob.
WAC	IAC	λ_{trace} tests	r = 0	0.393	30.740	20.262	0.001
			r ≤ 1	0.207	9.759	9.165	0.039
		λ_{max} test	r = 0	0.393	20.980	15.892	0.007
			r = 1	0.207	9.759	9.165	0.039
WAGRI	IAGRI	λ_{trace} tests	r = 0	0.242	25.502	15.495	0.001
			r ≤ 1	0.003	0.288	3.841	0.591
		λ_{max} test	r = 0	0.242	25.214	14.265	0.001
			r = 1	0.003	0.288	3.841	0.591
WENERGY	IEnergy	λ_{trace} tests	r = 0	0.501	47.578	25.872	0.000
			r ≤ 1	0.337	17.652	12.518	0.006
		λ_{max} test	r = 0	0.501	29.926	19.387	0.001
			r = 1	0.337	17.652	12.518	0.006
WMETAL	IMetal	λ_{trace} tests	r = 0	0.123	23.200	20.262	0.019
			r < 1	0.039	5.363	9.165	0.246
		λ_{max} test	r = 0	0.123	17.837	15.892	0.025
			r = 1	0.039	5.363	9.165	0.246

Source and Note: Same as in Table 6.9a

Table 6.9c: Results of Johansen Cointegration Test for 2008M10 to 2012M06

Variables		Null hypothesis		Eigen Value	Stat	Critical Values 5%	Prob.
WAC	IAC	λ_{trace} tests	r = 0	0.166	8.410	15.495	0.423
			r < 1	0.014	0.610	3.841	0.435
		λ_{max} test	r = 0	0.166	7.800	14.265	0.399
			r = 1	0.014	0.610	3.841	0.435
WAGRI	IAGRI	λ_{trace} tests	r = 0	0.231	12.968	15.495	0.116
			r ≤ 1	0.038	1.677	3.841	0.195
		λ_{max} test	r = 0	0.231	11.291	14.265	0.140
			r = 1	0.038	1.677	3.841	0.195
WENERGY	IEnergy	λ_{trace} tests	r = 0	0.406	27.329	20.262	0.005
			r ≤ 1	0.108	4.928	9.165	0.291
		λ_{max} test	r = 0	0.406	22.401	15.892	0.004
			r = 1	0.108	4.928	9.165	0.291
WMETAL	IMetal	λ_{trace} tests	r = 0	0.236	11.525	15.495	0.181
			r < 1	0.006	0.240	3.841	0.624
		λ_{max} test	r = 0	0.236	11.285	14.265	0.141
			r = 1	0.006	0.240	3.841	0.624

Source and Note: Same as in Table 6.9a

vector, which suggests that there exists a long run equilibrium relation between IAC and WAC for the period January 2001 to September 2008. Similarly, the cointegration between IFOOD and WFOOD indicates that the trace statistics (25.50) is insignificant and the maximum statistics (25.21) is also insignificant. That means, there is no long-run equilibrium relation between Indian food index (IFOOD) price and the international index

(WFOOD) price index. If we look at the cointegration between IENERGY with WENERGY, the trace statistics (47.58) is statistically significant at 1% significance level. The maximum statistics (29.93) is also significance at 1% significance level. That means, there exists a long-run relationship between IENERGY price and the WENERGY price. In case of IMETAL and WMETAL, the trace statistics (23.20) and the maximum statistics (17.84) are significant at 1% significance level, it means that there is also a long-run equilibrium relationship between IMETAL price and WMETAL price.

Table 6.9c reports the cointegration results for the post-crisis period from October 2008 to June 2012. If we look at the cointegration between IAC and WAC, the trace statistics and the maximum statistics values are statistically insignificant. This suggests that there is no long run relationship between IAC and WAC in the post-crisis period. The cointegration between IFOOD and WFOOD indicates that the trace statistics (12.97) is insignificant, whereas the maximum statistics (11.29) is also insignificant that means there is no cointegration between Indian food index price (IFOOD) and the international price (WFOOD). If we look at the cointegration between IENERGY and WENERGY, the trace statistics (27.33) is statistically significant at 1% significance level. The maximum statistics (22.40) is also significant at 1% significance level, which suggests that there is a long-run equilibrium relation between IENERGY price and WENERGY price. In case of IMETAL and WMETAL, the trace statistics (11.53) and the maximum statistics (11.29) are insignificant, which means that there is no long-run relationship between IMETAL price and WMETAL price during this period.

6.15 Analysis of VECM Results

From the above Johansen cointegration test, it is found that there is long-term relationship existing between the Indian commodity prices and the international commodity prices. To support/verify that finding, now it is necessary to test whether there is any short-run relationship. Hence, to examine the short-run relationship between Indian commodity prices and the international prices, we have used the Vector Error correction model (VECM). The estimation of VECM requires the appropriate lag selection. Therefore, we have used the SIC and AIC lag selection criteria to choose the optimum lag. The estimated VECM results are reported in Table 6.10 (block I to III) for the three periods.

Table 6.10 (block I) reports the VECM results for the full period from January 2001 to June 2012. The VECM result for the IAC and WAC coefficients (-0.05) is statistically significant at 5% significance level. This means, there is short-run relationship between IAC and WAC. The IFOOD and WFOOD VECM coefficient value (-0.04) is not significant. Therefore, there is no short-run dynamic relationship between IFOOD prices and WFOOD prices. Now if we look at the VECM results between IENERGY and WENERGY, the VECM coefficient value (-0.05) is significant at 5% significance level, which suggests that there exists a short-run dynamic relationship between IENERGY with and WENERGY price. Similarly, the VECM value (-0.03) is significant for the IMETAL and the WMETAL. This means, there also exists short-run dynamic relationship between IMETAL and WMETAL for the full-sample period, i.e., from January 2001 to June 2012.

In Table 6.10 (block II), we have reported the VECM results for the pre-crisis period, i.e., from January 2001 to September 2008. The VECM result for the IAC and WAC coefficient (-0.11) is statistically significant at 5% significance level. It means, there is short-run relationship between IAC and WAC. The IFOOD and WFOOD VECM coefficient value (-0.12) is insignificant. Therefore, there is no short-run relationship between IFOOD prices with WFOOD prices. Now if we look at the VECM result between IENERGY and WENERGY, the VECM value (-0.23) is significant which suggests that there exists a short-run dynamic relationship between IENERGY and the WENERGY. Similarly, the VECM value (-0.05) is insignificant for the IMETAL and the WMETAL. This means, there is no short-run dynamic relationship between IMETAL and WMETAL.

Table-6.10 (block III) reports the VECM results for the post-crisis sample period from October 2008 to June 2012. The VECM result for the IAC and WAC coefficient (-0.09) is statistically insignificant. This means, there is no short-run dynamic relationship between IAC and WAC. The IFOOD and WFOOD VECM coefficient value (-0.09) is insignificant. That means, there is no short-run relationship between IFOOD prices and WFOOD prices. Now if we look at the VECM result between IENERGY and WENERGY, the VECM value (-0.08) is significant which suggests that there exists a short-run dynamic relationship between IENERGY and the WENERGY. In the same way, the VECM value (-0.05) is insignificant for the IMETAL and the WMETAL that means there is no short-run dynamic relationship between IMETAL with WMETAL.

Table 6.10: Results of the Vector Error Correction Model

Variable		ECM Coeff	t-stat	Lag
I. 2001M01- 2012M06				
WAC	IAC	-0.05	-3.88	1.00
WFOOD	IFOOD	-0.04	-1.36	2.00
WENERGY	IENERGY	-0.05	-2.68	2.00
WMETAL	IMETAL	-0.03	-2.89	1.00
II. 2001M1- 2008M09				
WAC	IAC	-0.11	-4.26	1.00
WFOOD	IFOOD	-0.12	-4.51	1.00
WENERGY	IENERGY	-0.23	-3.30	1.00
WMETAL	IMETAL	-0.05	-4.15	1.00
III. 2008M10 - 2012M06				
WAC	IAC	-0.09	-1.36	1.00
WFOOD	IFOOD	-0.09	-0.95	1.00
WENERGY	IENERGY	-0.08	-5.25	2.00
WMETAL	IMETAL	-0.05	-1.67	2.00

Source: Author's Estimations

6.16 Analysis Causality Test

From the above cointegration test and VEC model, we have found that the commodity prices (except the food price) of India and international are co-integrated both in the long-run as well as in the short-run. This suggests that except the food prices, all other commodity prices between India and international are integrated. But to know which is the cause and who is the effect, we have reported the VECM lag coefficients. This suggests the direction of causality between the variables. Results are reported in Table-6.11 to 6.14.

In Table 6.11, the estimated results show that there is causality from the WAC price to IAC price in the full-sample period. In the pre-crisis period, there is also causality from WAC price to the IAC price. But in the post-crisis period, there is no causality between WAC and IAC index prices. Table 6.12 reports the VECM results of WFOOD and IFOOD. It indicates that in the full-sample period, there is no causality between WFOOD price and IFOOD price. In the same manner, in other two periods, i.e., pre-crisis and post-crisis, there is no causal relationship between WFOOD and IFOOD index prices. It means that the change in IFOOD price is not caused by the WFOOD price.

Results in Table 6.13 indicate that in the full-sample period, the change in IENERGY price is caused by the WENERGY price at lag 1 and 2. In the pre-crisis period, the change in WENERGY price causes the change in IENERGY price but not vice versa. Similarly, in the post-crisis period, it is also seen that the change in IENERGY price is due to change in the WENERGY price. Table 6.14 reports that in the full-sample period, the change in IMETAL price is not caused by the change in WMETAL price but by its own lag price. Similarly, in the pre-crisis period, the change in IMETAL price is not caused by the WMETAL prices and in the post-crisis period, the change in IMETAL price is also not caused by the change in WMETAL price but by its own lag price.

Table 6.11: Causality between IAC with WAC

		2001M01 to 2012M06		2001M01 to 2008M09		2008M10 to 2012M06	
		D(Log(IAC))	D(Log(WAC))	D(Log(IAC))	D(Log(WAC))	D(Log(IAC))	D(Log(WAC))
D(Log(IAC(-1)))		0.087	0.463	-0.022	-0.456	0.093	0.370
	t-stat	1.113	1.428	-0.241	-0.933	0.628	0.857
D(Log(WAC(-1)))		0.089	0.380	0.071	0.398	0.035	0.267
	t-stat	4.270	4.382	3.323	3.433	0.697	1.824

Source: Author's Estimations

Table 6.12: Causality between IAGRI with WAGRI

		2001M01 to 2012M06		2001M01 to 2008M09		2008M10 to 2012M06	
		D(Log(IAGRI))	D(Log(WAGRI))	D(Log(IAGRI))	D(Log(WAGRI))	D(Log(IAGRI))	D(Log(WAGRI))
D(Log(IAGRI(-1)))		0.004	0.008	0.140	-0.097	0.012	-0.260
	t-stat	0.047	0.048	1.524	-0.233	0.065	-1.081
D(Log(IAGRI(-2)))		-0.030	-0.205				
	t-stat	-0.344	-1.184				
D(Log(WAGRI(-1)))		-0.019	0.331	-0.030	0.548	-0.053	0.150
	t-stat	-0.446	3.924	-1.411	5.582	-0.521	1.087
D(Log(WAGRI(-2)))		-0.025	0.184				
	t-stat	-0.557	2.139				

Source: Author's Estimations

Table 6.13: Causality between IENERGY with WENERGY

		2001M01 to 2012M06		2001M01 to 2008M09		2008M10 to 2012M06	
		D(Log(IENERGY))	D(Log(WENERGY))	D(Log(IENERGY))	D(Log(WENERGY))	D(Log(IENERGY))	D(Log(WENERGY))
D(Log(IENERGY(-1)))		0.041	0.506	-0.020	-0.217	-0.087	0.717
	t-stat	0.478	1.166	-0.243	-0.528	-0.691	0.837
D(Log(IENERGY(-2)))		-0.047	-0.047			-0.025	-0.557
	t-stat	-0.646	-0.128			-0.241	-0.784
D(Log(WENERGY(-1)))		0.123	0.334	0.112	0.341	0.017	-0.102
	t-stat	6.758	3.622	4.578	2.836	0.743	-0.662
D(Log(WENERGY(-2)))		0.043	0.088			0.041	0.129
	t-stat	2.014	0.812			2.191	0.850

Source: Author's Estimations

Table 6.14: Causality between IMETAL with WMETAL

		2001M01 to 2012M06		2001M01 to 2008M09		2008M10 to 2012M06	
		D(Log(IMETAL))	D(Log(WMETAL))	D(Log(IMETAL))	D(Log(WMETAL))	D(Log(IMETAL))	D(Log(WMETAL))
D(Log(IMETAL(-1)))		0.556	-0.156	0.189	-0.700	0.582	0.285
	t-stat	7.811	-0.484	1.906	-1.213	3.378	0.536
D(Log(IMETAL(-2)))				0.374	0.325	0.032	-0.156
	t-stat			3.807	0.567	0.190	-0.303
D(Log(WMETAL(-1)))		-0.025	-0.007	-0.005	-0.013	-0.054	-0.160
	t-stat	-1.257	-0.077	-0.262	-0.109	-1.067	-1.027
D(Log(WMETAL(-2)))				-0.011	-0.063	0.009	-0.214
	t-stat			-0.537	-0.518	0.181	-1.456

Source: Author's Estimations

6.17 Summary

The main objective of this chapter 6 was to examine the commodity market integration and price transmission between Indian commodity prices and international commodity prices.

Therefore, this study started with determining the meaning of commodity market integration. After that, we have analysed different types and sources of market integration. Then, we have described the meanings of the price transmission and three types of price transmission – vertical, cross and spatial. The price transmission depends mainly on the law of one price (LOOP). The chapter also reviewed the existing literature both for India and other nations. The present study used the econometric techniques like cointegration test and VECM models to examine the market integration and price transmissions.

From the national (India) and international price trends, it was found that from 2000 to the mid of 2008, there had been continuous increase in the commodity prices. After the global financial crisis, there was a declining trend of prices but it recovered earlier than the financial market. Before striking any comparison between India and international prices, we checked the stationary conditions of all variables by using the econometrics techniques of ADF and PP tests. From the unit root test, it was found that all commodity price indices both for India and International prices were non-stationary at their level values but all became stationary in their first difference values.

From the cointegration test, we found that there was cointegration between IAC and WAC, which means that there was long run equilibrium relationship between IAC and WAC in the full period. In the pre-crisis period, there was also long-run equilibrium between IAC and WAC. But in the post-crisis period, there was no long-run relationship between IAC and WAC index price.

In the full-sample period, there was no long-run cointegration between IFOOD and WFOOD. But in the pre-crisis period, there was a long-run equilibrium relationship between IFOOD price and WFOOD price. In the post-crisis period, there was no long-run equilibrium relationship between IFOOD price and the WFOOD index price. It was also found that there was log-run equilibrium relationship between IENERGY price and WENERGY price in the three sample periods. In the full-sample and pre-crisis periods, there was log-run equilibrium relationship between IMETAL and WMETAL index prices but in the post-crisis period, there was no long-run equilibrium relationship between IMETAL and WMETAL index price.

The VECM results show that there was short-run dynamic relationship between IAC and WAC index prices both in the full-sample and pre-crisis period. But in the post-crisis period, there was no short-run dynamic relationship between IAC and WAC index price. The VECM results for IENERGY and WENERGY show that there was short-run dynamic relationship between these two price indices in the three sample periods. In case of metal prices, there was short-term dynamic relationship between IMETAL and WMETAL index prices both in full-sample and pre-crisis periods. But in the post-crisis period, there was no short-run relationship between IMETAL and WMETAL prices.

To understand whether the change in Indian commodity prices was due to the change in international prices, we analyzed the lag coefficients values of the VECM. The ECM test results showed that in both full-sample and pre-crisis periods, the change in IAC prices was due to the change in WAC index prices but in the post-crisis period there was no effect of WAC on IAC. In the case of food prices, the change in IFOOD prices was not increased due to the WFOOD prices in all the three sample periods. In the energy price, the change in IENERGY price was caused by the change in WENERGY price in all the three periods. In the case of metal prices, in the full-sample and pre-crisis period, the change in IMETAL price was due to the change in WMETAL price but in the post-crisis period, there was no effect of WMETAL price on IMETAL index price.

Thus, the main finding of this chapter is similar to other studies like Jha et al. (2005), Ghosh (2012), Rajmal and S. Mishra (2009) and Imai et al. (2008). These studies found that the domestic commodity prices co-moved with global commodity prices. But the integration of agricultural commodities was far from the complete in India and a major reason for this was the excessive government interventions.

CHAPTER 7
Summary and Conclusion

7.1 Summary and Major Findings

Understanding the commodity price behaviour is an important issue for the economic growth of any economy, developed or developing, as it influences the production, demand and supply. In the current era of globalization and liberalization, commodity price management has become more important, with a potential influence on the whole economy. Apart from economic agents, it is now a must focus for policy makers, academics and researchers. In order to understand the behaviour of commodity prices in a particular country, it is necessary to understand the price behaviour in other nations also as markets are integrated in this era of globalization and liberalization.

The behaviour of commodity prices in international markets has dramatically changed in the last couple of years, particularly since the beginning of 21st century. There were continuously upward trends of commodity prices since 2001 to the mid-2008. Commodity market was badly hit by the recent global turmoil; therefore, there were downward trends of commodity prices in 2008. But it recovered very faster than the financial market in the very beginning of 2009.

Now, India is one of the emerging countries in the world and the second largest economy right after China. Except that, India is the second largest populous country in the world. Therefore, the demand for many commodities is greater than the supply and this situation pushes the price level upwards. In the year 1991, Indian government adopted the new economic policy, where there were major changes in different policies for different sectors. Due to policy changes and major initiatives of government, India's national income (GDP) was growing at a high rate and it touched more than 9 per cent in the 21st century. With the increase in national income, there has been an increase in the demand for several other commodities in India. Available data show that there has been a rise in commodity prices in the recent decade, particularly since 2001. But, the trends suddenly fell downward when the global financial crisis was realized all over the world in 2008.

Therefore, lots of debates started on whether commodity price behaviour was really different before the crisis period and the post crisis period. If it was, then what were the determinants of price behaviour in both periods. There are several arguments and debates on the determinants of commodity prices. But these determinants can be broadly categorized into three – (a) fundamental or macroeconomic factors, (b) financialization of commodity market, and (c) price transmission from international markets to the domestic market in India.

Theoretically, different macroeconomic factors affect commodity prices in different ways. For example, take the macroeconomic variable of inflation. There may a bidirectional relationship related to inflation because some economists say that if inflation increases, price level will increase. This means that there will be higher price of commodities, and alternatively, if inflation declines, then it will reduce the price level and vice versa. Similarly, take the case of national income (GDP). Generally, when national income or GDP increases, commodity prices raise because the increase in national income or GDP leads to the increase in demand for various commodities and vice versa. Interest rate is also positively related with the commodity prices. That is, if there is an increase in interest rate, it increases the cost of production which leads to an increase in commodity prices and vice versa. Like these variables, there are some more macro-economic variables which affect commodity prices in India.

Another important determinant of the behaviour of commodity market and prices is the 'financialization' of commodity markets in India. 'Financialization' refers to financial actors or investors playing an important role in the commodity market and their activities leading to changes in the behaviour of commodity markets. Economists, policy makers and researchers thought that during the period of high commodity prices (i.e., during the period from 2002 to the mid-2008), there might have been the possibility of the roles of financial investors. There is also empirical evidence on this issue in the UNCTAD (2009 and 2010) reports. It is written that there is a role of financial investor to increase commodity prices from 2002 to 2008. One possible explanation of this is that both financial markets and the commodity markets are negatively related. Therefore, when there is a rise in commodity prices, to get higher profit by investing in commodity market, there might be transformation of investment from financial market to commodity markets. So, commodity market is used as an alternative investment asset for commodity markets. Sometimes, financial investors take actions in both markets to avoid loss. That is, if they loss in one market, they will gain in the other market. Hence, financialization of commodity market is also one of the determining factors.

International price transmission also one the important determinants for the behaviour of commodity prices in the 21st century. Commodity price transmission is made if the markets are integrated. If the markets are not integrated, there will be no price transmission. Therefore, technically both the terms are used simultaneously. If one term is examined, we get the information about the other term. The price transmission is generally made in three ways – vertical, spatial and cross commodity price transmission.

Many studies have been conducted on those above mentioned issues especially in developed countries. However, very few studies are available examining these issues in India. With the above main idea and motivation in mind, we started our study with the following three important objectives. Specific objectives are:

(a) to analyse the role of fundamental factors on the rise of commodity prices,

(b) to examine the financialization of commodity market and its impact on commodity price in India and

(c) to examine the impact of international commodity price integration on domestic price behaviour in India.

Above objectives of the present study were examined using the time series econometric techniques. The first objective was examined using the cointegration techniques like Johansen cointegration test and the Vector Error Correction (VEC) model. To examine the impact of fundamental demand and supply factors on commodity prices was very difficult whose measurement posed serious difficulties. Therefore, index of industrial production (IIP) was used as a proxy to represent the total demand for commodity. Although, the total demand for commodities depends on total national income (i.e., GDP), due to unavailability of monthly and daily data, we used the IIP as a proxy for GDP.

The second objective (i.e., to examine the impact of financialisation on commodity price) was categorized into two parts. Firstly, the relationship between stock/equity prices with the commodity prices was examined. Secondly, the relationship between commodity spot price and the futures price was examined. These two parts were examined using the cointegration techniques such as Johansen cointegration test and the VECM. Besides these two methods, the volatility spillover models like GARCH(1,1)-BEKK model was also applied to check whether there was any volatility spillover in the markets of study commodities. The VAR-Granger causality test and the impulse response function were also used to know about the cause and effect relationship between the study variables. The third objective (i.e., market integration and price transmission from international commodity market to the domestic market) was also examined by using the same cointegration techniques and the causality tests.

Before examining the stated objectives, the stationarity of selected study variables was checked as it is necessary to check the stationarity conditions of each variable by applying the Unit Root test such as Dickey-Fuller (1979), Augmented Dickey-Fuller (1981) and Philips-Parron test. If the Unit Root test shows that all variables are not stationary, then we can make them stationary by taking the first or second difference. At last, we applied the Gregory and Hansen (Gregory and Hansen, 1996a and 1996b) test to find out the multiple breaks in the total sample period that leads to show the relationship between different periods.

The entire analysis was carried out using the available monthly time series secondary data. The study used the data for the period from January 2001 to June 2012. The selected variables are commodity prices and stock price. Commodity prices are divided into three main categories – (i) food or agricultural, (ii) metals and (iii) energy. Food commodities included cereals (rice, wheat and maize), edible oil (groundnut oil, palm oil, rapeseed oil, soyabean oil and sunflower oil), cotton, rubber and sugar. Metals included aluminium, metal products (gold and silver) and other non-ferrous metals (copper, lead and zinc). The energy commodities included coal and mineral oil particularly crude oil. All these commodities' group prices were collected from the Reserve Bank of India (RBI) publications. However, data on international prices of each individual commodity were collected from the International Monetary Fund's (IMF) online database.

Apart from those commodity prices, data were collected for both spot and futures prices of MCX all commodity index prices, metal index, energy index and agri index prices. The MCX metal index includes seven commodities, namely, gold, silver, copper, zinc, aluminum, nickel and lead. Similarly, the MCX energy index includes two commodities - crude oil and natural gas. Lastly, the MCX agri index includes six commodities - refined soya oil, potato, chana, crude palm oil, kapaskhalli and mentha oil. Over and above these variables, data on total trading volume, value, number of contracts per day etc. were collected from the websites of the Multi Commodity Exchange (i.e., www.mcxindia.com) in India and the Forward Market Commission of India (www.fmc.gov.in). Though the MCX index prices are available daily, we have converted these prices to monthly by taking their each month end prices.

Data on study variables like exchange rate, inflation rate, interest rate and IIP were collected from the Reserve Bank of India (RBI) sources and other reliable sources. Therefore, data on the study variables were collected from various sources like IMF, National stock Exchange of India, RBI, MCX and FMC. The total sample period is from January 2001 to June 2012. We have chosen this sample period because particularly in this period, there was a high growth rate of commodity prices and also there was the global financial crisis. As a matter of fact, this study attempted to examine whether there was any distortion in the growth of commodity prices in India due to the global financial crisis. If it was there, then, in which period and whether there was any change in the behaviour of commodity prices in India.

Chapter-wise summary is described below briefly.

Chapter 2: The chapter 2 examined the behaviour of commodity prices and the role of fundamental factors or macro economic variables in India. With this aim, this chapter started with introduction where we reported why to study the behaviour of commodity prices and how macroeconomic variables are related with this. Then, we analysed the trends of international price as well as the trends of domestic prices in India. After that we analysed the characteristics of commodity price behaviour in India. It was observed that there were continuous increases in the commodity prices in India. From the variability/volatility of commodity prices in India, we found that there was high volatility of commodity prices and then there were debates on the behaviour of commodity prices in India. Thereafter, we reported the descriptive statistics of both the full sample and also for each year. From the full sample, it was observed that among the food items, edible oils and sugar prices were more volatile than other food items. Similarly, from the metal items, non-ferrous metal prices became more volatile than other metal prices. In case of energy prices, mineral oil price was more volatile than the coal price.

Cereals price's SD and CV showed that it was more volatile in the year 2009. But the 'cotton textiles' was more volatile in the year 2008 and 2010. So, there were high volatilities in these two years compared to the earlier years. Similarly, edible oil price had the highest volatility in the year 2008 but in case of rubber, the highest volatility was in the years 2006 to 2007. Sugar price had the highest volatility in the years 2003 and 2004, and again in the years 2009 and 2012. But the aggregate food Index descriptive statistics indicate that it was more volatile in the year 2010 compared to other years.

The descriptive statistics of metals indicated that there was a continuous increase in the aluminium price in India and also the volatility. But in the year 2006, the aluminium price was having the highest volatility compared to other years. Similarly, in case of the metal products (which includes gold and silver), there was a continuous increase in the average price of metal products. But it had the highest volatility in the year 2010 compared to other years. There was also an increase in the average price of non-ferrous metals in India and also the price volatility. But years 2005 to 2006 showed more volatile compared to other years. But, in case of Meta aggregate index, we found continuously increasing average prices and volatilities. In the years 2006 and 2010, there were more volatilities of metal index prices in India

Coal mining average prices were continuously increasing in India. The SD and CV indicated that there was also coal mining price fluctuation, but more price variations were observed in the years of 2003, 2004 and 2011. The descriptive statistics for mineral oil showed that price was more volatile in the year 2008 compared to other years. This might have been due to the effects of global financial turmoil. The descriptive statistics of the aggregate energy price index confirmed that the energy price index was more volatile in the year 2008 compared to other years.

From the debate on the behaviour of commodity prices, we found that there are three core factors which affect the behaviour of commodity prices in India. These factors are fundamental/macroeconomic factors, financialization of commodity market and lastly, the international price transmission.

Chapter 3: This chapter examined the relationship between commodity prices and fundamental factors in India. At first, we reviewed the existing literature on the linkages between fundamental/macro-economic variables with commodity prices. From the literatures review, it was found that macro economic variables like demand, interest rate, inflation, exchange rate, bio-fuel, etc. are affecting commodity prices in India. Though, in this study we used the nominal prices of commodities, we used the selected macroeconomic variables particularly, demand (IIP), interest rate (TBILL) and exchange. There is no data availability of bio-fuel.

Next, we used the Gregory-Hansen cointegration test for structural change to find out whether there was any structural change due to the global turmoil in 2008, and we found that there was structural change in the year 2008. Since the global financial crisis was realized in September, we used September as the structural point and then we categorized the total sample into two periods - pre-crisis period, i.e., from January 2001 to September 2008, and post-crisis period, i.e., from October 2008 to June 2012.

Before estimating any relationship between commodity prices with macro-economic variables, we had examined the unit root test by applying the ADF and PP test and the results showed that all the selected variables are non-stationary at their level values but all were stationary at their first difference. Then we examined the both long-run and short-run relationship between the commodity price indices with the macro economic variables by using the Johansen cointegration test and VECM. Though these two tests required the appropriate selection of lag length, we had selected the appropriate lag length for both these test by using the lag length criteria such as Schwartz information criteria (SIC) and Akaike information criteria (AIC).

The Johansen cointegration test indicated that there was no long-run correlation/co-movement between IAC with macro-economic variables in all the three sample periods. There was longer-run correlation/co-movement between IAGRI with macro-economic variables in the three sample periods. Only in the pre-crisis period, there was long-run relationship between IENERGY index prices with the macro-economic variables. But, there was no long-run relationship between IENERGY price index with the macro-economic variables in other two sample periods. There was no long-run relationship between the IMETAL index prices with the macro-economic variables in the full sample and pre-crisis period but it existed in the post-crisis period.

The VECM result showed that there was no short-run relationship between IAC with macroeconomic variable but there was short-run dynamic relationship between IAGRI with macroeconomic variable in all the three periods. There was short-run dynamic relationship between IENERGY with macroeconomic variable only in the pre-crisis period. And similarly, there was only short-run relationship between IMETAL with the macro-economic variables in the post-crisis period.

The causality test indicated that there was no causal relationship between macro-economic variables with the IAC in the three periods. But there was causality from the demand (IIP) with IAGRI and also causality from the Tbill to IAGRI in the full-sample period. But in the pre-crisis period, there was causality from the exchange rate and from the demand (IIP) to IAGRI index price in India. In the post-crisis period, there was causality from the demand (IIP) to the IAGRI index prices. There was causality from the exchange rate to IENERGY in the pre-crisis period. Similarly, there was only causality in the post-crisis period, that is, from the interest rate (Tbill) to the IMETAL index price in India.

The main finding of the chapter 3 is almost similar to those of Alexandratos (2008), Byrne, et al. (2013) and Dwyer (2011). They found that financial investors affected the short-run price dynamics for some commodities but the level and volatility of commodity prices appeared to be primarily determined by fundamental factors. The sharp rise of basic food commodity prices in the international markets were due to the shortfalls of global supply in relation to the demand.

Chapter-4: In chapter 4, we examined the financialization of commodity market in India. Mainly, we analysed the meaning of financialization and its role in commodity markets. The chapter basically focused on the role of speculation in commodity markets. Speculation in commodity derivatives markets performs a significant economic role. Firstly, speculation in these markets allows for the transfer of price risk from those least willing to bear it (commodity producers and consumers, or 'end users') to those with the greatest appetite and capacity to do so (generically, 'speculators'). Secondly, derivatives markets transmit valuable information about supply and demand conditions. Therefore, speculators can create a price distortion and speculative bubble with the anticipation of making significant profits from major movements in the markets. The recent surge in commodity price has made to study the commodity market and to find out whether there is any role of speculators for commodity price surge in India.

Subsequently, we analysed the history of commodity futures market and its ban in India. Commodity futures market in India has a long history. After independence, the central government became the sole body to define rules and regulations for the development of the commodity futures markets. Till then all central government departments have been regulating production, distribution and quality of products by using the FCRA rules. With the recommendation of a number of committees, the government approved futures trading in several commodities. Soon after several commodity exchanges were born. The main among them are the Multi Commodity Exchange (MCX), the National Commodity and Derivatives Exchange (NCDE) and the National Multi Commodity Exchange (NMCX).

Then, we analyzed the structure of the commodity futures market in India. It was seen that right after the set up of all nationalized exchanges, there was a continuous rise of commodity futures prices in India. As a result, the rise in commodity spot price in 2007 led to the ban of some commodities futures trading but after the investigation it was confirmed that that price rise was not due to the futures trading but the shortage of production. However, the main aim of futures trading is to give the future price information to the public. Therefore, in this chapter, we also analyzed how futures market gives price information. Next, we have analyzed the role of futures markets in commodity price formation in India. Then we have analyzed the motivations of finncialization of commodity market. As the main motive of financialization is to get profit with rise in commodity price in India, investors use various instruments like the futures market or swap agreements. Except these two, they also use the ETPs.

Chapter 5: In Chapter 5, we empirically examined the financialization of commodity markets in India in two ways. First, we examined the relationship between stock price and commodity spot price. Second, we examined the relationship between commodity spot and futures prices using the commodity futures price index, spot price index and equity index or stock price index for India over the period from June 2005 to June 2011. The study used the time series techniques of cointegration test, causality test and the volatility spillover tests. Some important findings of the chapter are given below.

From the relationship of stock price with commodity price, it was found that average stock price return was more than the commodity price return but compared to the commodity price volatility, stock price was more volatile than commodity price. Among the commodity price indices, energy price index provided more price return with the highest volatility, whereas food price had the least return with less volatility in three periods. From the unconditional correlation, it is found that commodity price indices were highly correlated with the stock prices in three periods. From the Johansen cointegration test, it was found that food price index was not related with the stock price in all the three periods. That might be the reason why it provided less liquidity. Similarly, for other commodities also, it was found that there was no relationship between stock price and the commodity price in the long-run.

From the Granger causality test for the full sample period, it was found that there existed only one way causality from stock price to IAC price. In case of IAGRI price index, there was no relationship between stock price and the IAGRI price. There existed one way causality, i.e., from stock price to IENERGY price. In the case of IMETAL, there was only one way causality from the stock price to IMETAL price in India.

In the pre-crisis period, IAC index price caused stock price in the period from January 2001 to September 2008. In the case of IAGRI, there was causality from IAGRI price to stock price. There was causality from IENERGY price to stock price. In the case of IMETAL price index, there existed only one way causality from stock price to IMETAL price in India.

The Granger causality test for the post-crisis period, i.e., from the period November 2008 to June 2012 showed that stock price causes IAC index price in the post-crisis period. There was causality from IAGRI to stock price and also there existed one-directional causality between IENERGY stock price, i.e, from stock price to IENERGY price in the period from July 2008 to June 2012. There was only one directional causality, i.e., from stock to IMETAL in the period from January 2001 to July 2008.

Next we analysed the volatility spillover results. From the full sample period of IAC, we found that there was volatility spillover from the stock market to the IAC. In the pre-crisis period, there existed a bi-directional cross market volatility between stock market and IAC, and IAC and stock price in the period from January 2001 to September 2008. Similarly, in the post-crisis period, it was found that there existed cross market volatility between stock market to IAC and IAC to the stock market in the pre-crisis period, i.e., from November 2008 to June 2012.

In the case of IAGRI, there was no cross market volatility spillover between stock market and the IAGRI market for the period January 2001 to June 2012. There was also no cross market volatility between IAGRI and stock price in the period from January 2001 to September 2008. That means in the pre-crisis period, while commodity prices were booming, that time financial investors were not interested to invest on food items. Similarly, in the post-crisis period, there was volatility spillover from IAGRI to stock market but opposite was not possible.

In the case of IENERGY, there were bi-directional cross market volatility spillovers from stock market to IENERGY market and vice versa in the full sample period. While looking at the pre-crisis period, we found volatility spillovers from stock market IENERGY but not from IENERGY to stock price for the period from January 2001 to September 2008. In the post-crisis period, we found that there was cross volatility spillover from stock market to IENERGY market but it was not from IENERGY to stock market for the period from August 2008 to June 2012.

In the case of metal, there was cross market volatility spillover between stock market and the IMETAL market for the period from January 2001 to June 2012. There was also cross market volatility between stock market and IMETAL market for the period from January 2001 to September 2008. There were also bi-directional volatility spillovers between stock market and IMETAL Market for the period from October 2008 to June 2012.

In the second part of the analysis of financilisation of commodity markets, we analyzed the relationship between commodity spot and future price. Before estimating the Granger causality test and volatility spillover models, we checked the stationarity condition by applying the unit root tests such as ADF and PP test. From the unit root test, we found that all spot and future commodity price indices were non-stationary at their significance level. But in the first difference, all variables were significant at 1% significance level. Next, we analysed the Granger causality test and from this test we found that in the full sample period, there were bi-directional granger causality between the Comdex spot and futures price, whereas there was no causality from the food futures prices to Food spot. But there was causality from the food spot price to food futures price. In case of energy, there was no causality from energy futures to its spot price. But the reverse was possible, which means that there was causality from energy spot to energy futures price. In the case of metal, there was causality from metal futures to metal spot price but reverse was not.

In the pre-crisis period, there was bidirectional causality between Comdex spot price and futures price. There was no causality between either Food spot price and its futures price or from food futures price to spot price in pre-crisis period, i.e., from the period of June 2005 to September 2008. In the case of energy, there was no causality from energy futures to the spot price but there is reverse causality, i.e., from the energy spot price to energy futures price. It indicates that if there was change in energy spot price, then it would cause to change in the energy futures price in India. Similarly, in the case of metal, there was a bi-directional causality existing between these two prices.

In the post-crisis period, Comdex future price caused Comdex spot price in the period from October 2008 to June 2012. There was only one way causality, that is, from the Comdex futures price to the Comdex spot price. In the case of food, there was also one way causality, that is, from Food spot price to futures price. In the case of energy, there was one way causality existing from the Energy futures to the Energy spot price. Lastly, the causality test results for metal showed that there was no causality between these two prices. It means that the change in price was caused by some other factors.

Subsequently, we analysed the volatility spillover estimation model [i.e., GARCH(1,1)-BEKK model]. In the full-sample period, it was found that there was volatility spillover from the Comdex futures to the spot price for the period from June 2005 to June 2012. In the pre-crisis period, there existed cross market volatility between Comdex spot and futures prices for the period from June 2005 to September 2008. In the same way, in the post-crisis period there was cross market volatility spillover between Comdex spot and futures prices and vice versa for the period from August 2008 to June 2012.

In the case of food in the full-sample period, we found that there existed cross volatility spillover, that is, from the food futures to spot price and food spot price to food future for the period from June 2005 to June 2012. In the pre-crisis period, it was found that there was a volatility spillover, that is, from the food spot price to the futures market of food for the period from June 2005 to September 2008. In the post-crisis period, there existed cross market volatility spillover between food spot price and futures prices for the period from October 2008 to June 2012.

In the case of energy in the full-sample period, there existed bidirectional volatility spillover between the energy spot and futures prices for the period from June 2005 to June 2012. Similarly, in the pre-crisis period, there also existed bi-directional volatility spillover effect between energy future and spot spot price for the period from June 2005 to September 2008. In the post-crisis period, there was no cross market volatility spillovers between energy spot and futures price for the period from October 2008 to June 2012.

In the case of metal in the full-sample period, it was found that there was volatility spillover from metal future price to spot price for the period from June 2005 to June 2012. In the pre-crisis period, there was bi-directional volatility spillover effect existing between metal spot and futures price for the period from June 2005 to September 2008. But, in the post-crisis period, there was no cross market volatility between metal spot price and futures prices for the period from October 2008 to June 2012. Therefore, it can be concluded that there was no clarity on whether there was financialisation of commodity markets in India or not. Hence, the answer is inconclusive.

Thus, in chapter 5, we found no strong evidence on the financialisation of commodity markets in India. This result is quite similar with the report of the Reserve Bank of India (RBI, 2009-10). The RBI annual report (2009-10) mentioned that commodity prices in India seemed 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. However, studies like UNCTAD TDR (2009, 2010 and 2011), Troester (2013) and Tang and Xiong (2012) found the evidence of financialisation of commodity markets in respective countries. And this led to large increase in the price volatility of commodities around the year 2008. Thus, the main finding of the present study is contrary to those studies.

Chapter 6: The main objective of this chapter 6 was to examine the commodity market integration and price transmission between Indian commodity prices and international commodity prices. Therefore, this study started with determining the meaning of commodity market integration. After that, we have analysed different types and sources of market integration. Then, we have described the meanings of the price transmission and three types of price transmission – vertical, cross and spatial. The price transmission depends mainly on the law of one price (LOOP). The chapter also reviewed the existing literature both for India and other nations. The present study used the econometric techniques like cointegration test and VECM models to examine the market integration and price transmissions.

From the national (India) and international price trends, it was found that from 2000 to the mid of 2008, there had been continuous increase in the commodity prices. After the global financial crisis, there was a declining trend of prices but it recovered earlier than the financial market. Before striking any comparison between India and international prices, we checked the stationary conditions of all variables by using the econometrics techniques of ADF and PP tests. From the unit root test, it was found that all commodity price indices both for India and International prices were non-stationary at their level values but all became stationary in their first difference values.

From the cointegration test, we found that there was cointegration between IAC and WAC, which means that there was long run equilibrium relationship between IAC and WAC in the full period. In the pre-crisis period, there was also long-run equilibrium between IAC and WAC. But in the post-crisis period, there was no long-run relationship between IAC and WAC index price.

In the full-sample period, there was no long-run cointegration between IFOOD and WFOOD. But in the pre-crisis period, there was a long-run equilibrium relationship between IFOOD price and WFOOD price. In the post-crisis period, there was no long-run equilibrium relationship between IFOOD price and the WFOOD index price. It was also found that there was log-run equilibrium relationship between IENERGY price and WENERGY price in the three sample periods. In the full-sample and pre-crisis periods, there was log-run equilibrium relationship between IMETAL and WMETAL index prices but in the post-crisis period, there was no long-run equilibrium relationship between IMETAL and WMETAL index price.

The VECM results show that there was short-run dynamic relationship between IAC and WAC index prices both in the full-sample and pre-crisis period. But in the post-crisis period, there was no short-run dynamic relationship between IAC and WAC index price. The VECM results for IENERGY and WENERGY show that there was short-run dynamic relationship between these two price indices in the three sample periods. In case of metal prices, there was short-term dynamic relationship between IMETAL and WMETAL index prices both in full-sample and pre-crisis periods. But in the post-crisis period, there was no short-run relationship between IMETAL and WMETAL prices.

To understand whether the change in Indian commodity prices was due to the change in international prices, we analyzed the lag coefficients values of the VECM. The ECM test results showed that in both full-sample and pre-crisis periods, the change in IAC prices was due to the change in WAC index prices but in the post-crisis period there was no effect of WAC on IAC. In the case of food prices, the change in IFOOD prices was not increased due to the WFOOD prices in all the three sample periods. In the energy price, the change in IENERGY price was caused by the change in WENERGY price in all the three periods. In the case of metal prices, in the full-sample and pre-crisis period, the change in IMETAL price was due to the change in WMETAL price but in the post-crisis period, there was no effect of WMETAL price on IMETAL index price.

Thus, the main finding of the chapter 6 is similar to other studies like Jha et al. (2005), Ghosh (2012), Rajmal and S. Mishra (2009) and Imai et al. (2008). These studies found that the domestic commodity prices co-moved with global commodity prices. But the integration of agricultural commodities was far from the complete in India and a major reason for this was the excessive government interventions.

Some of the main findings of this study are: (i) commodity prices (all commodity index) in India have been increasing since 2001 and the rise was very sharp specially after 2008. Among all groups of commodities, metal prices were at the top of rising trends. (ii) Due to the global financial crisis in 2008, structural breaks were observed in the price trends of all commodities. (iii) price transmission was the only factor, among the three groups of factors (fundamental, financialization and price transmission), found to be influencing towards the rising trends of commodity prices in India in the full-sample and pre-crisis period. (iv) the econometric results indicated that the change in the behaviour of agricultural prices in India was mainly by the fundamental factors. Metal prices were affected sometimes by the fundamental factors and sometimes by the international price transmission. However, the change in energy prices in India was mainly due to by the international price transmission.

7.2 **Policy Implications**

The rise of commodity prices is new in an emerging country like India. Interestingly, the directions and number of commodities involved have been larger in the recent period than in any other period. While mild rise in commodity prices is welcome and useful for producers, continuous/rapid rise is not good for the economy as a whole. Various factors are responsible for the rising prices. But these factors vary from commodity to commodity and time to time. Therefore, to control the unprecedented price rise in India, government should take proper measures so as to control the commodity prices. This is needed to control rising inflation in the country. In this study, we have found that agricultural commodities in India are affected by the fundamental factors. Metal prices are affected sometimes by the fundamental factors and sometimes by the international price transmission. But the energy prices in India are completely affected by the international price transmission. Those findings are a serious matter of concern for both the government and the public as a whole. Therefore, to control such unprecedented price change, government of India has been adopting different policies, viz., (i) to control food price inflation, govt. tried to increase agricultural productivity by implementing new schemes, and provided large budgetary support to these. (ii) Government has also reviewed import and export of all essential commodities on a regular basis and imposed controls on exports and eased restrictions on imports. (iii) Government of India also has purchased the essential commodities and provides consumers through the Public Distribution System and etc (Government of India, 2011).

So, to control the unprecedented price rise of the above commodities, we are also recommending the some policy measures, which government of India should adopt. Some of such policies are described below. Firstly, this study found that the prices of agricultural commodities are demand driven due to the shortage of supply of these commodities. Therefore, government should take measures to increase the production or supply of agricultural commodities. Though there are both controllable and uncontrollable factors responsible for less production or supply of agricultural commodities, yet government should focus on the controllable factors like providing HYV seeds, pesticides, proper storage facilities, marketing facilities, etc. Secondly, metal prices are driven by both fundamental and international price transmission. Hence, government should focus on more production of metals in the country. Proper harnessing of metals should be done from the available stocks and mines in the country. Thirdly, though crude oil price is driven by the international price fluctuation, there should be invention of new energy sources. Some of these sources include the wider use of solar power, wind power and biofuel, etc.

7.3 Limitations and Directions for Future Research

The present study suffers from some limitations. First, though huge number of commodities is consumed by the people, this study concentrated only on very few commodities. Therefore, for the better observation of price behaviour of commodities, the study must be carried out by including more number of commodities. This can be one line of future study. Secondly, due to unavailability of supply side factors like biofuel data, this study used more demand side factors to measure the impact of fundamental factors on commodity prices. Therefore, in the future, the study should use both demand and supply side factors. Thirdly, this study used the single structural break model. This can point out only a single structural break point. In the future research, the advanced structural break model should be tried to find out multiple structural break points.

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