STUDY ON CO-INTEGRATION AMONG INDIAN STOCK AND COMMODITY MARKET

(WITH SPECIAL REFERENCE TO SEASONALITY, CO-MOVEMENT AND VOLATILITY)

Thesis submitted to

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in

MANAGEMENT

By

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MITTAL SCHOOL OF BUSINESS

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DECLARATION

I, Gursimran Kaur, hereby declare that the thesis entitled “Study on Co-integration among Indian Stock and Commodity Market (With Special Reference to Seasonality, Co-movement and Volatility)” submitted to the Lovely Professional University for the award of Degree of Doctor of Philosophy in Management, is an original research work carried out by me in Mittal School of Business at the Lovely Professional University during the period of 2015-19 under the supervision of Dr. Babli Dhiman (Professor), Mittal School of Business, Lovely Professional University. Any extract to this research in part or as a whole has not been included, incorporated or added to any other work or similar title by any scholar in any other university.

Dated: Gursimran Kaur

CERTIFICATE

TO WHOM IT MAY CONCERN

I certify that Gursimran Kaur has prepared her thesis entitled 'Study on Co-integration among Indian Stock and Commodity Market (With Special Reference to Seasonality, Co-movement and Volatility)' for the award of PhD degree of Lovely Professional University under my guidance. She has carried out her work at the Mittal School of Business, Lovely Professional University.

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Gursimran Kaur

Date:

ABSTRACT

Globalization has made this world a smaller place. The world economies have integrated with each other through trade and financial flow. The commodities are key constituents for basic economic activity and considered as important for the economic development of a country. India is a price taker for almost all commodities. The trade relation and changes in the international currency makes a strong correlation between international and domestic commodities. Since the increase in commodity prices is considered as one of the elements of higher inflation and rate of interest in the economy, due to which there is decrease in stock prices. Therefore long position in the commodity market can provide hedge against the unexpected fluctuation in the equity prices (Conover et al., 2010).

Volatility in commodity market and stock market is one of the global issues since the financial crisis 2007-08. The uncertain movement in the commodity prices over the period of time is known as volatility. Uncertainty in the prices of commodities has significant impact on the income of producers and traders which ultimately reduce the performance of commodity market (World Bank, 1997). The rise in volatility increases the risk which dissuades the investors to invest in the financial markets. Due to cyclical fluctuations related to calendar year in the commodity market and equity market, the concept of volatility cannot be studied alone (Maitra, 2018). Seasonality in commodity market return is anticipated if mean returns are different over the period of one year. It is also a sign of market inefficiency (Kumar and Singh, 2008). Seasonality refers to the market trend whereby the return and volatility of certain periods are different from other periods and the investors can earn extra return during this time period by taking more risk (Wang et al., 2018).

Modern portfolio theory stated that investors are required to expand their portfolio in different asset classes, which are having negative correlation with each others in order to reduce the unsystematic risk. Commodities are considered as safe haven because of very less correlation with traditional assets like equities and bonds (Gormus, 2012). Commodities are considered as fortune of the nation. The increased dependence of worlds' economies on the commodities has raised the fluctuations in the prices of

commodities. The domestic and international markets are affected by these variations. It is regarded as predictor of economic downturn (Hamilton, 2011).

Further recent development in Indian commodity market by Security and Exchange Board of India (SEBI) has increased the exposure of commodities to individual investors. SEBI has recently taken step towards strengthening the integration between commodity market and stock market by integrating the investors, intermediaries and operational framework. The process of integration is implemented in two phases. The very first phase stressed on measures taken to increase the integration at intermediary level. In the second phase, the necessary measure have been decided to be taken to integrate the commodity market and stock market by enabling a single exchange for operating all market segments such as equity, commodities, equity derivatives and commodity derivatives (Sharma, 2017). The two major national level stock exchanges of India have recently applied for license to initiate the trading of commodity derivatives. It is an interesting step which has been taken towards the integration of commodity market and stock market in order to boost the investors' confidence (Zachariah, 2018).

Recently, SEBI has approved the option contracts in non-agricultural commodities. This has resulted in increased investors' participation in the commodity market as there is increase in the daily turnover of gold from 64 crore on December 2017 to 700 crore on July, 2018 with the introduction of gold option contract. Currently the option contracts are available for precious metals including gold and silver, crude oil, zinc and copper. Investors are using these commodities as hedging tool (Rukhaiyar, 2018). Given the evidence of recent developments and amendments in the commodity trading to boost the confidence and participation of investors, this study examine the co-integration among commodities and stock prices to provide better insights regarding the hedging effectiveness of commodities against the unexpected fluctuations in the stock market. Furthermore the linkage between prices of raw material and their related stock indices will provide relevant information about the potential substitution strategies between commodities and stocks (Creti et al., 2013). This study will be useful for the policy makers to boost involvement of retail investors in commodity market and stock market by using optimal weights and hedge ratios, computed by taking into consideration the findings of this study. Investors can use these weights and ratios to hedge their risk effectively. This way they will be better equipped to anticipate and prepare for unexpected fluctuations in commodity and stock prices.

Research gap

After going through the literature on seasonality, volatility spillover and co-integration between commodity market and stock market, it is summarized that after the financial crisis 2008, the interconnection between stock market and commodity market has been increased. Recently there is increase in number of financial investors in commodity market due to which commodities are considered as financial assets like stocks and bonds. The financialization of commodity market has also changed the dependence structure between commodities and stock market. Due to this it has become easy to forecast the movement in the price of stocks with the help of commodity prices because the commodity prices contain sufficient information related to unexpected economic conditions and secondly increase in commodity prices signify the increase in global economic demand. The later has strong impact on the prices of stocks (Black *et al.,* 2014).

Some researchers have given contradictory definition related to the correlation between commodity market and stock market. There is increase in inflation rate in the economy due to increase in commodity prices, which is considered as an underlying reason behind the decrease in stock prices. Therefore long position in the commodity market can provide hedge against the unexpected fluctuation in the equity prices (Conover et al., 2010). Therefore there is no common ground among researchers in explaining the concept of relationship between these two markets. Despite the surge in literature on the association between commodities and stock prices, this concept is still very confusing in Indian context. A significant number of studies on this concept have been carried out in developed economies but very limited literature has been available for emerging economies like India. The financial markets of emerging economies differ from the developed economies in terms of volatility, speculative activities (Ping et al., 2017). The lack of empirical research is one of the reasons surrounding the confusion regarding this concept in Indian context

All these issues and limitations when taken into consideration provide a framework for future research. The outcomes of this study have significant contribution in existing literature on the concept of co-integration between Indian commodity market and stock market by taking into consideration individual commodities and sectoral stock indices.

Objectives of the Study

1. To examine the seasonality in mean return and volatility for the Commodity Market and Stock Market
2. To examine the long run co-integration between the Commodity Market and Stock Market
3. To examine the causal relationship between the Commodity Market and Stock Market
4. To examine the return links and volatility transmission between the Commodity Market and Stock Market
5. To examine the dynamic correlation between the Commodity Market and Stock Market

Research Design and Methodology

The spot price data related to individual commodities has been collected from the Multi Commodity Exchange (MCX) of India website from the year 2007 to 2017. The selected commodities are covering four sectors which are Agriculture, Precious Metals, Base Metals and Energy Commodities. The data related to selected stock indices has been collected from National Stock Exchange of India (NSE) website from the year 2007-2017. The selected stock indices are NIFTY FIFTY, NIFTY Energy, NIFTY Metals and NIFTY FMCG. The econometrics models used in this study are: Generalized Autoregressive Conditional Heteroskedasticity, Johansen Co-integration Test, Toda and Yamamoto Granger Causality Test, VAR GARCH Model and Dynamic Conditional Correlation Model.

Major Findings

- There is the presence of seasonality in the mean return and volatility of commodity market and stock market.

- The seasonal effects in the commodity market are not similar to the stock market.
- The long run co-integration does not exist between commodity market and stock market.
- The causal relationship does not exist between commodities and their related stock indices except five commodities which are barley, cottonseed, mustardseed, jeera and wheat.
- Out of 25 commodity-stock pairs, there is significant impact of past shocks and volatility fluctuations in five commodity prices which are mustardseed, rubber, gold, silver and copper on the present conditional volatility of stock market..
- There is significant transmission of shocks across commodity market and stock market in crude palm oil, guargum and nickel.
- The current conditional volatility of crude palm oil, rubber, soya oil and nickel depends upon the past shocks in their related stock indices
- The current conditional volatility of barley, RBD palm oil, aluminum, lead and zinc depends upon the fluctuation in the past volatility of their related stock indices.
- Further the results of dynamic conditional correlation between commodities and their related stock indices suggest that the linkage between the stock and commodity prices is highly volatile throughout the study period.
- During the financial crises, the dynamic relationship between the commodity and stock prices decreased.
- The correlation between these commodities and stock returns rises immediately after the financial crisis

Conclusion

The results related to seasonality in commodity market and stock market has important implications. The findings of this study indicate that the monthly effect is not similar in both commodity market and stock market. It indicates the inefficiencies in the market due to which it becomes easy for the investors to earn abnormal returns by taking opposite positions in both the markets. The absence of co-integration between commodity and stock market prices in the long run implies that it is safe for the investors to invest in both markets to diversify their portfolio. It has been further suggested that shock spillover effect across the markets does not hold true. The results are in consistent with Nath and Verma (2003); Hammoudeh and Aliesa (2004); Kumar and Shollapur (2012) and Srinivasan (2014). From the investor's stance, the findings discussed earlier suggested that since there is absence of causality between commodities and their related stock indices, these stocks and commodities can be used as diversification tool in the portfolio. On the contrary, similar recommendations cannot be given for the commodities which are having causal relationship with stock market and unlike the common perception, it is suggested to the investors that they should be very careful while including these commodities in their portfolio. The magnitude of one period lagged own price shocks is strong as compare to the one period lagged cross price shocks. Compared to the magnitude of one period lagged own shocks and volatilities, the analysis depicts that the magnitude of one period lagged cross market shocks and volatilities is very less which suggests that the past own shocks and volatilities are considered as important to forecast present volatility. It further implies that commodities and stock indices do not belong to a similar group, rather these should be taken separately and to improve the overall weighted performance of a portfolio, it is better to add both commodities and stocks. The results obtained in this study are different from the developed economies because the Indian commodity market is different from global commodity market. It is still separated in different segments and kept away the investment from large financial corporations and banks. Overall the results imply that making commodities as part of a portfolio including different asset classes improve its weighted performance and it also helps to hedge the portfolio risk more effectively. The results also imply that the optimal weights and hedge ratios are different across sectoral indices.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criteria
ARCH	Autoregressive Conditional Heteroskedasticity
BSE	Bombay Stock Exchange
DCC	Dynamic Conditional Correlation
EMH	Efficient Market Hypothesis
FMC	Forward Market Commission
FMCG	Fast Moving Consumer Goods
FY	Financial Year
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
LM	Lagrange Multiplier
MCX	Multi Commodity Exchange
NCDEX	National Commodity Derivative Exchange
NSE	National Stock Exchange
OLS	Ordinary Least Square
SEBI	Security and Exchange Board of India
TY	Toda Yamamoto
US	United States
UK	United Kingdom
VAR	Vector Autoregressive
WFO	World Financial Organization

ABSTRACT

Globalization has made this world a smaller place. The world economies have integrated with each other through trade and financial flow. The commodities are key constituents for basic economic activity and considered as important for the economic development of a country. India is a price taker for almost all commodities. The trade relation and changes in the international currency makes a strong correlation between international and domestic commodities. Since the increase in commodity prices is considered as one of the elements of higher inflation and rate of interest in the economy, due to which there is decrease in stock prices. Therefore long position in the commodity market can provide hedge against the unexpected fluctuation in the equity prices (Conover et al., 2010).

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CHAPTER 1
INTRODUCTION

Globalization has made this world a smaller place. The world economies have integrated with each other through trade and financial flow. The commodities are key building blocks for the basic economic activity and the development of an economy. India is a price taker for almost all commodities. The trade relation and changes in the international currency makes a strong correlation between international and domestic commodities. The report of World Economic Outlook (Oct, 2016) suggests that global commodity market prices have rebounded 22 percent since the last year. Due to the involuntary outage, oil prices have increased by 44 percent. Natural gas prices have been declined due to the strong supply from Russia. Coal prices have also risen due to tighten demand and supply patterns. Metal prices and agriculture commodity prices have increased by 12 percent and 9 percent respectively. The risen control measures of the government on the trade of metals in Asia and unwillingness of producers to activate idle capacity has made the metal prices more volatile.

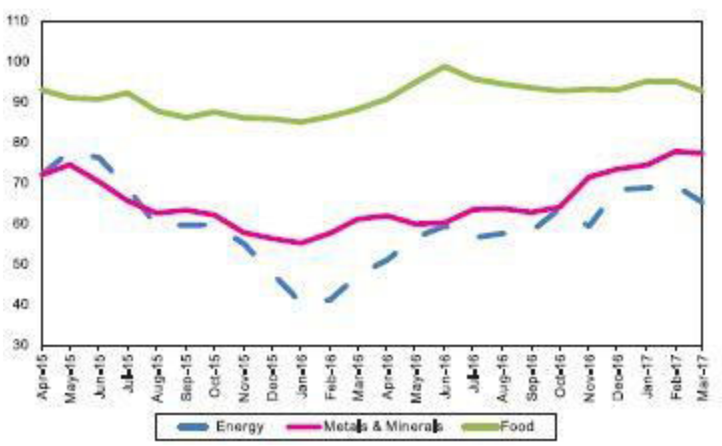


Figure 1.1: Fluctuations in Global Commodity Indices

Source: SEBI Annual Report 2016-17

Figure 1.1 shows the fluctuations in the prices of global commodity indices. X axis depicts the years and Y-axis depicts the price of global commodity indices. It has been noted that all the indices have shown increasing trend after February 2016. It is due to the strong demand and supply tightness globally during this time period (SEBI Annual Report, 2016-17)

1.1 A Brief introduction to commodity Market and Stock Market

The commodity future trading was started in the seventeenth century in Osaka, Japan. The historical evidences suggested that commodity future trade in China was originated 6000 years earlier. The organized and exchange oriented trading in the commodity future was started with the establishment of Chicago board of trade in the United States. In India, the commodity future trading was started with the establishment of Bombay Cotton Trade Association in the year 1875. In the beginning of the year 2002, there were about 20 commodity exchanges in India with 42 commodities traded actively in these exchanges.

Multi Commodity exchange is India's first listed exchange incorporated in the year 2003. It provides a platform for online commodity future trading in India. According to the future industry association, Multi Commodity Exchange is the world's seventh largest commodity exchange. National commodity and derivative exchange is a public limited company incorporated in the year 2003. NCDEX is multi commodity exchange professionally managed by national level institutions and public sector banks and companies. These exchanges are providing risk management opportunities to the traders and producers of the commodities to hedge against excessive price fluctuations in the real market. Besides it, MCX also plays a significant role in economic growth of the country by incentivizing the growth of modern warehouse and other supportive infrastructure. Recently the commodity market has undergone through a number of reforms aims at broadening and deepening the market due to which the investors' participation in the commodity market has been raised.

Forward Market Commission regulated commodity exchanges of India till 2015. In September 2015, there is merger of FMC with the Securities and Exchange Board of India (SEBI) under Security Contract Regulation Act (SCRA), 1956. Global Commodity Exchanges have flourished due to high liquidity, large market participation and forward looking regulation. This merger has provided more depth to the market liquidity, investor participation and price discovery (Modi, 2015). The main motive of SEBI is to widen the commodity derivative market as stated in the SEBI Annual Report. SEBI is taking necessary measures to increase the integration among commodity market and security market to boost up the participation rate and confidence of investors in the commodity market. The commodity exchange turnover has been boosted up by 9 percent in the year 2015-16. In the major commodity exchanges Multi Commodity Exchange and National Commodity Derivative Exchange, the number of traded contracts increased up by 56.5 percent in the year 2015-16. This continuous growth of commodity market will increase the confidence of the investors in the market which in turn increase the participation of investors in the commodity market.

The commodity market in India has been developing enormously since the establishment of commodity exchanges (Sinha and Mathur, 2013). The report of WFO stated that some of the emerging economies have witnessed more than expected growth rate and some of them have experienced slowdown. The growth rate of two emerging markets India and China has remained strong. The Indian commodity market has shown mixed trends in the year 2016-17 due to turnaround in international commodity markets, increased impact of domestic macro-economic indicators, price stability and impact of demonetization. The huge gain has been attributed in metal segment in the form of volume and value traded.

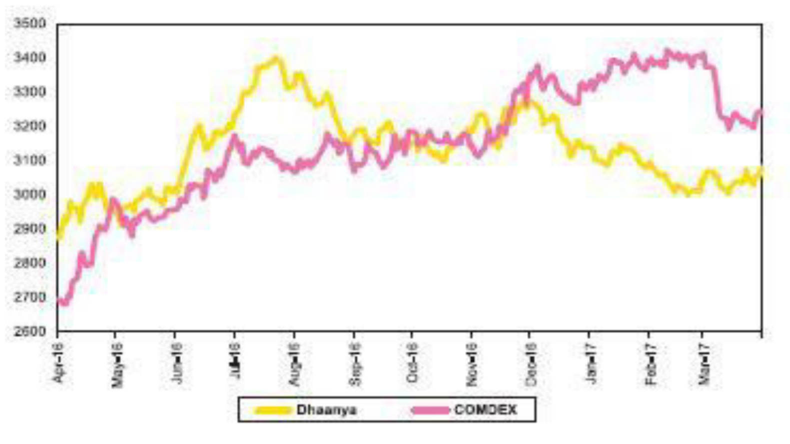


Figure 1.2: Fluctuations in the Prices of Benchmark Indices

Source: SEBI Annual Report 2016-17

The price trend in commodity market has been presented in Figure 1.2, discerned from the price trends in the benchmark indices of two major commodity exchanges which are Multi Commodity Exchange and National Commodity and Derivative Exchange of India. X axis depicts the years and Y-axis depicts the price of benchmark index. Two indices have been taken into account, out of which the first one is MCX COMDEX. It is combined index of three indices which are MCX Agriculture, MCX Metal and MCX Energy indices. The second index is NCDEX Dhaanya index which is a composite index of 10 agricultural commodities.

Figure 1.2 indicates that the percentage increase in MCX COMDEX and NCDEX Dhaanya index is 18.7 percent and 7.8 percent respectively in the year 2016-17. The MCX COMDEX and NCDEX Dhaanya have gained 512 points and 224 points respectively from March 2016 to April 2017. Further the MCX COMDEX is at highest level on February 2017 while the NCDEX Dhaanya index is at highest close on July 2016. The annualized volatility recorded in MCX COMDEX is 11.7 percent and for NCDEX Dhaanya index, it is 10.6 percent. The total number of permitted commodities as on March, 2017 is 25 for NCDEX, 16 for MCX and 13 for NMCE (See Figure 1.3)

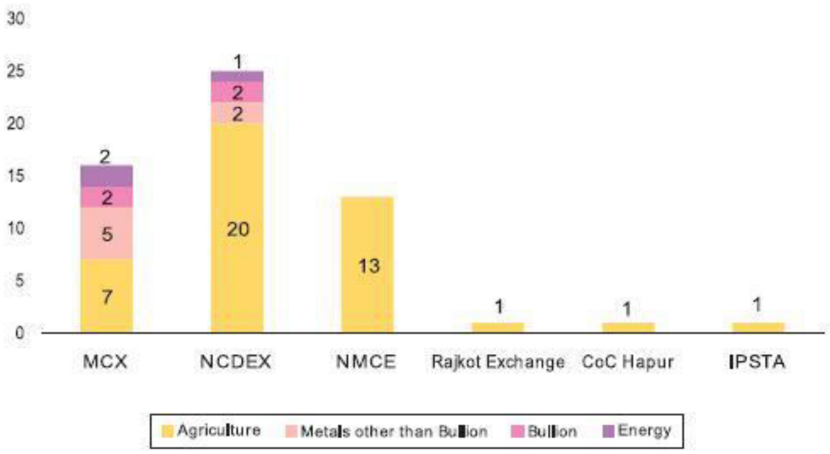


Figure 1.3: Number of Permitted Commodities (Sector Wise)

Source: SEBI Annual Report 2016-17

The contribution of top 10 agricultural commodities in the National Commodities and Derivatives Exchange turnover in the FY 2016-17 is 93.2 percent. The highly traded agricultural commodity in NCDEX is refined soy oil with its percentage share of 21.5 percent in total turnover, followed by mustard seed with a share of 14.2 percent. Despite the increasing growth of Indian commodity market since the last few years, the participation of investors is still very less. The liquidity in commodity market can be increased by financial investors rather than actual producers.

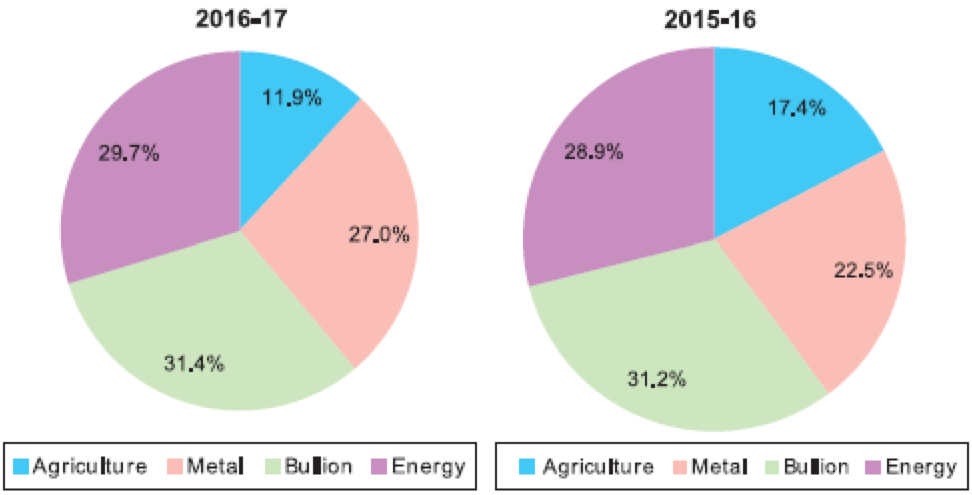


Figure 1.4: Turnover of Commodity Market (Product Segment Wise)

Source: SEBI Annual Report 2016-17

Figure 1.4 indicates that the share of agricultural commodities in the total turnover of commodity market is less as compare to non-agricultural commodities. There is decrease in the turnover of agricultural commodities in the year 2016-17 comparative to previous year, while the turnover of non agricultural commodities has been increased in the year 2016-17 as compared to previous year. The volume of trade has also been increased in non agricultural commodities. The highest increase has been witnessed in energy commodities, followed by metal, agriculture and bullions.

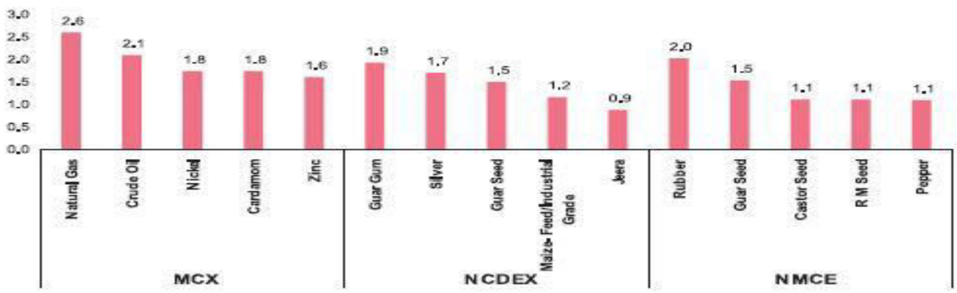


Figure 1.5: High Volatile Commodities (Exchange Wise)

Source: SEBI Annual Report 2016-17

Figure 1.5 shows the top five high volatile commodities. The most volatile commodity is natural gas in the year 2016-17. Among the agricultural commodities, guar gum is the most volatile commodity. The nickel is the highly volatile among the base metals (SEBI Annual Report, 2017).

The first stock exchange in India was commenced in an organized manner with the establishment of Native Share and Stock Brokers' Association of Bombay in the year 1875. In the year 1956, Government of India named this stock exchange as Bombay Stock Exchange (BSE) and recognized it as a first stock exchange of India. National Stock Exchange has started working in the year 1994. It is the first exchange in India which has provided modern and fully automated trading system. In India, now 24 regional and national stock exchanges are working.

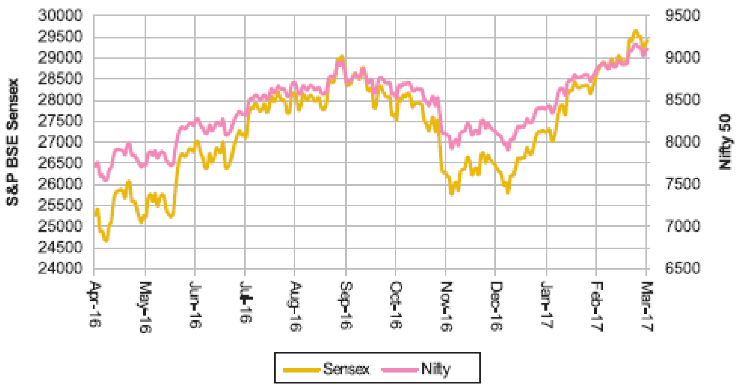


Figure 1.6: Fluctuations in the Price of Benchmark Stock Indices

Source: SEBI Annual Report 2016-17

The Indian stock market has witnessed strong growth in the year 2016-17 due to rising inflow of foreign institutional investors. NIFTY index has been increased up by 18.5 percent at the end of financial year 2016-17. Figure 1.6 shows the fluctuations in the price of SENSEX and NIFTY considered as benchmark indices. X-axis depicts years and Y-axis depicts the price of benchmark index. Both SENSEX and NIFTY has attained their highest level on March 2017. Both the indices reached at lowest level on November 2016 immediately after the announcement of demonetization of currency (SEBI Annual Report, 2017).

1.2 Volatility and Seasonality

Volatility in commodity market is global issue since the financial crisis 2007-08. The uncertain movement in the prices of commodity over the period of time is known as volatility. Therefore, as a result of these uncertain movements in the commodity prices, the income of producers and traders is affected which in turn reduce the performance of commodity market (World Bank, 1997). The global economic growth cycle is commodity intensive. The increased demand of commodities due to increasing industrialization in emerging economies like India and China led to surge the commodity price. Therefore the demand side shocks are most prominent that pulls the commodity prices up. The supply side factors are mostly prominent in agricultural commodities which occur due to adverse weather conditions. The increased variability in the price of commodities affects the economic growth of a country (Devlin et al., 2012).

The excess variability in the price of commodities is due to speculative activities. Speculation means transfer of risk from less risk bearing investors to the investors who have greater appetite and capacity to bear high risk. Speculators play destabilizing role in the commodity market (Devlin et al., 2012; Brunetti et al., 2016). Due to increase in speculative activities the agricultural commodity prices became more prone to the macro-economic shocks (Tang and Xiong, 2012). Further the increased variability in the prices of commodities increases the speculative activities in the commodity market which in turn affects the future trading on commodity market (Ramadas et al., 2014). The absence of arbitrage opportunities in the commodity market raises the asset prices due to increasing flow of information which lead to increase volatility (Mahalik et al., 2009).

The volatility is high in the commodity prices during short run. Price volatility is transferred across different commodities which makes the matter worse (Brown et al., 2008). Mishra (2018) suggested that high volatility in crude oil prices affects the whole commodity markets and other financial markets through production and mining which in turn affects the global economy and economic growth of the country. Rising volatility in price of commodities also have long term impact on the economy. Over the long run, the primary commodity prices start decreasing relative to the price of manufacturing goods. This has made it very costly to spend in technology and on buying of other commodities (Brown et al., 2008). The variations in the price of commodities pose challenges to the traders and more specifically to commodity importing developing countries. They can face problems related to balance of payment because of rising cost of import of these commodities. When the rising price of commodities globally transferred to the domestic countries, it will erode the purchasing power of household and buyer of other commodities (Mugera, 2015).

The high variability in the prices of the commodities leads to increase trading volume of commodities by increasing the trading opportunities for the investors (Ram, 2012). According the structural view, the rising prices of commodities are important for economic growth but sometimes these are detrimental to the economic growth as per monetarists view (Ramadas et al., 2014). The instability in the prices of commodities complicates the financial planning of commodity dependent economies (Brown et al., 2008). The unexpected fluctuations in the price of commodities increase the chances of getting losses to the producers, traders and market players.

Further the existence of volatility in stock prices is associated with two factor process. The first one is long run process which is slowly changing and the second one is short run process which is strongly mean reverting. The long run process includes macro-economic fundamentals such as future cash flows and discount rates. The short run process includes transitory factors such as investor's sentiments (Chiou and Lee, 2009). Financial markets follow economic cycle which is one of the reasons for excess volatility in these markets. Economic cycle includes boom followed by recession and then again market starts reviving that increases the confidence of investors towards the market and followed by boom period (Ahmed et al., 2017).

The high variability in the stock market has adverse effect on the confidence of investors and therefore affects the trading volume negatively (Kupiec and Studies, 1991). The large fluctuations in the stock market prices disturb the monetary policy transmission process and thereby create instability in the whole economy. It is required to have financial stability and liquidity in financial markets for transmission of information from one market to other market smoothly and efficiently. The excess variability in the prices of financial markets adversely affects the willingness of investors to invest in the financial markets because the volatility is transferred to the real economy and the transmission process become weaker and inefficient (Gugerell, 2003).

The rise in volatility increases the risk which dissuades the investors to invest in financial markets. Due to cyclical fluctuations related to calendar year in commodities, the volatility in the commodity market cannot be studied alone (Maitra, 2018). Seasonality in commodity returns is anticipated if mean returns are different over the period of one year. It is also a sign of market inefficiency (Kumar and Singh, 2008). Seasonality refers to the market trend whereby the return and volatility of certain period is different from other periods and the investors can earn the extra return during this time period by taking more risk (Wang et al., 2018).

The efficient market hypothesis stated that the perception of investors varies with the arrival of new information in the market and therefore, investors start revising their portfolio and these changes are immediately reflected in the price of financial assets (Tursoy & Faisal, 2017). Efficient market hypothesis affirmed that the information available in the financial markets is reflected in the price of financial security. It means it is impossible for the investors to generate extra profits from the market. It implies that price change adjusts itself in order to reflect the available information in the market.

This hypothesis is contradicted due to the occurrence of seasonality in the financial markets. The seasonality has been largely attributed in both commodity and equity prices even though the factors affecting both the markets are different from each other (Brooks and Prokopczuk, 2013). The imbalance in demand and supply is an underlying reason for seasonal fluctuations in commodity prices (Crain and Lee, 1996). Demand side fluctuations occur due to the dependence of demand of the particular commodity on the performance of its related industry while the supply side variability exists due to the unfavorable weather conditions especially in agricultural commodities.

Secondly there is increase in number of investors, who are considering commodity market similar to the other financial markets like stock and bond market. Therefore, the sentiments of investors during the unexpected shocks in the markets that affect the stock market will also become one of the reasons for increased fluctuation in the prices of commodities. In addition, the third reason is the financial market bubble that has exceeded the volatility in price of commodities. When the stock market is continuously rising, the investors start investing in commodities. If there is any shock in the stock market, the investors withdraw their money from the commodity market and vice versa because they no longer want to bear more risk due to which prices of these assets change from their fundamental value. It leads to create excess variability in the prices of financial assets which in turn increase the chances to earn abnormal return from the market.

1.3 Co-integration

Integration is the process of association between two segmented markets so that the investors can get the benefits of same unconstrained access to the financial assets. It is considered as the tendency of the markets and price of financial assets to come together in the long run. It also refers to the flow of funds from less profitable markets to highly profitable markets and unites these returns into one (Misra and Mahakud, 2009).

Co-integration is an important issue to take into consideration while modeling time series data that has many applications in financial markets. Sometimes the terms co-integration and correlation are used interchangeably. These terms are related to each other but a different concept. If the correlation between two assets is high, it does not mean that co-integration between them is also high. The correlation describes the co-movement in return but the prices are instable over the period of time. It is the short run phenomenon. On the contrary, the co-integration between two assets represented the long run association. The hedging strategies based only on correlation cannot guarantee the long run performance. There is required to include both risk and return to take into account the long term trends in the prices (Alexander, 1999).

Volatility spillover refers to the effect of lagged return and volatility of one market on the volatility of other markets. Risk-return relationship and time varying correlation are the important concept to develop optimal hedging strategies.

The modern portfolio theory stressed on the fact that investors are required to diversify their portfolio to lessen the unsystematic risk by using different assets classes which are negatively correlated with each other. Commodities are considered as safe haven due to their less correlation with conventional assets like equities and bonds (Gormus, 2012). Commodities are considered as fortune of the nation. The increased dependence of worlds' economies on commodities has raised the fluctuations in commodity prices. The domestic and international markets are affected due to these variations. This is regarded as the predictor of economic downturn (Hamilton, 2011). The variations in the stock prices affect the investor's confidence significantly, which in turn affects the commodity market. It is thus very important to examine the impact of changes in commodity prices on stock prices (Nguyen et al., 2015). The cross market linkage and interlocking markets is the subject of rigorous research area (Soucek and Todorova, 2013).

Over the past, there is swift increment in the investment in commodity market due to its low correlation with other financial assets. The underlying reason behind this is that the factors affecting the price of commodities are not similar to the factors affecting other financial markets. The investment in commodity market through financial instrument is considered as financialization. This concept has changed the concept of co-integration between commodity market and other financial markets. Financialization impacts the commodity markets in two ways. Firstly, it affects the diversification benefits of the investors. Secondly policy makers consider it important as it has strong impact on the real economy (Baldi et al., 2016)

Further the herding behavior of investors causes the bubble bursts in the financial markets which lead to increase volatility in financial markets. The behavior of investors regarding their portfolio strategies affects the trading strategies of other investors due to which the fundamental value of the assets deviates from the actual values. This phenomenon is driven by informed investors who affects the relationship between two markets through their speculative activities and secondly through noise investors who does not have much knowledge about the market and tried to imitate the behavior of others (Peri et al., 2014).

Moreover the linkage between commodity market and equity market has strong implications for retail participants of financial markets and policy makers. Policy makers concentrate on the volatility of commodity market and its impact on other related sectors to reduce the inflation pressure. The investors observe the behavior of commodity market and stock market to develop hedging strategies by including both raw material and their related stock indices in their portfolio (Creti et al., 2013).

1.4 Justification of the Study

Since the financial crisis 2007-08, co-integration between commodity and equity prices has become one of the attractive topics in the world (Tang and Xiong, 2010; Baldi et al., 2016). Research has shown that there is increase in co-integration between commodity market and stock market since past few years. The logic behind this is the increase in number of financial investors in commodity market which is termed as financialization. These investors consider commodities as other financial assets like stocks and bonds. Therefore, the factors affecting stocks and bonds have similar effect on the commodities also.

Some researchers have given contradictory definition related to the co-integration between commodities and stocks. The increase in price of commodities is considered as one of the elements of higher inflation and interest rate in the economy which affects the stock prices negatively. The long position in commodity market can provide hedge against the unexpected fluctuation in the stock market prices (Conover et al., 2010). Therefore there is no common ground among researchers in explaining the concept of relationship between these two markets. Despite the surge in literature on the linkage between commodity market and stock market, this concept is still very confusing in Indian context. The lack of empirical research is one of the reasons surrounding the confusion regarding this concept in Indian context

Further recent development in Indian commodity market by Security and Exchange Board of India (SEBI) has increased the exposure of commodities to individual investors. SEBI has recently taken step toward strengthening the integration between commodity market and stock market by integrating the investors, intermediaries and operational framework. The process of integration is implemented in two phases. The first phase stressed on the measures taken by SEBI to increase integration at intermediary level. In the second phase, the necessary measures have been discussed to be taken to integrate the commodity market and stock market by enabling a single exchange for operating all market segments such as equity, commodities, equity derivatives and commodity derivatives (Sharma, 2017). The two major stock exchanges of India BSE and NSE have recently applied for license to initiate the trading of commodity derivatives. It is an interesting step taken towards the integration of financial markets and to boost the confidence of investors (Zachariah, 2018).

Recently, SEBI has approved the option contracts in non-agricultural commodities. This has resulted in increased participation of investors in the commodity market as there is increase in the daily turnover of gold from 64 crore on December 2017 to 700 crore on July 2018 with the introduction of gold option contract. Currently the option contracts are available for soft metals, crude oil, copper and zinc. Investors are using these commodities as hedging tool against fluctuations in real economy (Rukhaiyar, 2018).

Given the evidence of recent developments and amendments in the commodity trading to increase the confidence and participation of investors, the co-integration between commodity market and stock market is examined in this study to provide better insights regarding the hedging effectiveness of commodities against the unexpected fluctuations in the stock market. Furthermore the linkage between prices of raw material and their related stock indices will provide relevant information regarding the potential substitution strategies between commodities and stocks (Creti et al., 2013). This study will help SEBI to extend the investors' participation in commodity market and stock market by using optimal weights and hedge ratios, computed by taking into consideration the results of this study. Investors can use these weights and ratios to hedge their risk effectively. This way they will be better equipped to anticipate and prepare for unexpected fluctuations in commodity and stock prices.

1.5 Chapter Plan

The thesis is structured into eight chapters.

Chapter 1: Introduction

This chapter highlights the origin and trends in the commodity market and stock market. The chapter highlights the causes and consequences of increased volatility, seasonality and co-integration between the stock market and commodity market. Further the chapter also provides the justification for conducting this study.

Chapter 2: Review of Literature

This chapter provides the theoretical as well as empirical framework on the concept of Efficient Market Hypothesis, seasonality in stock market and commodity market and co-integration between stock market and commodity market. The literature review has also identified the research gap and provides the basis for further study.

Chapter 3: Research Methodology

This chapter discusses in detail research methodology employed in this study. This study provides the detailed overview of need of the study, objectives of the study, data related to commodities and their related stock indices. This study highlights the econometrics tools used in this study.

Chapter 4: Seasonality in Commodity Market and Stock Market

This chapter discusses the monthly seasonality in different commodities and their related stock indices. This chapter throws light on the extent of volatilities in these markets.

Chapter 5: Co-Integration and Causality between Commodity Market and Stock Market

This chapter discusses the long run association between commodity market and stock market. It also provides the details related to the direction of relationship between commodity market and stock market.

Chapter 6: Return Spillover, Volatility Spillover and Dynamic Conditional Correlation between Commodity Market and Stock Market

This chapter discusses the short run linkage between the commodity market and stock market. It provides the important information regarding the return and volatility spillover across commodity market and stock market. It discusses the dynamic conditional correlation between stock market and commodity market.

Chapter 7: Findings, Conclusion and Suggestions

This chapter discusses the major findings of the study with conclusion. This chapter provides the optimal weights and hedge ratio to the investors and provide suggestions to the investors and policy makers.

References

CHAPTER 2
REVIEW OF LITERATURE

The co-integration across different financial market has become one of the attractive topics in the world. The present study examines the co-integration between commodity market and stock market by taking into account seasonality, co-movement and volatility. Therefore the review of literature has been presented on related topics in four different sections. Section 2.1 presents the concept of Efficient Market Hypothesis. Section 2.2 depicts the concept of seasonality in commodity market and stock market. Section 2.3 presents the review of past studies on volatility spillover and section 2.4 presents the review of past studies on co-integration between commodity market and stock market.

2.1 Efficient Market Hypothesis

Efficient market hypothesis, partly developed by Eugene Fama in 1960s has been widely accepted by the economists and researchers which indicates that security prices represent the available information in the market and it was impossible to generate abnormal return. When news comes in the market, it spreads rapidly in the markets and the information reflects quickly in the prices of the securities without any delay. Efficient Market Hypothesis stated that there are large number of investors seeking profits; keenly compete with each other to estimate the future price of individual securities and where the information required to predict the future price is freely available to all the investors (Malkiel and Fama, 1970). In the efficient market there are no undervalued or overvalued stocks. Due to this, no one can earn more than the expected returns either by using technical analysis which is used to predict the future prices from the previous day's prices or by using fundamental analysis which is used to predict future prices by using financial information of the company. In other words, it is not possible to generate excess profits in an efficient market by investing in the security market on the basis of availability of new information in the market (Jensen, 1978).

There are three forms of efficient market. In case of weak form of efficient market, the historical prices reflect the existing information and it is impossible for investors to earn excessive returns if the market meets weak form of efficiency. Secondly, in case of semi strong form of efficient market, prices of securities reflect past prices as well as the published information. Prices adjusted themselves as per the public announcements. In case of strong form of efficient market, share prices reflect both public as well as private information due to which no one can earn abnormal returns. In an efficient market, the future price and past price of a security is independent in nature. This property of efficient market is called instantaneous adjustment property. A market which has instantaneous adjustment property is called a random walk market (Malkiel and Fama, 1970). EMH is linked with the concept of Random Walk Theory, according to which the information flow in the financial market is unimpeded and is immediately reflected in the prices of the financial securities then it is impossible to predict future price based on the past price. The future price of security will reflect only future information rather than past information (Malkiel, 2003). The difference between the intrinsic value of the asset and its actual price is not systematic or it can be said that random in nature. If it is not random, but systematic, then the market participants can easily predict the market with their intelligence but due to the random nature of the difference, they are not able to predict the path by which actual price move towards the intrinsic value (Malkiel and Fama, 1970).

2.2 Seasonality

The random walk model implies that stock prices are independent of their past or time variant, but it has been noticed that the markets are not following the rule of efficient market hypothesis, rather the stocks deviates from the rule of efficient market hypothesis. These deviations are called anomalies. Anomalies are the indicators of inefficient market. Some anomalies occur once and then disappear while other happens frequently or continuously (Latif et al., 2011). Seasonality in the stock market denies the theory stated by Efficient Market Hypothesis. In the context of financial markets, there exist several seasonal effects due to which one can earn higher or lower returns depending upon the time which are called seasonality.

In recent years, the researchers are keen to understand the seasonal behavior of financial markets in the emerging economies (Balaban, 1995; Fountas and Segredakis, 2002; Ho and Cheung, 2006). Any pattern that can be predictable in the financial market returns, from which one may get the benefits and therefore consider as proof against efficient market hypothesis, this predictable pattern in the financial market return is called seasonality (Balaban, 1995). If the investor can able to estimate the trends in the volatility, it will be easier for him to make decision by taking into account risk and return (Kamaly and Tooma, 2009). Seasonality is the prominent feature of risk premium which is anticipated from the two factor capital asset pricing model (Rozeff and Kinney, 1976). Variables which are relevant enough to give explanation of the asset pricing seasonality are seasonal pattern in new issue, dividend sale and earnings (Bonin and Moses, 1974). One of the facts related to seasonality states that informational efficiency does not hold. Even if information available at present can be used to predict future, but it does not mean that investor is assuredly earn high profits (Fountas and Segredakis, 2002).

2.2.1 Seasonality in Stock Market

Seasonality in the stock market is one of the important topics in the area of finance which attracted the interest of researchers. Various scholarly articles have been done in the field of seasonality in the stock market according to which market does not follow random walk. There exist the opportunities to earn abnormal returns from the market. Some of the examples of the seasonality are daily effect, monthly seasonality, half month effect, and festive seasonality and Halloween effect. These are some of the effects which allow the investors to make some trading strategies through which they can earn more than the expected returns from the market.

Day of the Week Effect

The most prominent seasonal pattern seen in the financial markets in the short run is ‘day of the week’ effect. Pena (1995) examined the daily seasonality in the Spain stock exchange before and after the reforms in stock market from the year 1986 to 1992 by using regression. It was found that before the reforms, positive Monday effect has been revealed but after the reform. It might be due to the introduction of Big Bang that is the new way of trading in this market which leads to enhance the operational efficiency of Spanish stock market. In the emerging Asian Stock Market, Choudhry (2001) examined the daily seasonality from the year 1990 to 1995 by using GARCH model. It was found that daily seasonality is present in the selected countries' stock indices but the seasonality in mean and volatility is not identical in all the stock indices. In the Athens Stock Exchange, Kenourgios et al. (2005) examined the daily seasonality from the year 1995-2000 by using GARCH Model. It was found that daily seasonality is present in ASE which affects both volatility and return of the Athens Stock exchange but the anomalous behavior of stock market is weakened with the introduction of corporate governance rules and institutional reforms. In stock prices of Chinese stock exchanges Cai et al. (2006) examined the daily seasonality from the year 1992 to 2002. It was found that seasonality in return is negative and statistically significant for Monday and Tuesday. The return on Monday and Tuesday are negative. It may be due to the fact that the domestic investors in Chinese stock market do not buy stocks on Friday and stick on this decision until the following Monday and further the reason for negative Tuesday effect is the postponement of buying decision till Tuesday by the domestic and international investors. In Malaysian stock exchange, Lim et al. (2010) examined the daily seasonality from the year 2000 to 2006 by using ANOVA model. It was found that there is strong evidence for negative Monday effect in this market but this effect is strong during bad news and not visible during good news. In the eleven Eastern Europe Emerging Markets, Ajayi et al. (2014) has examined the daily seasonality from the beginning of each market's trading to 2006 by using regression analysis. There is strong evidence for negative Monday effect in the six countries' stock indices and positive Monday effect was found in remaining five countries' stock indices. The positive Monday effect is significant only in one country out of five and negative Monday effect is significant in two countries out of six countries.

The studies discussed above found negative Monday effect in the stock market. The main reason for Monday effect is arrival of unexpected news in the market during weekdays and it takes into consideration at weekend. Hence the selling pressure on investors gets increased on Monday (Barone, 1990). Monday effect occurs due to the increase in trading volume on the Monday. Due to the increase in selling activity on Monday, average price decline (Lakonishok and Smidt 1988). The other reason for the presence of Monday effect in the equity market is the bad news environment.

There is also Twist of the Monday effect in equity return according to which returns on Monday are strongly affected by previous week's return (Lim et al., 2010).

Pre-holiday Effect

In stock market, pre holiday effect was also documented by the investors according to which investors can earn high abnormal returns prior to the holiday. High abnormal returns are found in the New York Stock exchange on week day prior to holiday and it also indicated that the week day before the holiday was the worst day to buy (Meneu and Pardo, 2004). This effect was also found in the U.S., U.K. and Hong Kong markets but it was found to decline during the period 1991-1997. This effect was reversed and the mean return became negative during this period and this effect was eliminated during 1997-2003 (Chong et al., 2005). In Australian market, pre holiday anomaly was found to be strong mostly in the small cap stocks and in the retail industry (Marrett & Worthington, 2007). According to Barone (1990), the holiday anomaly exists in equity market because of news that affects stock market badly come on the day when there is holiday in the stock exchange.

Month of the Year Effect

One of the outstanding features of the seasonal effect that has been observed by the various researchers is January effect, which states the mean return in January is higher comparative to other month (Rozeff and Kinney, 1976; Keim, 1986 and Aggarwal and Rivoli, 1989). Calendar seasonality has been seen in the financial market due to the deviation in the stock's behavior with respect to the time (Latif et al., 2011). Calendar seasonality is based on the fact that past performance of the stock which is loaded with information can be used to forecast future behavior of the stock (Lim et al., 2010). Calendar seasonality contradict the weak form of efficient market hypothesis according to which the successive stock prices are not dependent of its past or it can be said that stock prices should not be serially correlated (jarrett and Kyper, 2005 and Lim et al., 2010) Monthly seasonality has been present in the market when the investors can earn higher returns in some of the months comparative to other months (Ayodeji, 2010).

The monthly anomaly in the BSE Sensex, small cap stock and mid cap stock was documented by using GARCH model. It has been found that Indian stock market is heterogeneous. Indian stock market follows integrated seasonal patterns which have strong impact on the small cap and mid cap stocks. There exist the chances to earn abnormal return for the investors (Jassal and Dhiman, 2015). Aggarwal and Tondon (1994) found similar results in US stock market. It was suggested that there is existence of January effect in the equity market, but it is more prominent in small cap stocks rather than mid cap and large cap because investors want to invest more in small cap stocks to earn higher returns after the end of financial year. (Ritter, 1988)

The significant January effect in four emerging stock markets of Hong Kong, Singapore, Malaysia and Philippines was documented by using regression model and it was suggested that anomalous behavior of these countries' stock markets is not similar to the US stock markets (Aggarwal and Rivoli, 1989). Similarly, the monthly seasonality in Australia, UK, Japan and Canada was documented by using regression model. It was concluded that the anomalous behavior of these countries' stock markets is not similar to the US stock market and secondly seasonality effect is strong on the last day of the month of January (Jaffe and Westerfield, 1989). Calendar anomaly in the Japanese security Market was documented and the results indicated that there is presence of seasonal effects in this market especially in the months of January and June in small scale companies. The reasons for January effect are similar to the US market. The reason for June effect can be the payment of large bonuses to the worker prior to the increase in these stocks by small scale companies (Ziemba, 1991). The seasonal effects in US stock market were examined and it was suggested that there is strong January effect during the first half of the January month, which might be due to cumulative wealth effect of investment (Hensel and Ziemba, 1996). The month of the year effect in the HangSeng Index was examined from the year 1985 to 1997 by using OLS regression model. It was found that seasonality in the month of January is not existed in the Hong Kong Stock exchange. Further the results found that the December return is less than January returns (Cheung and Coutts, 1999). The seasonality in the Athens Stock Exchange was examined by using regression model. It was found that January effect is present in the Athens stock exchange. It is due to the introduction of institutional reforms in Athens Stock Exchange (Coutts et al., 2000). Fountas and Segredakis (2002) examined the month of year effect in the stock market by applying GARCH model. It was found that seasonal effects are present in the stock market in the months other than January. Similarly, the month of the year effect in the Thai Stock exchange was documented and it was found that though the calendar effects are not found in this stock exchange still these effects improve the forecast performance. The seasonal behavior of stock market is different before, during and after the Asian crisis (Holden et al., 2005). Further, the turn of the month anomaly in 35 non-US countries' equity market was documented by using value weighted and equally weighted market indices. It was found that this anomaly is existed in 30 out of 35 countries' stock markets. It was concluded that this effect is not caused by increase in trading volume during this time period as the trading volume has not been increased during the turn of the month rather it remains same like other trading days (McConnell and Xu, 2008). In Ghana stock exchange, monthly effect was examined by using GARCH model. The results indicated that calendar seasonal effects are present in the equity market but instead of January effect, April effect exists in Ghana stock exchange. It might be due to the tax loss selling hypothesis as the financial year ends in the month of March in African market (Alagidede and panagiotidis, 2009)

Cadsby and Ratner (1992) recommended that the seasonality in January is prominent in the equity return due to the dividend payment and interest and principle amount payment on debt during the end of financial year. These months may be coinciding with turn of the tax year. Further Griffiths and White (1993) suggested the seasonality in the US and Canadian equity market is not because of end of financial year rather it is due to the tax loss selling hypothesis. The seasonality in the month of January is found in the stock market due to the tax-loss selling hypothesis which states that large abnormal returns are found in the stock market in January during the first week especially on the first day (keim, 1986). January effect has been revealed to be strong in the stock market due to the new information provided in previous year's financial announcement (Rozeff and Kinney, 1976). On the other hand, Jacobs and Levy (1988) argued that all these artificial phenomenon do not affect the stock market seasonality directly rather investors may consider these phenomenon important and behave accordingly which in turn increase the chances to earn abnormal returns.

Aggarwal and Tondon (1994) concluded that the existence of January seasonality in equity market is not only due to the tax loss selling hypothesis but it is also related with the portfolio adjustment and stocks adjustment of various traders at the end of financial year. Chein and Chen (2008) examined whether the prospect theory better explain the phenomenon of occurrence of seasonality in the month of January. It was found that the main reason for the occurrence of seasonality in January in stock market is the performance of stocks in preceding month December. If the performance of stocks is good, then it induces the investors to sell the stock in the month of January as early as possible. If the stock market is bearish in the month of December, investors would hold the stock for longer period of time which reduces the selling pressure in January.

Indian stock market does not follow similar theories related to the monthly seasonality. Calendar seasonality by its characteristics may not be a robust phenomenon. The pattern of seasonality changes according to the countries.

Dash et al. (2011) suggested the existence of monthly seasonality in the equity market of India. It was further concluded that significant November and December effect is due to the festivals during this time period and significant March effect is due the end of tax year in India. Kumar and Jawa (2017) found the significant December effect in the Indian equity market. Singh and Yadav (2018) confirmed the seasonality in the Indian stock market in the month of November. It was concluded that the stock markets are not only influenced by financial factors. There are some behavioral as well as emotional aspects also that influenced the stock market in their own way. Herding behavior of the investors in bearish and bullish market increases the chances of seasonality in the financial markets. During the bearish markets, investors follow the strategies of others to get rid of reputational biases and negative returns, while during the bullish period, they imitate others to get more return from the market. Herding behavior of investors is found to be strong during the bearish period because during this time period, investors are under-confident and they do not believe in their own strategies and during bullish period they are over-confident and do not herd others to great extent (Siddiqui and Narula, 2016)

2.2.2 Seasonality in Commodity Market

Understanding the behavior of the commodity market is of crucial importance for the investors engaging in the market. Brooks and prokopczuk (2013) suggest various reasons due to which investor's interest in the commodity market has been increased enormously. First reason is the relatively poor performance of the stocks and treasuries induce the investors to invest in the previously unexplored asset class from which they may earn good return. Second, the low correlation between the stocks and commodities and the ability of the commodities to provide hedge against the risk motivate the investors to invest in the commodities. But still the literature on seasonality in commodity market is very limited. Very less number of commodities has been taken into account.

Seasonality in Agricultural Commodities

The seasonal effects in the commodity market are different from the stock market especially in agricultural commodities. Milonas (1991) examined the seasonality in the Agriculture commodity market from the year 1966 to 1986 by using ANOVA. It was found that there is existence of month and year seasonality in agriculture commodities. The seasonal patterns in the cocoa spot and forward market were documented. It was found that due to the limited global cocoa production, there is moderate degree of volatility in the cocoa. The main cause for less volatility in cocoa is long harvest period of around five months (Geman and Sarfo, 2012). Similarly monthly seasonality was documented in the agriculture future market with stochastic dominance. It was found that the monthly seasonal effect is present in the four agriculture commodities selected for this study. The returns in the month of October for corn, April for Soybean and August for soybean meal and wheat are higher as compare to other months. These results are consistent with the seasonal cycle in the crop production (Lee et al., 2013). The monthly seasonality was examined in US agricultural commodities by using GARCH model. It was found that monthly effect is present in the agricultural commodities. The positive news caused seasonal effects in the corn, coffee, rough rice, Soybean and Soybean-meal while negative news caused seasonal effects in lean hogs (Munusuru, 2013).

The monthly, daily and weekend seasonality was documented in the agriculture commodity market by taking into account seven agriculture commodities from the year 1994 to 2014. It was found that monthly seasonality exists among all the selected agriculture commodities except coffee. There is strong evidence for the daily seasonality in the wheat, coffee, sugar and cocoa but weekend effect is found only in the cocoa market (Borowski and Lukasik, 2015a). The daily seasonality was examined in wheat from the year 1995 to 2012 by using GARCH Model. It was found that the wheat return and volatility is higher on Monday while the wheat return is lower on Tuesday but the volatility is higher. It was conclude that increase or decrease in the price of wheat does not have significant impact on the volatility behavior of wheat (Montengwe and Pardo, 2015).

Similarly Maitra (2018) examined the month of the year effect in Commodity Market of India by considering the agricultural commodities from the year 2005 to 2012 by using GARCH model. It was found that there is presence of seasonal effects in the agricultural commodities. The seasonal effects are prominent before the harvesting period when the inventory is less and demand is high for those commodities. It was suggested that monthly seasonality in the commodity market is associated with the crop sowing and harvesting season. As the new crop enters the market, any news related to quality of new crop disseminated into the market and then affects the prices of agricultural commodities through the equilibrium of demand and supply (Milonas, 1991). Seasonality in demand and supply generate seasonality in the marginal convenience yield and the seasonal effects are present in both demand and supply side (Fladmark and Grimstad, 2013). The reason for the occurrence of supply side seasonality is the adverse weather condition and the demand side seasonality in the industrial commodities observed due to the industrial requirement of raw material under the different situation which affect the performance of that particular industry (Maitra, 2018).

Seasonality in Gold

A wide majority of researchers have examined the seasonal behavior of gold. The monthly seasonality was examined in the gold prices from the year 1987 to 1997 by using regression model. It was found that monthly effect is not present in the gold index. These results support the efficient market hypothesis which suggests that no one can earn abnormal return in the market. The market is efficient enough to provide all the relevant information (Coutts and Sheikh, 2000). The seasonality in the Gold Market was examined by using GARCH Model. It was found that the gold returns are significant in the months of September and November months as compare to other months. The Autumn effect is also present in the gold market which might be due to the Hallowean effect in the equity market, negativity in the investors sentiment during the shorter daylight and increased jewelry demand during the wedding season (Baur, 2012). The monthly seasonality in the Chinese Gold Market was examined by using GARCH model. It was found that there is occurrence of seasonality in the months of February, April, August, September, November and December. The seasonality occurs in this market during golden weeks of China. The holidays during golden week increase the demand of gold which causes seasonality in gold return (Qi and Wang, 2013).

The weekend effect was documented in the gold and crude oil by using probability distribution approach. It was found that pre weekend effect is exists in the gold market and secondly mid weekend effect is also found in the crude oil market (Yu and Shih, 2011). The different seasonal pattern of gold market from the previously done studies implies that the investors' sentiments and their trading behavior change over time. Traditional weekend effect is not present in the gold during the study period. The absence of seasonality in gold market is due to the fact that gold inventories are always high because central banks always hold reserves in the form of gold due to which spreads are less varying. Therefore the volatility in the gold market is less compare to other metals (Geman and Smith, 2012). The day of week effect was documented in the gold and silver commodities from the year 2008 to 2011 by using GARCH model. It was found that volatility is high in gold comparative to silver. Both the commodities react differently to the good and bad news. As the gold is less responsive to the news creating negativity in financial markets, it makes gold a good investment opportunity in the expectation of bad time (Aksoy, 2013). The weekend seasonality was documented in the bull and bear gold market returns by using regression model. The results after examining the three phases indicate that, the weekend effect is strongest when the market is in bear phase while during bull phases, there was no difference between the returns during week days and weekend returns (Blose and Gondhalekar, 2013).

The poor performance of the stocks is suggested as one of the important causes for rising investment in the commodities. Gold is taken as a hedging instrument against the stock market uncertainties. So it seems to be necessary to note that whether the seasonality occur in Gold market (Borowaski and Lukasik, 2015b). The daily seasonality was documented in shanghai and London gold market by using GARCH model. It was found that in case of shanghai gold market, the return on Monday are higher than other weekdays, while in case of London gold market, the return on Thursday is higher than other weekdays. It was concluded that the occurrence of seasonality in shanghai exchange might be due to weak market system and its own pricing system. The seasonality in London stock exchange might be due to the adjustment of market mechanism (Wang et al., 2018).

In India, (Kumar and Singh (2008) examined the monthly seasonality in return and volatility in the commodity and stock market by taking into account gold, NIFTY and soybean from the year 1990 to 2007 by using GARCH model. It was found that in case of NIFTY, the returns are higher for January, February, April, July, September, October and November. The seasonality is present in the returns of soybean in the months of October and November and in volatility in April, August and October. In case of gold, the seasonality in return is absent but the seasonal effects are present in the volatility in the month of December.

Seasonality in the gold market and stock market is affected by the most relevant theory related to the arrival of news (Lucey and Tuley, 2006). Secondly festival season during this time period is also one of the important causes for rising volatility and occurrence of seasonality in the gold market.

Seasonality in Oil Market

Ayodeji (2010) examined the monthly seasonality in the oil market. It was found that the monthly seasonality was present in the oil price volatility but the seasonal effects are not present in oil return. Asian financial crisis is considered as one of the biggest reasons for rising seasonality in the returns of the oil prices as compare to the global financial crisis. The monthly seasonality was documented in the natural gas prices by using state space model. It was found that the price of natural gas is higher during winters and lowers during summers due to seasonality (Fladmark and Grimstad, 2013). The seasonality in the energy commodities is also affected by demand and supply patterns. The demand of energy commodities is high during winters because of the requirements of commercial sectors for heating purpose (Geman and Smith, 2012). The daily seasonality was documented in crude oil by using GARCH model. It was found that there is significant Monday effect in the crude oil market. It might be due to the fact that the news coming on the weekdays is considered by the investors at the end of the week, in the absence of additional news which increases the selling pressure on Monday (Auer, 2014).

The pattern of volatility was documented in Indian Commodity Market by taking into account crude oil by using GARCH model. It was found that Indian oil market is mostly influenced by global oil commodity market which led to increase the volatility in domestic oil market (Mukherjee and Goswami, 2017).

Seasonality in Metal Commodities

The seasonality in the copper and aluminum metals was examined by using GARCH Model. It was found that daily seasonality is existed in the both copper and aluminum market but the seasonality in the month of January is not found in both the markets (Kohli, 2014). The seasonality effect was documented in the metal commodities including gold, silver, palladium, platinum and copper. It was found that there is no evidence of seasonality in the gold, silver, platinum and copper but the evidence of seasonality has been found in the palladium in the month of September. Daily seasonality is not found in any of the commodities but the weekend effect is present in the gold and copper (Borowski and Lukasik, 2015b).

2.3 Volatility Spillover between Stock Market and Commodity Market

Since the financial crisis 2008, the transmission of volatility across the different financial market has become one of the attractive topics in the world (Tang and Xiong, 2010; Aboura and Chevallies, 2015; Baldi *et al.,* 2016). Volatility transmission describes the effect of variations in volatility in the commodity market on the volatility of the stock market and vice versa (Bouri, 2015b). The effect of volatility has been transferred from one market to the other market due to certain reasons. The cost of production of the companies will increase due to the rise in price of the commodities which have been used by those companies as their raw material. If the company will not completely shift that increased input cost to the customers or investors, profits of the companies will get reduced and hence expected return will also reduce. Therefore the shocks in the commodity prices have negative impact upon the stock market (Broadstock *et al.,* 2012). Inflation is one factor that affects stock and bonds negatively as these two assets lost their value during inflation while commodity prices are positively affected by the inflation. The long run expectations of earning and coupon rate positively affect the stocks and bonds while commodity prices are based on short term expectations of demand and supply. Due to all these reasons commodities are having less correlation with the stocks or bonds (Narsimhulu *et al.,* 2016). The negative effect of unexpected news on crude oil has negative impact on the stock market too. It is due to the fact that the linkage between both the markets partly reflects the informational efficiency of each others' market because if the markets are fully information efficient, it means stocks fully reflect the all available current information which may include the oil price variations (Cong *et al.,* 2008). Though the co-integration between commodity and equity prices increased after the financial crisis but still the findings of volatility transmission across equity market and commodity market can be used to avoid unexpected shocks and modify expectations. The return and volatility spillover among the world gold prices and stock market was examined by using VAR-GARCH model. The results indicated that that past gold prices has significant impact on conditional returns as well as volatility of Chinese stock market. It was suggested that gold can be used as a hedge tool in portfolio of stocks and it will improve the risk adjusted returns (Arouri et al., 2015). The spillover effect between oil price shocks and the stock markets of 11 countries was examined by using VAR GARCH models. It was found that spillover effect vary according to the time. The transmission of volatility from oil price to equity price is not same for all countries rather it depends upon the time under investigation (Antonakakis et al., 2014). The impact of oil price uncertainty on the South Africa's stock returns was examined by using VAR model. It was found that uncertainty in price of crude oil affects stock returns of South Africa negatively. Results of impulse response function indicated that positive oil price shocks reduces the African stock return and the negative shocks in oil price cause positive change in the African stock returns but these changes are very small as compare to changes in stock return due to positive oil price shocks (Aye, 2014). The spillover effects between oil prices and Lebanese stock exchange were examined and the results indicated the weak unidirectional spillover effect is present which runs from oil to stock market during whole period. The volatility transmission across these markets increase during the crisis period. It was suggested that the underlying reason behind these results is the effect of oil volatility on the anticipated discounted prospected cash flow. Therefore any shock in the price of these companies' raw material causes unexpected variations in the stock prices (Bouri, 2015a). The linkage between crude oil and stock market was examined and the results suggested the bi-directional causality across gold and sectoral stock indices except health and utility sector. The uncertain variations in oil price affect equity prices of G-7 countries negatively. It was further suggested that the effect of global oil price volatility on the stock market is strong comparative to domestic oil price volatility. The negative oil price shocks affects stock market strongly as compare to the positive oil price shocks (Orouji, 2016). The linkage between oil prices and sectoral equity prices of MENA countries was examined by using CCF tests and the robustness of this model is checked by using VARMA-GARCH model and found the significant impact of the oil prices on the stock markets of these countries but the influence of oil price on different sectors is heterogeneous. The volatility is significantly transferred from oil to industrial sector but it is found to be negligible from oil to financial services. The results also found that the shocks in the price of crude oil affect less to the industrial sector. The industrial sector is mostly affected by fluctuations in the volatility of oil prices especially during Arab Uprising (Bouri, 2015). Commodity price shocks affect the stock market in different ways. First one is commodity price demand shocks that create negative relationship between the stocks and commodities. The second one is aggregate economic demand shock. These shocks have positive impact on the stock market. Global economic expansion affects stock market positively. At the same time due to increase in demand of commodities domestically and globally, the commodity prices also driven up. Demand shock in the commodity prices transmit to the stock market during the turbulent period while supply side and commodity specific shocks transmit to the stock markets during global geopolitical unrest period. It was also found that spillover effect does not only differ across the commodity importing and exporting countries rather varied within the countries in each group (Antonakakis et al., 2014). In addition to these reasons, over-reaction to news and investors sentiments is also playing an important role in risk spillover between commodity market and stock market (Du and He, 2015).

2.4 Integration between Stock Market and Commodity Market

According to the efficient market hypothesis, it is assumed that stock prices contain the publically available information and the stock prices cannot be forecasted by using this information or by using price index of the other financial market. If two markets are not co-integrated, it means the efficient market hypothesis has been violated as one market contains sufficient information by which one can predict the behavior of other financial market. If there is co-integration between the two financial markets, then loss in the one market cannot be compensated by the gain in other market and it also reduces the number of asset available for the investors from which they can hedge the risk. Due to the less interdependence between the Nifty and COMDEX, it was stated that both the markets are independent and offer good opportunities for the investors for diversifying their portfolio (Narsimuhulu *et al.,* 2016).

The less dependence between the commodities and stocks is due to the different factor determining the value of stocks and commodities (Deskalaki and Skiadopolous, 2011; Hammoudeh *et al.,* 2014). Due to the low correlation of the commodities with bonds and stocks, commodities tend to perform distinctively and are very sensitive to different economic factors. These reasons made commodities a safe haven against the stock and bonds (Olson *et al.,* 2014). The interconnection between stocks and commodities is important to determine the risk management strategies to build an optimal portfolio (Shahzad et al., 2017). Bekiros et al. (2015) found the performance of diversified and undiversified portfolio (including commodities and stocks only) and found that the performance of these portfolios differs across investment horizon. As the new information comes to the market, investors will filter the information relevant to their position in the financial markets due to which lead or lag relationship exists across the financial markets. Conover et al. (2010) confirms these findings and suggests that inclusion of commodities in the portfolio lessen the possibility of getting losses even without forfeiting the return. It is required for the investors to keep an eye on the cross sector heterogeneity to build optimal portfolio to maximize return and minimize volatilities (De Boyrie and Pavlova, 2016).

Daskalaki and Skiadopolos (2011) **contradicted** these findings and suggested that increased financialization of commodity market reduced the benefits of portfolio diversification. Recent research done in the field of co-movement between commodities and stock prices states that there are some common factors that affect both the markets and due to the financialization of the commodities, the co-movement between both the market has been increased (Cheung and Miu, 2010; Tang and Xiong, 2010; Daskalaki and Skiadopolous, 2011; Silvennonian and Thorpy, 2013; Hammoudeh *et al.,* 2014). Yamori (2010) concluded that the cointegration between equity market and commodity market is raised after financial crisis 2008. The commodity bubble is one of the reasons for these results. Investors who predict the large profits in the stock market, starts investing in the commodity market while ignoring the demand and supply pattern of commodity market. When the investors start earning losses in the stock market they pull out their money from commodity market as they can no longer take more risk. Hence prices in commodity market go down. During the financial crisis, the less co-integration between the stock market and commodity market indicates that investment in the commodities during this period leads to less diversification benefits (Graham et al., 2013). The risen investment in the commodity market and equity market due to financialization of the commodity markets leads to gradual increase in the co-integration between both the markets which in turn increase the volatility spillover between both the financial markets (Tang and Xiong, 2010; Buyuksahin and Robe, 2011; Black *et al.,* 2014; Baldi *et al.,* 2016). Studies done so far concluded that the co-integration between the two markets has been increased since the early 2000.

This fact is overlooked by the previously done literature that increased correlation between both the markets made commodities as a safe hedge for the investors investing in the equity market but is still a pertinent question that attract the attention of various researchers, policy makers, producers, academicians, the media an consumers (Olson *et al.,* 2014). When the stock market go through the uncertain period then the commodities are consider as safe haven against the stocks (Sensoy, 2013). Recently, it has been viewed that the investors are very keen to understand the commodity equity co-movement to find out the direction of commodity and stock prices (Choi and Hommoudeh, 2010. The co-integration between the commodities and equity prices leads to increase in the participation of hedgers who want to reduce the chances of getting risk by trading in both the equities and commodities (Bayuksahin and Robe, 2011).

Ping et al. (2017) suggested that though the linkage between commodity market and stock market has increased, but still some of the countries show different results. The fact behind these results is the country wise difference between the characteristics of stock market. The stock markets in emerging countries like India and China exhibit different characteristics such as difference in volatility behavior of financial markets and speculative activities.

Relationship between Gold and Stock Market

A large body of literature focused upon two commodities gold and crude oil and examined their relationship with stock market. The linkage between gold prices and European stock market was examined by using GARCH model. The results indicated that gold can be used as safe haven against shock but in the short run in emerging and developing economies. Gold is considered as safe haven immediately after the occurrence of shocks. The findings of this also revealed that this role is limited to the developed economies and only during the period of rising uncertainty but during the period of extreme uncertainty; there is increase in co-integration between the gold and stock market (Baur and McDermott, 2010). The linkage between gold and US stock index was examined by using impulse response functions. It was found that there is negative and weak linkage between gold and stocks during the financial crises due to which gold is considered as best hedging tool during financial unstable period (Soucek, 2013). The association between gold and Chinese stock index was examined from the year 2009 to 2015 by using GJR GARCH and Copula approaches and found weak tail association across gold and Chinese equity market. It was further suggested that gold performs a positive role in stock market of china and acts as risk reducing agent (Beckman et al., 2015). The association between equity and gold price volatilities in US market was examined by using Autoregressive Distributive Lag model. It was suggested that long run association exists between gold and equity market. It was also suggested that the stock prices converges to long run equilibrium by the volatilities of gold and stock prices by the 1.2% of speed of adjustment (Gokmenoglu and Fazlollahi, 2015). The two way causality was found between gold prices and G-7 stock prices. The stock market is more prominent to negative shock as compare to the gold prices. It was further suggested that gold prices can provide better hedge against stock prices as compare to stock market. It is based on the fact that the variability in prices of gold is less because it is characterize as store of value and remain at the same value for the longer period of time (Morales, 2008). The long run and short run linkage between the gold and stock price in Turkey was examined from the year 1986 to 2016 by using ARDL Bound test and found the negative long run and short run association between gold and stock prices. The causal relationship is found to be uni-directional from gold to stock market. It was suggested that investors can use gold as safe hedge against the equity (Tursoy & Faisal, 2017).

In India, Srinivasan (2014) examined the linkage between gold and stock market by using ARDL test and granger causality test. It was concluded that there is absence of long run Comovement and causality between gold and stock prices. It was suggested that investors cannot predict the stock market by using significant information from gold and vice versa. Similarly Kaliamoorthy and Parithi (2012) and Narang and Singh (2012) found the similar results which suggested that gold price does not contain sufficient information to predict future stock prices. On the contrary, Mishra (2014) examined the causality between gold and equity price index in India from the year

1978 to 2014 by using granger causality test. The results indicated the bi-directional causality between gold and stock prices. It means both the markets are having predictive powers to predict the behavior of each other. The linkage between gold prices and stock index prices was examined by using Vector Error Correction Model. It was found that there is unilateral causality running from gold prices to the stock market. It was suggested that Indian stock market contain sufficient information to predict the gold prices. In the Indian context, gold is considered as an important asset in providing hedge against financial instability in the stock market. Some companies are using gold as hedge against the fluctuations in the exchange rates. The falling gold prices are considered as improvement in the economy as a whole (Shiva & Sethi, 2015). Similarly Bouri et al. (2017a) examined the long run co-movement and causal association between gold and Indian stock market from the year 2009 to 2017 and found the presence of long run relationship between both the markets and suggested that implied volatilities of gold have significant impact on the implied volatilities of stock market. It was suggested that Indian stock market is mostly affected by positive shocks in the gold rather than negative shocks which indicated the impact of asymmetry on the linkage between both the markets. On the contrary, Bouri et al. (2017b) examined the causal relationship between the gold and stock markets of India and China from the year 2011 to 2017. The results indicated that implied volatilities of India and China stock markets affect the volatilities in gold at different frequencies which further suggested that gold sometimes behaves like equity especially after the global financial crises. It implied that financialization in commodity market has significant impact on the relationship between gold and stock market. Thuraisamy et al. (2012) suggested that volatility in the gold prices significantly affects the stock prices but it is pertinent during the pre crisis period. They further suggested that the stock markets of Asian countries have heterogeneous response to the shock in the gold. Similarly Oztec and Ocal (2016) suggested that the linkage between gold prices and stock index is increased during the period of financial instability. Even the positive correlation between both the markets is very weak (0.20). Therefore gold is considered as hedging tool against the stock market.

Relationship between Crude Oil and Stock Market

Further Ahmed et al. (2017) and Tursoy & Faisal (2017) concluded the linear positive relationship between oil prices and stock index prices but there are some evidence from the past research done in the field of association between commodities and stock market according to which oil price affect the stock market in non linear fashion (Ciner, 2001). The linkage between the stock markets of GCC member countries and oil prices was examined by using Vector Autoregressive model. It was found that the stock markets of these countries are not directly linked to oil prices which implied that these markets do not have power to predict the oil prices. The stock markets of GCC member countries are influenced by their own shocks (Hammoudeh and Aliesa, 2004). Similarly Magheyereh and Kendari (2007) found absence of co-integration between the oil prices and stock market of GCC countries but it was further suggested that there is significant impact of oil price on the stock prices of these countries, but in non linear way. It implied the chances to predict stock market prices by taking into account oil prices. The causality between the stock prices and exchange rates in Turkey was examined by using Toda-Yomamoto (TY) method. It was found that there is bidirectional causal relationship between exchange rate and overall stock indices. Further results indicates that there is negative causality among oil prices and national 100, financial, industrial and service indices while positive causality has been found from technology indices to exchange rate (Aydemir and Demirhan, 2009). The effect of shocks in oil prices on the volatility of equity return was identified by using jump model. It was found that the unexpected fluctuations in the oil prices have negative impact on the stock returns. If the shocks in oil market are due to the economic fluctuations, then these shocks have asymmetric effect on the stock market (Chiou and Lee, 2009). The association between the crude oil, exchange rate and selected commodity prices was examined by using Johansen co-integration and VECM Models. It was found that there is strong linkage between the oil and three out of four commodities corn, soybeans and cotton and no evidence for linkage between oil and wheat has been found (Harri et al., 2009). The effect of fluctuations in oil price on the energy related stocks in china was examined by using DCC GARCH Model. It was found that there is correlation between the international oil prices and energy related stocks in china but in the time varying way. The conditional correlation has been increased after the financial crisis 2008 (Broadstock et al., 2012). The relationship between crude oil and stock market was examined by using Vector Autoregressive model. It was found that during the period of financial distress, the correlation between the oil and stock has been decreased (Soucek, 2013). On the contrary, Urrutia & Malliaris (2005) found that the causal relationship between stocks and crude oil become more strong during the period of financial distress which lead to decrease the diversification benefits among investors. Guesmi & Fattoum (2014) examined the conditional correlation between the brent crude oil index and stock market index of OECD countries by using DCC GARCH Model. It was found that the conditional correlation do not vary across the different countries. The conditional correlation changes over the period of time due to the changes in global business life cycle. The relationship between energy commodities and Islamic stock return was examined by using dynamic conditional correlation model. It was found that there is strong relationship between the energy commodities and stock prices and financialization of commodities plays an important role in the positive relationship between both the markets (Chebbi and Derbali, 2015). The relationship between oil and Kuwait stock prices at sectoral level was examined by using ARDL test. The results indicated that there is bi-directional causal relationship between the positive oil prices shocks and stock prices of banking, consumer goods, consumer services, industrial and real estate sector. Negative shocks in crude oil have significant impact on the stock prices of banking, consumer goods, consumer services, industrial and real estate sector (Kisswani and Elian, 2017).

Zhu et al. (2014) examined the links between oil and Asia Pacific stock returns and found low correlation between oil prices and asian stock indices but the pattern changed immediately after the financial crises 2008. Oztec and ocal (2016) suggested that increase in the number of financial investors in the commodity market, termed as “financialization in commodity market” is one of the important reasons behind increased co-movement between stock market and commodity market since last few years (De Boyrie and Pavlova, 2016). The increase in the trading volume of commodity futures shows that the commodity market is recently more susceptible to the investor's sentiments. Demand and supply pattern have lost their influence on the variability in the prices of commodity market and stock market.

Ghosh and Kanjilal (2016) examined the relationship between international crude oil prices and **Indian** stock market prices. It was suggested that oil prices affected the Indian stock market via the channel of financial deficit. The cost of imports risen up due to increase in the prices of crude oil. Therefore, subsidy burden increased on government. Therefore there is increase in the inflation in the domestic country. Hence investment in stock market also decreased due to the wealth effect (Girardi, 2015). Further Bouri et al.(2017) found the co-integration and non-linear causal relationship between crude oil and stock market by using implied volatility indices in Indian Context. The results indicated the presence of co-integration between crude oil and stock market. There is a uni-directional causal relationship run from crude-oil to stock market. It was suggested that crude oil is among the top imports of India and any variation in the price of crude oil is transferred to the Indian financial markets' volatility. Dutta (2017) found significant co-integration and causality between global oil prices and US energy stock market using implied volatility index. The causality runs from the oil to US stock due to the fact that US energy firms are major user of crude oil. The unexpected variations in the crude oil prices affect the stock performance of these firms also.

Relationship between Agricultural Commodities and Stock Market

In order to study the relationship between agricultural commodities and MSCI world stock market, Lehecka (2014) used Johansen Co-integration test and Granger Causality test and suggested that agriculture based companies have faced different return and volatility patterns due to increased cointegration of agriculture market with equity. It was further suggested that there is difference between traditional investors and new financial investors. The new financial investors, unlike traditional market participants invest in different financial markets rather than invest in one market in order to improve risk sharing. It has also increased the sensitivity of all the markets towards financial shocks. As a result the correlation between food commodities and stock prices increased. Secondly the correlation between these two markets increased due to biofuel mandates. It was argued that the increased correlation between the agricultural commodities and stock market is not due to the integration rather the interconnection between food and crude oil prices has indirect impact on the relationship between agricultural commodities and stock markets. Further, Girardi (2015) examined the correlation between sixteen agricultural commodities and stock prices of US by using DCC GARCH model. It was suggested that linkage between both the markets is related to the financialization and financial shocks. Market fundamentals such as demand and supply patterns do not have significant effect on the stock prices. It was further suggested that during the period of financial stress, investors liquidate their position in all the markets because of getting negative return in one of their important markets, known as wealth effect. Baldi et al. (2016) examined the relationship between the agriculture commodities before and after the dot com bubble and 2008 financial crises by using VAR Model. It was found that volatility spillover from commodity market to stock market is negative before and after the dot.com crisis. This spillover effect has been increased after the 2008 financial crises. Assets like corn are more financialized because of their trading on stock market as an alternative asset class. Ederer et al. (2016) examined the association between agricultural commodities and stock market by using multivariate vector autoregressive model. It was suggested that the commodity prices of four different commodities coffee, cotton wheat and oil are significantly affected by financialization of commodities in addition to market fundamentals. Oztec and Ocal (2016) examined the correlation between commodity market and stock market was examined by using DSTCC GARCH model. It was found that the correlation between agricultural commodities and stock market is increased especially during the period of financial shocks. It can cause changes in the dynamics of relationship between the commodity market and stock market. It means correlation between stocks and commodities does not remain same. It was suggested that the investors can diversify their portfolio in both the markets during the calm period.

Relationship between Metals and Stock Market

A wide majority of studies carried out on examining the relationship between gold and stock prices but relatively less research has been conducted on studying the relationship between base metals and stock market. The relationship between metal prices and stock prices of 10 European countries was examined by using Panel granger causality model. It was suggested that the linkage between the prices of metal and stock market is explained in different ways. First of all, variability in the prices of metal cause increase or decrease in wealth of metal producer and metal consumer respectively. Secondly increase in the prices of metal commodities increase the inflation in the country which led to decrease the stock returns (Irandoust, 2017).

The correlation between 25 commodity price returns and US stock market index was documented by using DCC GARCH model. It was found that the correlation between these two markets changed according to the time. These markets are highly volatile during the financial crisis and the linkage between both the markets reduced immediately after the financial stress for the short period of time. It was further concluded that the correlation between these two markets is also affected by speculative activities. The increased speculation cause high correlation between stock market and commodity market during bull period while the correlation is decreased during the bear market (Creti et al., 2013). Similarly Khan aand Masih (2014) investigated the time varying correlation between commodity market and stock market by taking into account energy, precious metal, agricultural, non-ferrous metals and soft commodity indices by using DCC GARCH model. It was found that time has played an important role in the relationship between stock and commodity market. The correlation between commodity market and stock market has been increased after the financial crisis. During the financial crisis, the markets move in opposite direction to each other. The less correlation between these markets is linked with the flight to quality phenomenon which states that during the times market risk, investors starts investing in the commodity markets as the commodities are considered as safe haven against the excessive stock market risk. In addition, the increase in correlation after financial crisis is linked with the herding behavior of the investors according to which investors start imitating the behavior of the others after getting losses due to unexpected shocks in the market which lead to deviate the commodity prices from their actual value. Therefore there is increase in relationship between commodity market and stock market (Demiralay and Ulsoy, 2016).

While analyzing the interrelationship among different markets, it was found that there is considerable volatility spillover from the equity market to commodity market but no evidence was found for the transmission of fluctuations from the commodity market to stock market (Palakkod, 2012). The return links and volatility spillover across stock market and commodity market prices for energy, food, gold and beverages was examined by using VAR-GARCH Model. It was found that there is significant volatility spillover between stock market and commodity market. The study found significant higher conditional correlation among S&P 500 and Gold index as well as S&P 500 and WTI index Mensi et al., 2013). The linkage between commodities and US stock market was examined by using VAR framework. It was suggested that the direction of causality depends upon the commodity under consideration, investment horizon and the effect of inflation. Further the symmetric linkage between stock market and commodity market indicates the usefulness of considering commodities in the portfolio diversification Nguyen et al., 2015).

There is strong evidence for no co-integration between the stock market and commodity market which lead to increase the diversification benefits of investing in both the markets (Narsimhulu et al., 2016). Graham *et al.* (2013) examined the long run as well as short run relationship between the stock market and commodity market by using wavelet squared coherency. It has been found that there is no co-integration between the commodities and spot market which would increase the diversification benefits of investing in both the markets. For the long term investors the benefits of diversification are less during the period of financial crisis rather for the short run investors, financial crisis show no measurable impact on the diversification benefits. Lagesh et al. (2014) examined the relationship between commodity market and stock market in India by using Dynamic Conditional Correlation Model. It was found that there is weak relationship between the commodity market and stock market, indicating the diversification benefits of using commodities in the portfolio. It was suggested that commodity market is segmented from the financial assets like stock, therefore these commodities can be used for strategic asset allocation.

2.4 Research gap

After going through the literature on seasonality, co-integration and volatility spillover between commodity market and stock market, it is summarized that the interconnection between these markets has been increased since last few years. Recently the number of financial investors in the commodity market has been raised due to which commodities are considered as financial assets like stocks and bonds. The financialization of commodity market has also changed the dependence structure between commodity market and stock market. One can predict the stock market movement with the help of commodity prices because the later contain sufficient information related to the future expected economic conditions such as increase in commodity prices signify rise in global economic demand which in turn affect the stock prices (Black *et al.,* 2014).

Some researchers have given contradictory definition related to the co-integration between commodity market and stock market. The increase in commodity prices is considered as one of the important elements of higher inflation and interest rates in the economy which in turn have negative impact on the stock prices. Therefore long position in the commodity market can provide hedge against the unexpected fluctuation in the stock market prices (Conover et al., 2010). Therefore there is no common ground among researchers in explaining the concept of relationship between these two markets. Despite the surge in literature on the relationship between commodity market and stock market, this concept is still very confusing in Indian context. A significant number of studies on this concept have been carried out in developed economies but very limited literature has been available for emerging economies like India. The financial markets of emerging economies differ from the developed economies in terms of volatility and speculative activities (Ping et al., 2017). The lack of empirical research is an underlying reason surrounding the confusion regarding this concept in Indian context

All these issues and limitations when taken into consideration provide a framework for future research. The outcomes of this study will fill the gap in the existing literature on the concept of co-integration between Indian commodity market and stock market by taking into account individual commodities and sectoral stock indices.

This study will also highlight the concept of volatility transmission and dynamic conditional correlation between commodity market and stock market which will give an outlook to the market professional and investors including speculators, hedgers, portfolio managers and financial analysts (Chiou and Lee, 2009; Choi and Hammoudeh, 2010). They can adjust their portfolio in order to make it better resist during the period of financial uncertainty. Volatility transmission between two financial markets gives better idea to the investors regarding what to include in and exclude from the portfolio. It is important for an investor who seeks to minimize portfolio risk, to understand the time varying volatility, co-movement and spillover between commodity market and stock market (Balasubramanayan, 2004). This study will help the policy regulators to understand the relationship between stock market and commodity market and provide a better insight to investors regarding the investment strategies.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter discusses need and research objectives of the study. The focus of this chapter is to highlight the data collection sources. This is followed by discussing the econometrics tools used to analyze the data.

3.1 Need of the Study

The active participation of retail investors in the Indian stock market has been increased from last five years. According to Central Depository Service India Limited Annual Report 2017-18, there is increase in active participation of retail investors, represented with the increase in turnover of shares traded in NSE rising to 140 lakh crore in the financial year 2017-18 from 28 lakh crore in the financial year 2013-14 . Now the investors are also interested to make investment in the commodity market. NCDEX data has shown that there is 23% increase in the retail investors investing in the Indian commodity market (Singh, 2011). There is increase in retail investors in the NCDEX, represented in the form of volume traded increased to 2,17,736 thousand tones in the financial year 2016-17 from 1,94,255 thousand tones in the financial year 2015-16. The volume traded in the MCX has been increased from 89,331 thousand tones in the year 2015-16 to 93,078 thousand tones in the financial year 2016-17 (SEBI Annual Report, 2016-17). The investors use commodities for the purpose of risk management as these are less volatile as compare to stock market. Despite the improvements in the performance of Indian commodity market and stock market, the active participation of percentage of retail investors of total population is still very less. SEBI investor survey, 2015 stated that out of total population of India, 1.9 crore investors are investing in stock market and there are only 21 lakh investors in commodity futures. The less participation in these markets is due to the less knowledge of investors to carry out fundamental analysis of financial assets; they tend to go with general market flow and direction. This study will be helpful for these investors to get more information about the financial markets.

This study examines the co-integration between commodity market and stock market to provide better insights regarding the hedging effectiveness of commodities against the unexpected fluctuations in the stock market. Furthermore the linkage between prices of raw material and their related stock indices will provide relevant information about the optimal substitution tactics between commodities and stocks (Creti et al., 2013). This study will help the policy makers to increase the participation of investors in commodity market and stock market with the help of optimal weights and hedge ratios, calculated on the basis of results of this study. Investors can use these weights and ratios to hedge their risk effectively. This way they will be better equipped to anticipate and prepare for unexpected fluctuations in commodity and stock prices.

3.2 Objectives of the Study

1. To examine the seasonality in mean return and volatility for the Commodity Market and Stock Market
2. To examine the long run co-integration between the Commodity Market and Stock Market
3. To examine the causal relationship between the Commodity Market and Stock Market
4. To examine the return links and volatility transmission between the Commodity Market and Stock Market
5. To examine the dynamic correlation between the Commodity Market and Stock Market

3.3 Research Design and Methodology

Research design is a framework which provides direction to conduct investigation effectively and efficiently

3.3.1 Data Collection

The spot price data related to individual commodities has been collected from the official website of Multi Commodity Exchange (MCX) and National Commodities and Derivatives Exchange (NCDEX), India from the year 2007 to 2017. Trading on NCDEX mainly concentrated on the agricultural commodities and MCX focuses on non-agricultural commodities. The total number of commodities and their related stock indices selected for this study are given in table 3.1. The total number of commodities traded on NCDEX is 23 out of which 16 agricultural commodities have been selected in this study. The other agricultural commodities which are chana, coriander, castor seed, cotton, kapas, maize and sugar have not been taken into account due to non availability of data.

Table 3.1: Commodities and Related Stock Indices

Sr. No.	COMMODITY NAME	STOCK INDEX
1	Aluminum	NSE Metal Index
2	Copper	NSE Metal Index
3	Lead	NSE Metal Index
4	Nickel	NSE Metal Index
5	Zinc	NSE Metal Index
6	Gold	NIFTY Index
7	Silver	NIFTY Index
8	Crude oil	NSE Energy Index
9	Natural gas	NSE Energy Index
10	Barley	NSE FMCG Index
11	Cotton Seed Oil Cake	NSE FMCG Index
12	Crude Palm Oil	NSE FMCG Index
13	Guar gum	NSE FMCG Index
14	Guar Seed	NSE FMCG Index
15	Gur	NSE FMCG Index
16	Jeera	NSE FMCG Index
17	Mustard seed	NSE FMCG Index
18	Pepper	NSE FMCG Index
19	RGB Palm oil	NSE FMCG Index
20	Soya Oil	NSE FMCG Index
21	Rubber	NSE FMCG Index
22	Soy bean	NSE FMCG Index
23	Turmeric	NSE FMCG Index
24	Wheat	NSE FMCG Index
25	Yellow Peas	NSE FMCG Index

Source: Official Websites of NSE, MCX and NCDEX

The total number of non-agricultural commodities traded on MCX is 9. The data related to these 9 non-agricultural commodities, covering three sectors which are Precious Metals, Base Metals and Energy, is collected from the official website of

MCX. The data related to selected stock indices has been collected from the official website of National Stock Exchange of India (NSE) from the year 2007 to 2017. The selected stock indices are NIFTY FIFTY, NIFTY Energy, NIFTY Metals and NIFTY FMCG.

3.3.2 Data Analysis Tools and Techniques

Generalized Auto-Regressive Conditional Heteroskedasticity (GARCH)

GARCH model is used widely for modeling volatility and seasonality in the financial markets. In this study, GARCH model is applied to model seasonality in commodity market and stock market.

Before applying the GARCH model, it is required to estimate ARCH-LM (Lagrange Mutiple) test to study the presence of ARCH effect in the residuals (ε_t). Then the residuals are squared and regressed on their own lagged return of order one to four.

The estimated equation is given below:

$$\varepsilon_t^2 = c + \sum_{i=1}^{4} \alpha_i \, \varepsilon_{t-1}^2 + k_t \qquad (1)$$

Here k_t is the error term. The null hypothesis for ARCH-LM test is the absence of ARCH effect in the error term. If the coefficient of ARCH-LM test is statistically significant, it confirms the presence of ARCH effect in the error term.

Engle (1982) introduced the concept of modeling volatility in the financial markets by introducing Autoregressive conditional heteroskedasticity model. This model states that the forecasted conditional variance of the mean equation is changed with the change in previous period's squared error term. The error terms should be serially uncorrelated. The generalized version of ARCH model is known as GARCH model. Further Bollerslev (1986) extended the ARCH model based on the assumption that conditional variance not only depends upon the past error term, but it is also affected by its own past lagged variance. The mean equation of GARCH model is given below:

$$r_t = c + \varepsilon_t \qquad (2)$$

The variance equation is:

$$h_t = \mu + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1}^2 \qquad (3)$$

Here c is the constant term, ε_t is the error term at time t, the terms α and β represents the ARCH and GARCH terms respectively. If the GARCH term is high, it means the volatility is highly persistent while the higher ARCH term represents the insensitivity of conditional variance to the unexpected market reactions. The sum of α and β should be close to one, implying the high persistence of shock in the market.

Further in order to measure the seasonality, Dummy Augmented GARCH model is employed. Here eleven dummies are introduced that represents the month of the year in the mean equation to study the monthly seasonality in the mean equation. Now the mean equation is

$$r_t = c + \sum_{t=1}^{11} \emptyset_t D_t + \varepsilon_t \qquad (4)$$

The eleven dummies are introduced again but now as exogenous variable in GARCH model in order to captures the monthly seasonality in the conditional variance equation. The variance equation is:

$$h_t = \mu + \sum_{t=1}^{11} \emptyset_t D_t + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1}^2 \qquad (5)$$

Here r_t is the return of either stock market or commodity market. D_t is the dummy variable, $\emptyset_t$ is the coefficient of dummy variable, where t=1,2,3.........11 representing the months of the year from January to November respectively. The constant term captures the December effect in this model.

Unit Root Test

In order to study the order of integration for each series, various methods are used. These methods include Augmented Dickey Fuller (ADF) Test, Phillip-Perron Test, KPSS Test. The majority of study used ADF test. The null hypothesis for ADF test is the series has a unit root which implies that the series is non-stationary (Dickey and Fuller, 1979). The regression equation for this test is given below:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{i-1}^{n} \alpha_i \, \Delta y_t + \varepsilon_t \qquad (6)$$

Here y_t is the price series of individual commodity or stock index series, Δ is first difference operator, i=1,2...n represents the number of lags.

Johansen Co-integration Test

Further Johansen co-integration test is applied to predict long run relationship between the commodity market and stock market. Two or more markets move jointly in the long run regardless the markets individually drifted, and then the difference between them is constant, known as co-integration and it is also termed as long run equilibrium association (Hall and Henry, 1989). If there is absence of co-integration between these variables, it means they drifted away from one another (Dickey et al., 1994). The johansen co-integration equation is given below:

$$y_t = \mu + \Delta_1 y_{t-1} + \Delta_p y_{t-p} + \ \varepsilon_t \qquad (7)$$

Here y_t is the price series of individual commodities or stock index, ε_t is error term

Further two different methods are used to find out the co-integration vector. The first one is trace statistics and the second is Eigen value criteria (Johansen, 1988).

Toda and Yamamoto Granger Causality Test

Furthermore in order to study the causal relationship between the commodities and stocks, Granger Causality Test approach proposed by Toda & Yamamoto (1995) has been employed. This approach is relatively more efficient than the other traditional methods used to study the causal relationship. Firstly validity of this method does not depend upon the order of integration of the variables under study. This method can be applied on any order of integration. Secondly, it is not required to find out the co-integrating relationship between the variables before detecting the causal relationship between them. Thirdly the bias associated with the unit root test and co-integrating properties of the variables has been reduced by this method.

Toda and Yamamoto method is based on the idea of applying Vector Autoregressive Model at level (p= k+d_{max}) with correct VAR order k and d extra lag, where d represents the maximum order of integration of time series. At last the wald statistics has been used in order to study the causality between the variables under study. The implementation of Toda and Yamamoto approach of Granger Causality linking both the variables under study as follow:

$$\mathrm{Y_t} = \mathrm{A_0} + \mathrm{A_1 Y_{t-1}} + \mathrm{A_2 Y_{t-2}} \dots \dots \dots \mathrm{A_k Y_{t-k}} + \varepsilon_\mathrm{t} \qquad (8)$$

Where $Y_t = \begin{bmatrix} Y_{1t} \\ Y_{2t} \end{bmatrix} = \begin{bmatrix} Com_t \\ SI_t \end{bmatrix}$ and $\varepsilon_t \sim i.i.d\ N\ (0, \mu)$. Here com stands for individual commodities and SI stands for stock index.

The following equation represents the augmented level VAR (k+d_{max}) in order to detect causal relationship between the variables.

$$\mathrm{Y_t} = \alpha + \mathrm{A_1 Y_{t-1}} + \mathrm{Y_{t-k}} + \mathrm{A_{k+1} Y_{t-k+1}} + \mathrm{A_p Y_{t-p}} + \varepsilon_\mathrm{t} \qquad (9)$$

VAR-GARCH Model

In this study, the VAR (1)-GARCH (1,1) model is used to study the spillover effects across stock market and commodity market. Ling and McAleer (2003) introduced this model and subsequently it is used by various researchers (Arouri et al., 2012; Jouini, 2013; Mensi et al., 2013; Bouri et al., 2017). This model is appropriate to find out the return and volatility transmission across financial markets. It provides the benefit of multi-variate analysis of conditional variance of the individual market and volatility spillover across financial markets. Secondly this model provides appropriate resultswith less computational complications (Arouri et al., 2012). The mean equation for this model is:

$$y_t = c + \partial y_{t-1} + \varepsilon_t \qquad (10)$$

$$\varepsilon_t = D_t \varphi_t \qquad (11)$$

Here y_t=($r_t^s | r_t^c$), r_t^s and r_t^c represents the return series of stock market and commodity market respectively

$\varepsilon_t = (\varepsilon_t^s | \varepsilon_t^c)$, ε_t^s and ε_t^c represents the residual term for mean equation of stocks and commodities respectively

$\varphi_t = (\varphi_t^s | \varphi_t^c)$, refers to independently identical white noise terms

$D_t = \left(\sqrt{h_t^s} \middle| \sqrt{h_t^c}\right)$, h_t^s and h_t^c represents the conditional variance for mean equation of stocks and commodities respectively

The variance equation is

$$h_t^s = c_s + \alpha_s(\varepsilon_{t-1}^s)^2 + \beta_s h_{t-1}^s + \alpha_c(\varepsilon_{t-1}^c)^2 + \beta_c h_{t-1}^c \quad (12)$$

$$h_t^c = c_c + \alpha_c(\varepsilon_{t-1}^c)^2 + \beta_c h_{t-1}^c + \alpha_s(\varepsilon_{t-1}^s)^2 + \beta_s h_{t-1}^s \quad (13)$$

Here α is the coefficient of ARCH term and β is the coefficient of GARCH term. The above equation represents the volatility spillover across commodity market and stock market. $(\varepsilon_{t-1}^s)^2$ and $(\varepsilon_{t-1}^c)^2$ represents the impact of own one period lagged and cross market lagged return innovations on the current conditional volatility of stock market. h_{t-1}^s and h_{t-1}^crepresents the impact of own one period lagged conditional variance and cross market lagged conditional variance on the current conditional variance of stock market. the second equation represents the opposite of it.

Dynamic Conditional Correlation

To investigate the conditional correlation between stock market and commodity, DCC-GARCH model is applied. This model is introduced by Engle (2001). The mean equation of this model is given below

$$r_t = \mu + \varepsilon_t \quad (14)$$

Here r_t is return series for commodities and stock indices. The covariance matrix is given below

$$h_t = D_t R_t D_t \quad (15)$$

Where $D_t = \left(\sqrt{h_t^s} \middle| \sqrt{h_t^c}\right)$. It is a diagonal matrix of dynamic conditional standard deviation estimated from the univariate GARCH model.

Here R_t is the conditional correlation matrix of standardized return ε_t

$$R_t = \begin{bmatrix} 1 & q_{12t} \\ q_{21t} & 1 \end{bmatrix}$$

Further the above matrix decomposed

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1}$$

Here Q_t is the positive definite matrix containing the conditional variance and co-variance of ε_t and Q_t^{*-1} is the inverted diagonal matrix.

The DCC(1,1) model specification is as follows

$$Q_t = \theta + \alpha \varepsilon_{t-1} \varepsilon_{t-1}^{'} + \beta Q_{t-1} \quad (16)$$

Here α is ARCH term and β is GARCH term

Finally dynamic conditional correlation is represented as

$$\rho_{12t} = \frac{q_{12t}}{\sqrt{q_{11t} q_{22t}}} \quad (17)$$

Optimal Weights and Hedge Ratio

If an investor is holding stocks of an industry and want to hedge his position against the unexpected fluctuations in the commodity market. Therefore the main motive of investor is to minimize the risk without sacrificing the expected return. The optimal weights of stocks and commodities are given in the table by following the formula given by Kroner and Ng (1998).

The formula is given below:

$$w_t^{SC} = \frac{h_t^s - h_t^{sc}}{h_t^C - 2h_t^{SC} + h_t^C} \quad (18)$$

$$w_t^{SC} = \begin{cases} 0, if\ w_t^{SC} < 0 \\ w_t^{SC}, if\ 1 \le w_t^{SC} \le 0 \\ 1, if\ w_t^{SC} > 1 \end{cases}$$

Here w_t^{SC} is the weight of commodity in 100 rupees portfolio of stocks and commodities. h_t^s and h_t^C are the conditional variance of stocks and commodities respectively. h_t^{SC} is the conditional co-variance between stocks and commodities. The optimal weight of stock sector index is given by 1-w_t^{SC}.

The investors can also calculate the optimal hedge ratio for their portfolio. The long position in commodities is hedged by taking the short position in the stock market in β_t rupees. The formula to calculate hedge ratio, describe by Kroner and Sultan (1993) is given below:

$$\beta_t^{SO} = \frac{h_t^{SO}}{h_t^S} \tag{19}$$

CHAPTER 4
SEASONALITY IN COMMODITY MARKET AND STOCK MARKET

Seasonality refers to the nature of financial assets return that demonstrate regular pattern during certain period of time such as day, week, month or year. Due to the occurrence of these kind of patterns, commodity return tend to move up or down in a particular period as compare to normal period. Such type of effects cannot be clarified by conventional asset pricing models. Thus, these effects are named as anomaly and also violate the rule of 'Efficient Market' (Parikh, 2009; Munusuru, 2013). This study focuses on the monthly seasonality to examine the evidence of seasonality in a particular month and tend to generate more than expected returns during that particular month. Milonas (1991) suggested that except metals, all the commodities follow monthly seasonal patterns. The occurrence of seasonality in the commodity market has two implications. First higher return in the particular period or month implies the potential to generate abnormal profits based on identifying patters (Auer, 2014) and secondly difference in volatility during the months lead to promote new explanatory variable relevant to include in the existing volatility forecasting models (Auer, 2014). Existence of seasonality has important implications for investors in taking decision related to optimal portfolio. Investors can take decision to get profits through their trading strategies. In other words, commodities follow certain pattern which depends on demand and supply patterns exceptional to each commodity, investors can get benefits if they exploited seasonal patterns successfully. Seasonality in the financial markets also suggests that markets are inefficient as the information available in the market does not reflect in the prices of financial assets (Munusuru, 2013).

The phenomenon of seasonality has been extensively analyzed in the stock market. The results in this field recommend that prices of financial asset such as stocks display weekend, January and turn of the year effect. On the contrary, related studies in the field of commodity market are few in numbers. This objective fills the gap in existing literature by investigating the existence of monthly seasonality in the commodity market. Commodity returns follow a combination of normal distributions. These distributions are considered to be serially correlated as all the distributions hve different variances. The underlying reason for the formation of different variances is the existence of seasonality in the commodity market. Any statistical test used for commodity price should make adjustment for the seasonality and resulting heteroskedasticity (Milonas, 1991). To achieve this objective a dummy augmented GARCH model has been used for commodity returns in order to avoid misleading inferences caused by departure from normality, serial correlation and heteroskedasticity (Chien and Chen, 2008; Auer, 2014).

4.1 Monthly Seasonality in the agriculture commodities and NSE FMCG Returns and Volatility

Seasonality in the agriculture commodities has been earlier documented by, Milonas (1991), Lee et al. (2013), Munusuru (2013). These commodities follow their own cycle of production from planting to the harvest and this cycle of production is repeated across the commodities (Lee et al., 2013). In the initial stage, Ordinary Least Square Regression is carried out in order to study the monthly seasonality in the agricultural commodities and NSE FMCG index. In the mean equation, monthly dummies have been included as explanatory variable. The intercept of the mean equation describes the mean returns of December and the coefficient of dummy variables describes the difference in the average return from January through November and December. The results are presented in the Table 4.1 which revealed that Soya bean returns are found to be statistically significant for May, June, September October and December months at 10% level of significance. Gur returns are found to be statistically significant for April, October, November and December. Barley returns are found to be statistically significant for March, April and October while Rubber returns are significant for August, October and November. Wheat returns are statistically significant for March, April and July. Yellow peas returns are significant for August, September and October. Pepper returns are statistically significant for April and October. Two out of sixteen commodities are having only one significant month September and July respectively. Six out of sixteen commodities (cottonseed, guar gum, guar seed, jeera, mustard seed oil and RBD palm oil) and NSE FMCG index showed no evidence of monthly seasonality as their monthly returns are non-significant.

Table 4.1: Results of OLS Regression for Agricultural Commodities and FMCG Stock index

	C	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	LM	ARCH
Barley	-0.0016	0.0012	-0.0031	-0.0094	0.0133	0.0017	-0.0023	0.0059	0.0025	0.0068	0.0095	0.0060	13.42	0.45
	(0.643)	(0.80)	(0.53)	(0.054)	(0.007)	(0.73)	(0.64)	(0.23)	(0.61)	(0.17)	(0.05)	(0.22)	(0.00)	(0.00)
Cottonseed	0.011	0.014	-0.0059	-0.0096	-0.0054	-0.006	-0.002	-0.002	-0.012	-0.018	-0.022	-0.029	90.38	244.67
	(0.40)	(0.46)	(0.76)	(0.61)	(0.77)	(0.74)	(0.91)	(0.88)	(0.51)	(0.34)	(0.23)	(0.12)	(0.00)	(0.00)
Crude Palm Oil	0.0024	-0.0036	0.0077	-0.0031	0.0031	-0.00058	-0.0071	-0.011	-0.00083	-0.00082	-0.006	0.0046	16.70	17.23
	(0.55)	(0.95)	(0.19)	(0.58)	(0.59)	(0.92)	(0.22)	(0.06)	(0.88)	(0.42)	(0.28)	(0.42)	(0.00)	(0.00)
Guargum	0.0118	-0.0008	-0.0030	-0.0066	-0.030	-0.0099	-0.0093	-0.007	0.0020	-0.032	-0.015	-0.018	70.89	55.73
	(0.70)	(0.98)	(0.94)	(0.88)	(0.49)	(0.82)	(0.83)	(0.87)	(0.96)	(0.47)	(0.73)	(0.67)	(0.00)	(0.00)
Guarseed	0.0194	-0.0058	-0.0205	-0.0122	-0.041	-0.0048	-0.034	-0.013	-0.0352	0.0035	-0.012	-0.045	29.41	6.27
	(0.46)	(0.87)	(0.59)	(0.74)	(0.28)	(0.89)	(0.36)	(0.72)	(0.35)	(0.92)	(0.75)	(0.23)	(0.000)	(0.000)
Gur	0.0078	-0.004	-0.0104	-0.0062	0.0128	-0.0005	-0.0072	-0.006	-0.0102	-0.0035	-0.015	-0.028	2.31	38.36
	(0.08)	(0.53)	(0.12)	(0.33)	(0.04)	(0.93)	(0.27)	(0.30)	(0.11)	(0.59)	(0.02)	(0.00)	(0.10)	(0.00)
Jeera	0.0025	-0.0031	-0.0054	-0.0045	0.0074	-0.001	0.0008	0.0098	-0.0066	-0.012	-0.006	0.0090	31.91	202.04
	(0.64)	(0.68)	(0.49)	(0.55)	(0.33)	(0.89)	(0.91)	(0.20)	(0.39)	(0.11)	(0.39)	(0.24)	(0.00)	(0.00)
Mustard seed	0.0019	0.0133	-0.005	-0.004	0.0039	0.0063	0.0040	0.0047	0.0019	-0.0033	0.0038	0.0029	0.15	0.002
	(0.84)	(0.35)	(0.70)	(0.75)	(0.78)	(0.66)	(0.78)	(0.74)	(0.98)	(0.82)	(0.79)	(0.84)	(0.85)	(0.09)
Pepper	-0.0029	0.0062	-0.001	0.0088	0.0187	0.0021	0.0074	0.0085	0.0055	-0.0017	0.0098	-0.005	15.58	23.96
	(0.45)	(0.25)	(0.86)	(0.102)	(0.00)	(0.69)	(0.17)	(0.12)	(0.32)	(0.75)	(0.06)	(0.93)	(0.00)	(0.00)
RBD Palm Oil	0.0019	-0.0022	0.0065	-0.0029	0.0009	0.00012	-0.0073	-0.006	0.0021	-0.006	-0.006	0.0051	14.33	26.40
	(0.59)	(0.68)	(0.23)	(0.23)	(0.85)	(0.98)	(0.17)	(0.25)	(0.69)	(0.20)	(0.22)	(0.34)	(0.00)	(0.00)
Rubber	0.0072	-0.0096	-0.0037	0.0022	-0.011	-0.0061	-0.007	-0.003	-0.015	-0.008	-0.013	-0.014	11.10	14.81
	(0.13)	(0.16)	(0.60)	(0.74)	(0.87)	(0.38)	(0.26)	(0.65)	(0.02)	(0.20)	(0.05)	(0.04)	(0.00)	(0.00)
Soybean	0.0085	-0.0034	-0.0052	-0.0018	0.0056	-0.011	-0.012	-0.008	-0.0087	-0.028	-0.011	-0.004	1.55	137.7
	(0.05)	(0.59)	(0.41)	(0.77)	(0.37)	(0.09)	(0.05)	(0.18)	(0.16)	(0.00)	(0.06)	(0.94)	(0.02)	(0.00)
Soyoil	0.0041	-0.0041	-0.0064	-0.0062	-0.002	-0.003	-0.002	-0.005	-0.003	-0.007	-0.004	0.0031	1.18	7.29
	(0.21)	(0.37)	(0.18)	(0.18)	(0.67)	(0.47)	(0.66)	(0.22)	(0.57)	(0.11)	(0.35)	(0.51)	(0.21)	(0.007)
turmeric	0.0065	-0.009	-0.011	-0.0026	-0.0052	-0.006	-0.008	0.011	-0.01	-0.014	0.0019	0.004	3.15	39.21
	(0.29)	(0.19)	(0.13)	(0.72)	(0.47)	(0.42)	(0.27)	(0.12)	(0.17)	(0.05)	(0.79)	(0.54)	(0.00)	(0.00)
Wheat	0.0007	0.0049	-0.0043	-0.012	-0.011	0.0049	0.0022	0.0075	0.0004	-0.0027	0.0054	0.0025	1.23	3.29
	(0.78)	(0.20)	(0.29)	(0.00)	(0.00)	(0.20)	(0.56)	(0.05)	(0.90)	(0.49)	(0.17)	(0.52)	(0.29)	(0.06)
Yellow peas	0.0037	-0.0012	-0.014	0.0016	0.0010	-0.003	0.004	-0.008	-0.013	-0.009	-0.014	0.0072	1.31	0.62
	(0.33)	(0.82)	(0.79)	(0.75)	(0.85)	(0.48)	(0.45)	(0.88)	(0.01)	(0.09)	(0.00)	(0.18)	(0.10)	(0.04)
FMCG index	0.004	-0.0061	-0.0085	0.0029	0..0015	0.0011	-0.0031	0.006	-0.0074	0.0015	-0.004	-0.055	0.52	0.00002
	(0.22)	(0.25)	(0.11)	(0.57)	(0.77)	(0.83)	(0.56)	(0.19)	(0.16)	(0.77)	(0.41)	(0.30)	(0.59)	(0.09)

Source: Author's Calculations

Further Serial Correlation LM test clearly indicate that in eleven out of sixteen commodities, there is presence of serial correlation in standard residuals as the value of F-statistics is significant at 99 percent confidence interval for eleven commodities. The mean equation in eleven out of sixteen agricultural commodities include AR(1) term in GARCH specification to eliminate the problem of autocorrelation that may originated by synchronous trading (Munusuru, 2013). In the remaining five commodities, the absence of serial correlation in residual implies that it is not required to include higher order autoregressive terms in GARCH specification.

Furthermore to assess the presence of ARCH effect in returns of commodities and stocks used for analysis, Heteroskedasticity ARCH LM test is carried out which highlights that F-statistics is statistically significant for all the series. It clearly indicates that OLS is not considered as an adequate model to capture the characteristics of time series data which include the problem of heteroskedasticity and the concept of dynamic volatility and volatility clustering. Further by taking into account the limitations of OLS model, GARCH model is used to understand the concept of seasonality in commodity market and equity market. This method represents a groundbreaking alternative to previously used linear regression models which are unable to capture the dynamic volatility. Dynamic volatility can only be captured in the financial markets by using GARCH models as suggested by Engle (1982) and Bollerslev (1986).

Further the two models are considered in order to find out the seasonality in the mean return and volatility. First model is taking into account GARCH (1,1) specification by incorporating monthly dummies in the mean return. Secondly in order to model conditional variability of commodities and stock index returns, the monthly effect is incorporated into the model by taking monthly dummies as exogenous variables. Table 4.2 and 4.3 summarizes the results obtained by estimating the GARCH (1,1) models for return and volatility separately. As discussed earlier, return in all the commodities except five commodities (gur, mustard seed, soy oil, wheat and yellow peas) and NSE FMCG index follow AR process. As discussed earlier, return in all the commodities except five commodities (gur, mustard seed, soy oil, wheat and yellow peas) and NSE FMCG index follow AR process.

Table 4.2: Results of GARCH(1,1) Model for Agricultural Commodities and FMCG Index (Mean Equation)

	AR	c	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	LM	ARCH
Barley	0.2811 (0.00)	0.0003 (0.90)	0.00176 (0.57)	-0.00412 (0.24)	-0.00431 (0.16)	0.01075 (0.00)	-0.00537 (0.19)	-0.00352 (0.33)	0.00125 (0.70)	0.00212 (0.55)	0.00061 (0.86)	0.00170 (0.62)	0.00331 (0.34)	0.023 (0.68)	0.25 (0.99)
Cottonseed	0.143 (0.00)	0.0097 (0.10)	0.0027 (0.68)	-0.0061 (0.44)	-0.00263 (0.72)	-0.0131 (0.09)	-0.0044 (0.55)	-0.0001 (0.98)	-0.0023 (0.75)	-0.0126 (0.10)	-0.0178 (0.01)	-0.0122 (0.07)	-0.023 (0.00)	0.015 (0.69)	0.007 (0.93)
Crude Palm Oil	0.234 (0.00)	0.0018 (0.69)	-0.0043 (0.45)	0.00536 (0.40)	-0.0022 (0.71)	0.00389 (0.54)	0.0002 (0.97)	-0.0053 (0.35)	-0.0065 (0.31)	-0.00052 (0.93)	-0.0015 (0.81)	-0.00054 (0.92)	0.0063 (0.29)	-0.016 (0.156)	0.74 (0.71)
Guar gum	-0.033 (0.46)	-0.0029 (0.59)	0.0029 (0.71)	0.0023 (0.78)	0.0106 (0.22)	0.0091 (0.24)	-0.0011 (0.89)	0.00235 (0.75)	0.0162 (0.03)	0.0057 (0.46)	-0.0053 (0.58)	0.0008 (0.91)	0.00213 (0.78)	0.019 (0.74)	0.0012 (0.97)
Guar seed		-0.0016 (0.73)	0.0022 (0.72)	-0.00432 (0.63)	0.0003 (0.98)	0.0111 (0.13)	-0.0062 (0.52)	0.000061 (0.99)	0.0159 (0.04)	0.0069 (0.46)	-0.0080 (0.25)	-0.00442 (0.67)	0.00038 (0.92)	-0.068 (0.81)	0.009 (0.92)
Gur	-0.022 (0.00)	0.0068 (0.20)	-0.0037 (0.59)	-0.0105 (0.14)	-0.0087 (0.14)	0.0121 (0.03)	-0.0072 (0.21)	-0.0082 (0.22)	-0.0043 (0.54)	-0.0096 (0.17)	-0.00008 (0.98)	0.0070 (0.20)	-0.0070 (0.21)	0.041 (0.60)	0.303 (0.58)
Jeera	0.0931 (0.01)	-0.0008 (0.83)	0.0011 (0.81)	-0.0070 (0.16)	-0.0006 (0.89)	0.0052 (0.29)	-0.0004 (0.93)	0.0032 (0.53)	0.0089 (0.07)	-0.0032 (0.56)	-0.0073 (0.19)	-0.0020 (0.68)	0.007 (0.13)	-0.012 (0.101)	0.11 (0.73)
Mustardseed		0.0006 (0.80)	-0.0136 (0.00)	-0.0087 (0.02)	-0.0034 (0.36)	0.00345 (0.37)	0.0054 (0.17)	0.0051 (0.24)	0.0064 (0.13)	0.0004 (0.91)	-0.0011 (0.80)	0.0036 (0.37)	0.0054 (0.21)	0.002 (0.99)	0.0002 (0..98)
Pepper	0.327 (0.00)	-0.0012 (0.73)	0.0057 (0.25)	-0.0025 (0.64)	0.0038 (0.44)	0.0157 (0.00)	0.0036 (0.53)	0.0064 (0.26)	0.0037 (0.55)	0.0021 (0.67)	0.0006 (0.91)	0.0045 (0.47)	-0.0033 (0.57)	0.060 (0.90)	0.008 (0.92)
RBD Palm oil	0.241 (0.00)	0.00178 (0.69)	-0.0063 (0.25)	0.0025 (0.68)	-0.0032 (0.60)	0.0006 (0.91)	0.0022 (0.72)	-0.00515 (0.39)	-0.0048 (0.45)	0.0034 (0.52)	-0.0040 (0.53)	-0.0029 (0.60)	0.0066 (0.24)	-0.014 (0.13)	0.13 (0.71)
Rubber	0.254 (0.00)	0.0085 (0.00)	-0.0100 (0.11)	-0.0063 (0.22)	-0.0021 (0.70)	-0.0065 (0.28)	-0.0066 (0.27)	-0.0069 (0.20)	-0..011 (0.07)	-0.0198 (0.00)	-0.0120 (0.05)	-0.0103 (0.11)	-0.0102 (0.04)	-0.038 (0.39)	0.013 (0.91)
Soybean	0.138 (0.00)	0.0074 (0.13)	-0.0040 (0.52)	-0.0055 (0.46)	-0.0022 (0.72)	0.0031 (0.61)	-0.0098 (0.15)	-0.0128 (0.06)	-0.0061 (0.39)	-0.0082 (0.25)	-0.038 (0.00)	-0.0089 (0.15)	0.0016 (0.81)	-0.043 (0.84)	0.69 (0.43)
Soyoil		0.0004 (0.22)	-0.0035 (0.39)	-0.0084 (0.11)	-0.0059 (0.18)	-0.0017 (0.72)	-0.0037 (0.43)	-0.0030 (0.52)	-0.0045 (0.33)	-0.0019 (0.66)	-0.0046 (0.29)	-0.0022 (0.61)	0.0054 (0.19)	-0.035 (0.43)	0.006 (0.93)
Turmeric	0.328 (0.00)	0.0078 (0.14)	-0.0089 (0.17)	-0.0040 (0.63)	0.0010 (0.86)	-0.0027 (0.73)	-0.0118 (0.15)	-0.0132 (0.10)	-0.0041 (0.61)	-0.0140 (0.07)	-0.0153 (0.04)	-0.0013 (0.72)	0.0022 (0.76)	-0.007 (0.189)	0.84 (0.61)
Wheat	0.060 (0.25)	0.0003 (0.90)	0.0107 (0.00)	-0.0049 (0.16)	-0.0123 (0.00)	-0.0092 (0.03)	0.0047 (0.25)	0.0018 (0.66)	0.0029 (0.47)	-0.0008 (0.83)	-0.0005 (0.89)	0.0032 (0.36)	0.0017 (0.67)	0.008 (0.93)	0.05 (0.81)
Yellowpeas		0.0025 (0.45)	-0.0007 (0.88)	-0.0023 (0.62)	-0.0012 (0.80)	0.00056 (0.90)	-0.0041 (0.41)	0.00355 (0.455)	-0.0032 (0.50)	-0.0085 (0.07)	-0.0123 (0.00)	-0.0132 (0.01)	-0.0010 (0.82)	0.024 (0.79)	0.56 (0.45)
FMCG Index		0.0037 (0.25)	-0.0057 (0.24)	-0.0086 (0.08)	0.0056 (0.23)	0.0016 (0.75)	0.0021 (0.65)	0.0009 (0.85)	0.00587 (0.22)	-0.0060 (0.21)	0.00205 (0.68)	-0.0021 (0.66)	-0.0051 (0.29)	-0.036 (0.19)	0.75 (0.38)

Source: Author’s Calculations

As for the monthly seasonality in mean return, results given in table 4.2 show that the estimated coefficients of Aprils' dummy variable for Barley, Gur and pepper are positively significant while the coefficients of Aprils' dummy variable are found to be negative and statistically significant for cotton seed and wheat. The dummy coefficients of July are positive in case of guar gum, guar seed and jeera while the July dummy coefficient is negative for rubber. The coefficients of Septembers' dummy are negative for five out of sixteen commodities which are cotton seed, rubber, soya bean, turmeric and Yellow peas. August dummy coefficient is found to be negative for rubber, turmeric and yellow peas while November dummy coefficient for cottonseed and rubber is negative. The coefficient of January dummy is negative for mustard seed while the same is positive and statistically significant for wheat. February dummy coefficient is negative and significant for Mustard seed and NSE FMCG index and October dummy coefficient is negative for cottonseed and yellow peas. The coefficients of March and June dummy are found to be negative for wheat and soya bean respectively. The coefficient of December is positive and significant for rubber. The coefficient of May dummy is not significant for any of the commodities. Three out of sixteen commodities (crude palm oil, RBD palm oil and soy oil) had no significant return for any of the month signifying that seasonality effect does not exist in these commodities.

Table 4.3 represents the results of monthly seasonality in agricultural commodity and NSE FMCG volatility. The results show that the coefficient of January dummy is positive for barley, guar gum, guar seed and jeera. The dummy coefficient of February month is statistically significant for crude palm oil and guarseed. The coefficient for the month of March is statistically significant for barley, gur, guar seed, guar seed, rubber and wheat. The dummy coefficient of April month is statistically significant for crude oil, guar gum, guar seed an turmeric. The coefficient of May dummy is statistical significant for cottonseed, guar gum, guar seed, gur, jeera, rubber and NSE FMCG.

Table 4.3: Results of GARCH(1,1) Model for Agricultural Commodities and FMCG Index (Variance Equation)

.	c	α	B	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov
Barley	-0.00004 (0.07)	0.342 (0.00)	0.483 (0.00)	0.000051 (0.07)	0.000008 (0.25)	0.000632 (0.00)	0.000123 (0.32)	0.000053 (0.16)	0.000044 (0.17)	0.000056 (0.02)	0.000059 (0.08)	0.000015 (0.23)	0.000078 (0.00)	0.000040 (0.01)
Cottonseed	0.00106 (0.00)	0.495 (0.00)	0.277 (0.00)	-0.00010 (0.77)	-0.00042 (0.23)	-0.00026 (0.46)	-0.00058 (0.11)	-0.00068 (0.04)	-0.00079 (0.01)	-0.00078 (0.01)	-0.00069 (0.04)	0.000241 (0.61)	0.0015 (0.01)	0.007601 (0.00)
Crude Palm Oil	0.00025 (0.04)	0.093 (0.00)	0.872 (0.00)	-0.00001 (0.91)	-0.00013 (0.05)	0.00002 (0.69)	-0.00013 (0.05)	0.00007 (0.40)	-0.00010 (0.20)	0.00002 (0.79)	-0.00006 (0.46)	-0.00002 (0.73)	-0.00003 (0.73)	0.000002 (0.97)
Guar gum	0.00121 (0.00)	0.137 (0.00)	0.835 (0.00)	-0.00116 (0.00)	0.00159 (0.16)	-0.00147 (0.00)	-0.00041 (0.00)	-0.00133 (0.00)	-0.00037 (0.35)	-0.00023 (0.64)	-0.00078 (0.06)	-0.00113 (0.00)	-0.00089 (0.00)	-0.00080 (0.01)
Guar seed	0.00073 (0.00)	0.147 (0.00)	0.819 (0.00)	-0.00084 (0.00)	-0.00045 (0.05)	-0.00090 (0.00)	-0.00027 (0.00)	-0.00092 (0.00)	-0.00032 (0.12)	-0.00028 (0.39)	-0.00070 (0.00)	-0.00076 (0.00)	-0.00048 (0.00)	-0.00072 (0.00)
Gur	0.00020 (0.00)	0.470 (0.00)	0.444 (0.00)	-0.00008 (0.48)	-0.00002 (0.84)	-0.00003 (0.00)	0.00091 (0.77)	0.00044 (0.00)	-0.00014 (0.09)	-0.00009 (0.36)	-0.00010 (0.36)	0.00015 (0.23)	0.00227 (0.00)	0.00023 (0.43)
Jeera	0.00117 (0.00)	0.358 (0.00)	0.069 (0.02)	-0.00077 (0.09)	-0.00059 (0.20)	-0.00047 (0.33)	-0.00044 (0.32)	-0.00088 (0.04)	-0.00094 (0.03)	-0.00068 (0.13)	-0.00103 (0.01)	-0.00105 (0.01)	-0.00076 (0.08)	0.00065 (0.24)
Mustardseed	0.00013 (0.03)	0.0027 (0.00)	0.712 (0.00)	0.00040 (0.12)	0.00009 (0.74)	0.000001 (0.97)	-0.00011 (0.22)	-0.00009 (0.18)	-0.00012 (0.03)	-0.00004 (0.51)	-0.00011 (0.06)	-0.00006 (0.39)	-0.00007 (0.27)	-0.00004 (0.62)
Pepper	0.00021 (0.00)	0.115 (0.00)	0.859 (0.00)	-0.00010 (0.18)	0.00013 (0.20)	0.00005 (0.54)	0.00005 (0.56)	-0.00008 (0.24)	-0.00009 (0.22)	-0.00015 (0.01)	-0.00011 (0.08)	-0.00013 (0.03)	-0.00002 (0.56)	-0.00014 (0.06)
RBD Palm oil	0.000038 (0.45)	0.065 (0.00)	0.902 (0.00)	0.00000 (0.96)	-0.00009 (0.15)	-0.00002 (0.96)	-0.00006 (0.33)	0.00002 (0.74)	-0.00005 (0.47)	-0.00002 (0.71)	0.00006 (0.45)	-0.00002 (0.75)	-0.00003 (0.32)	0.00001 (0.93)
Rubber	0.00012 (0.05)	0.186 (0.00)	0.726 (0.00)	-0.0001 (0.19)	0.00012 (0.31)	-0.00020 (0.02)	0.00012 (0.35)	-0.00018 (0.07)	-0.00002 (0.84)	-0.00013 (0.12)	0.00005 (0.59)	-0.00006 (0.43)	-0.00015 (0.03)	0.00005 (0.73)
Soybean	0.000031 (0.59)	0.064 (0.00)	0.892 (0.00)	-0.00002 (0.84)	-0.00002 (0.84)	0.00004 (0.64)	0.00001 (0.88)	-0.00005 (0.53)	-0.00002 (0.74)	0.00006 (0.45)	-0.00006 (0.50)	0.00036 (0.00)	-0.00025 (0.00)	-0.00003 (0.76)
Soyoil	-0.00001 (0.73)	0.063 (0.01)	0.877 (0.00)	0.00003 (0.72)	0.00004 (0.39)	0.00005 (0.39)	0.000002 (0.96)	0.00005 (0.33)	0.00003 (0.59)	0.00002 (0.63)	0.00007 (0.23)	0.00011 (0.09)	-0.00003 (0.62)	0.00017 (0.06)
Turmeric	0.00026 (0.02)	0.25153 (0.00)	0.64477 (0.00)	-0.00004 (0.76)	-0.00017 (0.19)	0.00019 (0.21)	-0.00035 (0.00)	0.00012 (0.41)	-0.00021 (0.09)	-0.00016 (0.25)	-0.00013 (0.36)	-0.00009 (0.50)	-0.00008 (0.52)	-0.00025 (0.04)
Wheat	0.00002 (0.09)	0.20225 (0.02)	0.64810 (0.00)	0.00018 (0.11)	0.00007 (0.61)	0.00026 (0.05)	-0.00007 (0.17)	0.00007 (0.20)	0.00001 (0.88)	0.00006 (0.34)	-0.00002 (0.35)	0.00001 (0.56)	0.00005 (0.18)	-0.00003 (0.04)
Yellowpeas	0.00015 (0.16)	0.138 (0.00)	0.501 (0.00)	0.00004 (0.68)	0.00011 (0.27)	0.00007 (0.42)	0.00007 (0.45)	-0.00010 (0.22)	0.00008 (0.39)	0.00006 (0.53)	0.00005 (0.68)	0.00020 (0.15)	0.00016 (0.19)	0.00015 (0.18)
FMCG Index	-0.00005 (0.35)	0.042 (0.05)	0.901 (0.00)	0.00010 (0.23)	0.00012 (0.11)	0.00010 (0.26)	0.00002 (0.77)	0.00016 (0.06)	0.00006 (0.46)	0.00013 (0.12)	0.000002 (0.97)	0.00012 (0.12)	0.00008 (0.27)	0.00016 (0.16)

Source: Author’s Calculations

June effect is present in cottonseed, gur, jeera, mustard seed and turmeric. The dummy coefficient of July month is statistical significant for barley, cotton seed and pepper. The August dummy coefficient is statistically significant for Barley, cotton seed, guar gum, guar seed, jeera, mustard seed, and pepper. The September dummy coefficient is statistically significant for guar gum, guar seed, jeera, soy bean, soy oil and pepper. October effect is existed in eight out of sixteen commodities barley, cotton seed, guar gum, guar seed, gur, jeera, rubber and soybean. The dummy coefficient of November is statistically significant for barley, cottonseed, guar gum, guar seed, mustard seed, turmeric soy oil and pepper. The coefficient of December dummy is positive for all commodities. Further the GARCH coefficient describes the impact of one period lagged volatility on the present volatility and ARCH coefficient represents the magnitude of conditional shock on the conditional variance (Narayan & Narayan, 2007). The sum of ARCH and GARCH coefficient should be one as suggested by Bollerslev (1986) which implies the high level of persistence of shocks in the financial markets (Bollerslev, 1988) and it also suggests that shock to return have longer lasting effect. In table 4.3, the GARCH coefficient is significant for all commodities except RBD palm oil, soybean, soya oil and yellow peas suggesting that present volatility is affected by precedent volatility in the commodities as the GARCH coefficient is significant for these commodities. The sum of ARCH and GARCH coefficient is near to 1 for barley, crude palm oil, guar gum, guar seed, gur, RBD palm oil, rubber, soy oil, turmeric, wheat and NSE FMCG INDEX implies that shocks in these commodities are persisted for the longer period of time. If there is new information in the market, it affects the return generated from that market for longer period time. On the other hand sum of ARCH and GARCH coefficient less than one for remaining commodities implies low persistent. The diagnostic test shows the correct specification of GARCH models and absence of ARCH effect in estimated GARCH model. The Ljung Box Q statistics for standard residuals and squared residuals is not statistically significant, indicates the correct specification of GARCH model for all agricultural commodities and FMCG stock index.

4.2 Monthly Seasonality in the energy commodities and Energy Stock Returns and Volatility

As discussed earlier, in the initial stage, Ordinary Least Square Regression is carried out in order to study the monthly seasonality in the agricultural commodities and NSE FMCG index.

Table 4.4: Results of OLS Regression for Energy Commodities and Energy Stock index

Month	Crude oil	Natural Gas	Energy Index
C	-0.0093 (0.17)	-0.0138 (0.123)	0.0047 (0.327)
Jan	0.0004 (0.96)	0.0087 (0.4893)	-0.0040 (0.55)
Feb	0.0249 (0.01)	0.0004 (0.9707)	-0.0104 (0.133)
March	0.0177 (0.07)	0.0122 (0.332)	-0.00061 (0.928)
April	0.0182 (0.06)	0.0204 (0.110)	0.00303 (0.658)
May	0.0115 (0.24)	0.0253 (0.04)	-0.0007 (0.911)
June	0.0146 (0.13)	0.0213 (0.09)	-0.0058 (0.395)
July	0.0029 (0.764)	-0.0002 (0.98)	-0.0003 (0.958)
Aug	0.0100 (0.308)	0.0007 (0.95)	-0.0093 (0.168)
Sept	0.0075 (0.444)	0.0259 (0.04)	0.0017 (0.794)
Oct	0.0052 (0.591)	0.0168 (0.184)	-0.0040 (0.553)
Nov	0.0095(0.336)	0.0260 (0.013)	-0.0080 (0.242)
LM	1.21 (0.18)	1.93 (0.14)	1.26 (0.14)
ARCH	34.14 (0.00)	21.36 (0.00)	102.1 (0.00)

Source: Author's Calculations

The results are presented in the Table 4.4 which reveal that crude oil returns are found to be statistically significant for February, March and April month. Natural gas returns are found to be statistically significant for May, June, September and December. Energy stock index returns are not statistically significant for any of the months. Further Serial Correlation LM test here clearly indicate that in natural gas, crude oil and energy stock index, serial correlation in standard residuals has not been found as the value of F-statistics is not significant. It suggests that it is not required to include autoregressive term in the GARCH model.

Table 4.5: Results of GARCH (1,1) (Mean and Variance) for Energy Commodities and Energy Stock index

	GARCH(1,1) Mean Equation			GARCH(1,1) Variance Equation		
	Crude oil	**Natural Gas**	**Energy Index**	**Crude oil**	**Natural Gas**	**Energy Index**
C	0.0019 (0.74)	-0.013 (0.05)	0.0038 (0.37)	0.0015 (0.20)	0.0016 (0.00)	0.00007 (0.52)
Jan	-0.0057 (0.52)	0.0038 (0.687)	-0.0020 (0.71)	-0.0018 (0.15)	-0.0005 (0.55)	0.000057 (0.72)
Feb	0.01342 (0.06)	0.0006 (0.95)	-0.0072 (0.31)	-0.0009 (0.45)	-0.0006 (0.34)	-0.000015 (0.89)
March	-0.0012 (0.87)	0.0098 (0.35)	-0.0006 (0.90)	-0.0013 (0.28)	-0.0012 (0.04)	0.000038 (0.77)
April	0.00251 (0.77)	0.0191 (0.05)	0.0008 (0.89)	-0.0007 (0.57)	-0.0009 (0.13)	-0.000064 (0.60)
May	-0.0078 (0.30)	0.0190 (0.05)	-0.0045 (0.42)	-0.0014 (0.24)	-0.0007 (0.23)	0.000161 (0.25)
June	0.0021 (0.79)	0.0158 (0.12)	-0.0008 (0.89)	-0.0011 (0.36)	-0.0011 (0.08)	-0.000037 (0.77)
July	-0.0021 (0.80)	0.002 (0.84)	0.00035 (0.95)	-0.0010 (0.39)	-0.0009 (0.13)	0.000026 (0.84)
Aug	-0.0048 (0.56)	0.0038 (0.69)	-0.0055 (0.37)	-0.0013 (0.27)	-0.0010 (0.10)	-0.000074 (0.55)
Sept	-0.0042 (0.60)	0.0201 (0.07)	0.00236 (0.67)	-0.0010 (0.37)	-0.0014 (0.01)	0.000118 (0.43)
Oct	-0.0018 (0.81)	0.0139 (0.11)	0.00293 (0.63)	-0.0011 (0.42)	-0.0006 (0.37)	0.000051 (0.74)
Nov	0.0058 (0.46)	0.0259 (0.00)	-0.0105 (0.09)	-0.00131 (0.22)	-0.0009 (0.13)	0.000000 (0.99)
A	-	-	-	0.239 (0.021)	0.230 (0.00)	0.166 (0.00)
B	-	-	-	0.623 (0.00)	0.568 (0.00)	0.743 (0.00)
LM	-	-	-	0.091 (0.76)	10.64 (0.714)	17.72 (0.22)
ARCH	-	-	-	20.45 (0.11)	0.971 (0.32)	0.568 (0.45)

Source: Author's Calculations

To examine the ARCH effect in the return of energy commodities and stock prices used for analysis, Heteroskedasticity ARCH LM test is carried out which highlights that F-statistics is statistically significant for all the series. It suggests that OLS model is not an efficient model to study the characteristics of financial time series data which includes the problem of heteroskedasticity or dynamic volatility and volatility clustering. Further GARCH model is applied to identify the seasonal patterns in commodity prices. The results presented in Table 4.5 indicate that crude oil returns are positive and statistically significant in the month of February. There is significant April, May, September November and December effect in the natural gas returns. The negative significant November effect has been found in the Energy stock index returns.

Table 4.5 represents the outcomes of seasonality in energy commodities and energy stock index volatility. The results show that there is absence of monthly seasonality in the volatility of crude oil and energy stock index. The volatility of natural gas is high in December followed by March and September.

The sum of ARCH and GARCH coefficient is close to 1 for crude oil, natural gas and energy stock index suggests that shocks that affect current conditional volatility significantly are persisted for longer period of time in these commodities. If there is new information in market, it affects the market return for longer period time. The diagnostic test shows the correct specification of GARCH models and absence of ARCH effect in this model. The Ljung Box Q statistics for standard residuals and squared residuals is not statistically significant, suggesting the correct specification of GARCH model for all energy commodities and energy stock index.

4.3 Monthly Seasonality in the Precious Metal Commodities and NIFTY Stock Returns and Volatility

As discussed earlier, in the initial stage, Ordinary Least Square Regression is carried out in order to study the monthly seasonality in the precious metal commodities and NIFTY index. The results are presented in the Table 4.6 which revealed that gold returns are statistically significant for January, February, August and November month. Silver returns are statistically significant for February. NIFTY index returns are not statistically significant.

Further Breusch- Godfrey Serial Correlation LM test indicate that in gold and silver, serial correlation does not exist in standard residuals as the F-statistics is not statistically significant. It implies that there is no need to include autoregressive term in the GARCH model of these commodities. In order to assess the presence of ARCH effect in series used for analysis, Heteroskedasticity ARCH LM test is carried out which highlights that F-statistics is statistically significant for all the series. It indicates that OLS is not considered as reliable for the data series with the problem of heteroskedasticity or dynamic volatility and volatility clustering. Further GARCH model is applied to avoid the limitations of OLS model.

Table 4.6: Results of OLS Regression for Precious Metal Commodities and NIFTY Stock index

Month	Gold	Silver	NIFTY Index
C	-0.0036 (0.25)	-0.0026 (0.60)	0.0046 (0.28)
Jan	0.0102 (0.02)	0.0100 (0.15)	-0.0051 (0.40)
Feb	0.0106 (0.01)	0.0135 (0.06)	-0.0084 (0.18)
March	-0.0006 (0.88)	0.0020 (0.77)	0.0005 (0092)
April	0.0056 (0.20)	0.0055 (0.44)	0.0010 (0.86)
May	0.0014 (0.75)	-0.0039 (0.58)	0.0012 (0.84)
June	0.0061 (0.16)	0.0008 (0.91)	-0.0059 (0.33)
July	0.0036 (0.42)	0.0044 (0.53)	0.0012 (0.84)
Aug	0.0136 (0.00)	0.0087 (0.22)	-0.0095 (0.12)
Sept	0.0055 (0.21)	0.0032 (0.65)	0.0032 (0.60)
Oct	0.0032 (0.46)	-0.0019 (0.78)	-0.0065 (0.29)
Nov	0.0093 (0.03)	0.0053 (0.46)	-0.0072 (0.24)
LM Statistics	1.24 (0.16)	0.67 (0.50)	4.22 (0.01)
ARCH	16.78 (0.00)	12.54 (0.00)	43.03 (0.00)

Source: Author's Calculations

In the next stage, the two models are considered in order to find out the seasonality in the mean return and volatility. First model is GARCH (1,1) specification by incorporating monthly dummies in the mean return. Secondly in order to model conditional variability of commodities and stock index returns, the monthly effect is incorporated into the model by taking monthly dummies as exogenous variables

Table 4.7: Results of GARCH (1,1) (Mean and Variance) for Precious Metal Commodities and NIFTY Stock index

	GARCH(1,1) Mean Equation			GARCH(1,1) Variance Equation		
	Gold	**Silver**	**NIFTY**	**Gold**	**Silver**	**NIFTY**
C	-0.0044 (0.13)	-0.0038 (0.37)	0.0030 (0.36)	0.00002 (0.41)	-0.000056 (0.45)	-0.00003 (0.32)
Jan	0.0082 (0.04)	0.0120 (0.05)	-0.0014 (0.75)	0.000023 (0.59)	0.00008 (0.49)	0.00008 (0.25)
Feb	0.0105 (0.01)	0.0133 (0.03)	-0.0040 (0.40)	0.000064 (0.07)	0.00021 (0.03)	0.00009 (0.12)
March	0.0005 (0.89)	0.0008 (0.89)	0.0018 (0.67)	0.000034 (0.34)	-0.00002 (0.81)	0.00003 (0.65)
April	0.0091 (0.02)	0.0045 (0.45)	0.0004 (0.93)	0.000101 (0.01)	0.00037 (0.00)	0.00001 (0.81)
May	0.0013 (0.73)	-0.0011 (0.86)	0.0012 (0.79)	-0.000002 (0.95)	-0.00003 (0.75)	0.00009 (0.13)
June	0.0068 (0.11)	0.0028 (0.65)	-0.0017 (0.74)	0.000009 (0.78)	0.00011 (0.28)	0.000022 (0.96)
July	0.0026 (0.51)	0.0038 (0.55)	0.0032 (0.51)	0.000076 (0.04)	-0.00001 (0.92)	0.00007 (0.24)
Aug	0.0124 (0.00)	0.0088 (0.15)	-0.0081 (0.06)	0.000062 (0.15)	0.00049 (0.00)	0.00008 (0.23)
Sept	0.0066 (0.10)	0.0082 (0.17)	0.0033 (0.41)	-0.000006 (0.85)	-0.00003 (0.73)	0.00004 (0.61)
Oct	0.0052 (0.18)	0.0013 (0.82)	0.0028 (0.58)	0.000096 (0.01)	0.00016 (0.15)	0.00007 (0.26)
Nov	0.0086 (0.02)	0.0060 (0.32)	-0.0060 (0.21)	0.000037 (0.54)	0.00016 (0.33)	0.00005 (0.57)
α	-	-	-	0.078 (0.00)	0.079 (0.00)	0.083 (0.00)
β	-	-	-	0.878 (0.00)	0.867 (0.00)	0.898 (0.00)
LM	-	-	-	11.53 (0.64)	16.61 (0.27)	9.23 (0.60)
ARCH	-	-	-	0.007 (0.93)	0.81 (0.36)	0.146 (0.70)

Source: Author’s Calculations

Table 4.7 summarizes the results obtained by estimating the GARCH (1,1) models for return and volatility separately. It indicates that gold returns are found to be positive in January, February, April, August and November. Silver returns are positive and statistically significant for January and February. NIFTY stock index returns are not significant. Table 4.7 clearly represents the results of monthly seasonality in precious metal commodities and NIFTY stock index volatility. The results show that there is absence of seasonal effects in the volatility of NIFTY stock index. The volatility in the gold returns is positive in the month of February, April, July and October. The volatility in the silver is significantly positive for February, April and August.

The sum of ARCH and GARCH coefficient is close to 1 for gold, silver and NIFTY stock index suggests that shocks that affect current conditional volatility significantly are persisted in these commodities for longer period of time. If there is new information in market, it will have implication on return for longer period time. The diagnostic test shows the correct specification of GARCH models and absence of ARCH effect in this model. The standard residuals and squared residuals are not statistically significant, suggesting that there is correct specification of GARCH model for all precious metal commodities and stock index.

4.4 Monthly Seasonality in the Base Metal Commodities and Base Metal Stock Returns and Volatility

As discussed earlier, Ordinary Least Square Regression is carried out in the preliminary stage in order to study the monthly seasonality in the base metal commodities and base metal index. The results are presented in the Table 4.8 which reveal that monthly seasonality is statistically significant only for base metal stock index. Base metal stock index returns are statistically significant in the months of February, June, August, October, November and December. Further Breusch-Godfrey Serial Correlation LM test here clearly indicate that in all metal commodities and base metal stock index except copper, there is absence of serial correlation in standard residuals as the F-statistics is not statistically significant. It implies that there is no need to include autoregressive term in the GARCH model of these commodities.

Table 4.8: Results of OLS Regression for Base Metal Commodities and Base Metal Index

Momth	Aluminum	Copper	Lead	Nickel	Zinc	Metal Index
C	0.00008 (0.98)	0.00248 (0.63)	-0.00506 (0.47)	0.00041 (0.95)	0.00422 (0.47)	0.01189 (0.08)
January	0.00003 (0.99)	-0.00125 (0.86)	0.01303 (0.19)	0.00767 (045)	-0.00851 (0.31)	-0.01495 (0.12)
February	0.00531 (0.41)	0.00690 (0.36)	0.00676 (0.51)	0.00322 (0.76)	0.00192 (0.82)	-0.01692 (0.09)
March	-0.00264 (0.67)	0.00264 (0.72)	0.00389 (0.69)	-0.00105 (0.91)	-0.00908 (0.28)	-0.00696 (0.46)
April	0.00464 (0.46)	-0.00231 (0.75)	0.00942 (0.35)	0.00676 (0.51)	0.00009 (0.99)	-0.00313 (0.75)
May	-0.00589 (0.35)	-0.00448 (0.54)	-0.00605 (0.54)	-0.01027 (0.32)	-0.00878 (0.30)	-0.00553 (0.57)
June	0.00259 (0.68)	0.00170 (0.81)	0.01148 (0.25)	-0.00681 (0.51)	-0.00320 (0.70)	-0.01796 (0.06)
July	0.00309 (0.62)	0.00082 (0.91)	0.01600 (0.11)	-0.00223 (0.82)	0.00277 (0.74)	-0.00835 (0.39)
August	0.00263 (0.67)	0.00219 (0.76)	0.01545 (0.12)	0.00394 (0.70)	-0.00067 (0.93)	-0.01771 (0.07)
September	-0.00135 (0.83)	-0.00606 (0.41)	0.00964 (0.33)	-0.00522 (0.61)	-0.00335 (0.69)	-0.00587 (0.54)
October	-0.00467 (0.45)	-0.01075 (0.14)	-0.00654 (0.51)	-0.01206 (0.24)	-0.01373 (0.10)	-0.01627 (0.09)
November	-0.00036 (0.95)	-0.00529 (0.48)	0.00374 (0.71)	-0.00256 (0.80)	-0.00406 (0.63)	-0.01797 (0.07)
LM	0.028 (0.97)	3.56 (0.02)	1.77 (0.17)	1.73 (0.17)	0.177 (0.83)	7.408 (0.00)
ARCH	7.64 (0.00)	4.49 (0.03)	40.90 (0.00)	15.72 (0.00)	13.40 (0.00)	60.48 (0.00)

Source: Author's Calculations

Table 4.9: Results of GARCH (1,1) for Base Metal Commodities and Metal Stock index (Mean Equation)

	Aluminum	Copper	Lead	Nickel	Zinc	Metal Index
C	0.0001 (0.98)	0.0075 (0.17)	0.0004 (0.92)	0.0022 (0.64)	0.0063 (0.21)	-0.0046 (0.33)
Jan	0.00003 (0.99)	-0.0101 (0.15)	0.0002 (0.97)	-0.0001 (0.98)	-0.0080 (0.23)	-0.0062 (0.27)
Feb	0.0053 (0.40)	-0.0031 (0.66)	-0.0039 (0.58)	-0.0022 (0.79)	-0.0018 (0.80)	-0.0016 (0.79)
March	-0.0026 (0.67)	-0.0087 (0.28)	-0.0044 (0.54)	-0.0072 (0.36)	-0.0158 (0.04)	0.0053 (0.23)
April	0.0046 (0.44)	-0.0104 (0.15)	0.0075 (0.25)	0.0034 (0.65)	-0.0007 (0.93)	-0.0052 (0.33)
May	-0.0059 (0.38)	-0.0074 (0.34)	-0.0100 (0.15)	-0.0102 (0.24)	-0.0097 (0.15)	-0.0052 (0.21)
June	0.0026 (0.67)	-0.0046 (0.52)	0.0043 (0.53)	-0.0063 (0.36)	-0.0012 (0.85)	0.0064 (0.27)
July	0.0031 (0.63)	-0.0037 (0.60)	0.0066 (0.35)	-0.0017 (0.81)	0.0009 (0.89)	-0.0046 (0.48)
Aug	0.0026 (0.67)	-0.0030 (0.68)	0.0091 (0.17)	0.0020 (0.78)	0.0013 (0.86)	0.0073 (0.26)
Sept	-0.0013 (0.83)	-0.0122 (0.07)	0.0010 (0.89)	-0.0071 (0.44)	-0.0080 (0.24)	0.0094 (0.09)
Oct	-0.0047 (0.44)	-0.0071 (0.37)	-0.0061 (0.34)	-0.0062 (0.42)	-0.0108 (0.11)	-0.0052 (0.30)
Nov	-0.0004 (0.96)	-0.0079 (0.30)	0.0031 (0.64)	-0.0035 (0.66)	-0.0029 (0.69)	0.0108 (0.04)

Source: Author’s Calculations

To assess the existence of ARCH effect in data sets used for analysis, Heteroskedasticity ARCH LM test is carried out which highlights that F-statistics is statistically significant for all the series. It suggests that OLS is considered as an inadequate model to understand the concept of seasonality by taking into consideration the important assumptions of financial time series data such as problem of heteroskedasticity or time varying volatility and volatility clustering that cannot be ignored while computing the results. Further GARCH model is used to study the concept of monthly seasonality by taking into account the limitations of traditional models.

In the next stage, the two models are considered in order to find out the seasonality in the mean return and volatility. First model is GARCH (1,1) specification by incorporating monthly dummies in the mean return. Secondly in order to model conditional variability of commodities and stock index returns, the monthly effect is incorporated into the model by taking monthly dummies as exogenous variables. Table 4.9 and 4.10 summarizes the results obtained by estimating the GARCH (1,1) models for return and volatility respectively. It indicates that there is presence of seasonality effect in return in two out of five commodities. Copper returns are negative in September. Zinc returns are found to be negative in the month of March. Base metal stock index returns are found to be statistically significant in the month of September and November.

Table 4.10 clearly represents the results of monthly seasonality in base metal commodities and base metal stock index volatility. The results show that there is absence of monthly seasonality in the volatility of Nickel, Zinc and base metal stock index. The volatility in the aluminum returns is found to be positive and statistically significant in the month of April. The volatility in the copper is found to be positive and statistically significant for January and April. The volatility in the lead return is found to be negative and statistically significant in the months of August and October. The sum of ARCH and GARCH coefficient is close to 1 for base metal commodities and base metal stock index implies that shocks to conditional variance will be highly persistent for these commodities. If there is new information in new price shock, it will have implication on return for longer period time.

Table 4.10: Results of GARCH (1,1) for Base Metal Commodities and Metal Stock index (Variance Equation)

	Aluminum	Copper	Lead	Nickel	Zinc	Metal Index
C	-0.00003 (0.55)	-0.000074 (0.20)	0.00015 (0.01)	0.0019 (0.97)	-0.00012 (0.26)	-0.000009 (0.95)
Jan	0.000104 (0.21)	0.000319 (0.00)	-0.00020 (0.22)	-0.00167 (0.98)	0.00029 (0.14)	0.00009 (0.73)
Feb	0.000126 (0.06)	0.000119 (0.30)	-0.00001 (0.96)	-0.00127 (0.98)	0.00007 (0.71)	0.00017 (0.55)
March	-0.000073 (0.23)	-0.000048 (0.70)	-0.00028 (0.13)	-0.00115 (0.98)	0.00003 (0.89)	-0.00008 (0.73)
April	0.000241 (0.01)	0.000243 (0.04)	-0.00007 (0.65)	-0.00149 (0.98)	0.00014 (0.38)	0.00005 (0.82)
May	0.000038 (0.67)	-0.000102 (0.29)	-0.00020 (0.11)	-0.00047 (0.99)	0.00023 (0.13)	-0.00009 (0.65)
June	-0.000037 (0.63)	0.000142 (0.17)	-0.00020 (0.12)	-0.00211 (0.96))	0.00001 (0.96)	0.00013 (0.51)
July	0.000114 (0.13)	0.000174 (0.11)	-0.00003 (0.67)	-0.00127 (0.98)	0.00017 (0.23)	0.00019 (0.41)
Aug	0.000150 (0.20)	0.000007 (0.95)	-0.00031 (0.02)	-0.00157 (0.97)	0.00010 (0.46)	0.00021 (0.46)
Sept	0.000034 (0.74)	0.000220 (0.03)	0.00012 (0.26)	-0.00093 (0.98)	0.00027 (0.14)	-0.00009 (0.73)
Oct	0.000055 (0.53)	-0.000015 (0.85)	-0.00031 (0.00)	-0.00159 (0.97)	0.00002 (0.89)	0.00003 (0.91)
Nov	0.000063 (0.58)	0.000119 (0.42)	-0.00015 (0.21)	-0.00124 (0.98)	0.00021 (0.33)	0.00012 (0.72)
A	0.084 (0.03)	0.066 (0.00)	0.067 (0.00)	0.047 (0.02)	0.019 (0.01)	0.105 (0.00)
B	0.882 (0.00)	0.914 (0.00)	0.926 (0.00)	0.944 (0.00)	0.972 (0.00)	0.877 (0.00)
LM	8.75 (0.89)		12.74 (0.62)	7.99 (0.92)	8.10 (0.92)	
ARCH	0.005 (0.94)		2.04 (0.15)	0.76 (0.38)	0.00009 (0.97)	

Source: Author’s calculations

The diagnostic test shows that the GARCH models have fit appropriately and there is no remaining ARCH effect in estimated GARCH model. The standard residuals and squared residuals are insignificant, suggesting that all the GARCH models are correctly specified.

The results discussed above indicate that the seasonal effects are not similar in commodities and their related stock indices; it implies that both stock market and commodity market are not co-integrated. These markets are informational inefficient. Therefore, investors can take position in both the markets to earn abnormal returns.

CHAPTER 5
CO-INTEGRATION AND CAUSALITY BETWEEN COMMODITY MARKET AND STOCK MARKET

5.1 Co-integration test

If two or more than two series are independently non-stationary but their linear combination is stationary at same order of integration. Then both series are said to be co-integrated (Ahmed et al., 2017). Although all the time series included in the co-integration model follow some stochastic trend individually, it is possible that they share some common stochastic trend in the long run (Pan et al., 2007; Lehecka, 2014). A non-stationary series by definition tends to drift too apart but a linear combination of non stationary series has the property to keep them together. Under these circumstances, the two variables are said to be co-integrated (Maghyereh and Kandari, 2007). If both the markets are not co-integrated at the same order or causality is not found in both the directions, then it means both the markets are independent of each other and secondly if the causality runs from one market to other then it means the second market is informational efficient. If causality runs in both the directions and even the markets are co-integrated then it would be beneficial for the policy makers to take quick action against the shock in a market as it quickly reflects in the other market due to the common stochastic trend followed by both the markets (Reddy and Sebastin, 2009). If both the markets are not co-integrated, investors can hedge against the risk by diversifying their portfolio (Reddy and Sebastin, 2009; Yamori, 2010; Dutta, 2017).

5.1.1 Co-integration between Agricultural Commodities and FMCG Stock Index

To study the long run relationship between agricultural commodities and FMCG stock prices, Johansen Co-integration test has been applied. Both the series should be non stationary at level. In order to identify the order of integration, Augmented Dickey Fuller (ADF) test has been employed. Table 5.1 represents the unit root test results for Agricultural Commodities and NSE FMCG Index. It has been verified that all the series are non stationary at level except guar gum and guar seed, which validates the preliminary condition for co-integration. Then, the series are differenced and the property of unit root has been tested again. All the series are found to be stationary.

Table 5.1: Results of Augmented Dickey Fuller Test for Agricultural Commodities and NSE FMCG Index

Variables	Level		First Difference	
	t-statistics	Probability	t-statistics	Probability
Barley	--3.238846	0.7790	-18.55199	0.0000
Cotton Seed	-1.880784	0.3414	-18.14378	0.0000
Crude Palm Oil	-2.428424	0.1343	-18.10402	0.0000
Guar Gum	-1.861588	0.0598	-16.36367	0.0000
Guar Seed	-1.929598	0.0514	-17.60355	0.0000
Gur	-2.163152	0.2203	-14.41631	0.0000
Jeera	-2.794771	0.1998	-17.08799	0.0000
Mustard Seed	-1.154905	0.6952	-22.65227	0.0000
Pepper	-1.199627	0.6762	-13.08413	0.0000
RBD Palm Oil	-2.511512	0.1132	-18.40271	0.0000
Rubber	-1.941752	0.3130	-13.52955	0.0000
Soya Oil	-2.000974	0.2865	-20.87938	0.0000
Soy Bean	-2.227381	0.1968	-18.60497	0.0000
Turmeric	-1.964288	0.3028	-16.14210	0.0000
Wheat	-1.390162	0.5880	-21.21297	0.0000
Yellow Peas	-2.038413	0.2704	-20.18628	0.0000
NSE FMCG Index	0.320178	0.9792	-24.09633	0.0000

Source: Author's Calculations

Furthermore, the optimal lag length of the variables under study has been selected by using Vector Auto Regressive (VAR) lag order selection model as shown in table 5.2, in order to capture the most reliable representation for co-integration model (Kisswani and Elien, 2017).

Once the appropriate lag length has been selected for sixteen pairs, the study has been proceeded further with the appropriate Co-integration Model. Johansen co-integration test has been applied for all the pairs except guar gum and guar seed. For guar gum and guar seed, ARDL Bound test need to be applied as the order of integration is not same with respect to the integration order of FMCG stock index return

Table 5.2: **Optimal Lag Length for Pairs of Individual Agricultural Commodities and NSE FMCG Index**

Pairs of Variables	Optimal Lag Length
Barley-NSE FMCG	5
Cotton Seed- NSE FMCG	5
Crude Palm Oil- NSE FMCG	5
Guar Gum- NSE FMCG	5
Guar Seed-NSE FMCG	1
Gur-NSE FMCG	5
Jeera-NSE FMCG	5
Mustard Seed-NSE FMCG	1
Pepper-NSE FMCG	5
RBD Palm Oil-NSE FMCG	6
Rubber-NSE FMCG	5
Soya Oil-NSE FMCG	2
Soy Bean-NSE FMCG	2
Turmeric-NSE FMCG	2
Wheat-NSE FMCG	5
Yellow Peas-NSE FMCG	2

Source: Author's Calculations

To achieve this objective, Johansen's Co-integration test has been applied and the results are shown in the table 5.3. Johansen Co-integration model consists of two tests namely trace and maximum eigenvalue test. The results show that long run co-integrating relationship does not exist between agricultural commodities and FMCG Stock index. For guar gum and guar seed-FMCG stock index pairs, the results of ARDL Bound test presented in Table 5.4 indicates the absence of long run relationship between guar gum, guar seed and FMCG stock index as the F statistics is less than the lower bound value.

Table 5.3: Johansen Co-integration Test Results for Agricultural Commodities and FMCG Stock Index

Variables		Trace Statistics		Maximum Eigenvalue	
	No. of CEs	Trace Stat	p-value	Eigen Stat	p-value
Barley-NSE FMCG	None	13.04486	0.1132	13.01030	0.0781
	At most 1	0.034555	0.8525	0.034555	0.8525
Cotton Seed- NSE FMCG	None	9.530521	0.3186	9.423894	0.2526
	At most 1	0.106627	0.7440	0.106627	0.7440
Crude Palm Oil- NSE FMCG	None	8.547737	0.4088	8.048908	0.3738
	At most 1	0.498830	0.4800	0.498830	0.4800
Guar Gum- NSE FMCG	None	2.120872	0.4312	2.751571	0.2721
	At most 1	0.369307	0.5434	0.369307	0.5434
Guar Seed-NSE FMCG	None	2.561527	0.5121	2.468491	0.3210
	At most 1	0.093032	0.7603	0.093032	0.7603
Gur-NSE FMCG	None	11.01496	0.2106	10.85125	0.1618
	At most 1	0.163712	0.6858	0.163712	0.6858
Jeera-NSE FMCG	None	10.65486	0.2336	10.12736	0.2037
	At most 1	0.527505	0.4677	0.527505	0.4677
Mustard Seed-NSE FMCG	None	4.398010	0.8689	4.334833	0.8224
	At most 1	0.063177	0.8015	0.063177	0.8015
Pepper-NSE FMCG	None	3.021561	0.9659	2.955088	0.9497
	At most 1	0.066473	0.7965	0.066473	0.7965
RBD Palm Oil-NSE FMCG	None	8.564157	0.4072	8.165189	0.3622
	At most 1	0.398968	0.5276	0.398968	0.5276
Rubber-NSE FMCG	None	5.622708	0.7396	5.622154	0.6620
	At most 1	0.000554	0.9831	0.000554	0.9831
Soya Oil-NSE FMCG	None	6.550054	0.6305	6.418084	0.5602
	At most 1	0.131970	0.7164	0.131970	0.7164
Soy Bean-NSE FMCG	None	8.268912	0.4371	8.261308	0.3528
	At most 1	0.007604	0.9301	0.007604	0.9301
Turmeric-NSE FMCG	None	4.073205	0.8975	3.893404	0.8704
	At most 1	0.179800	0.6715	0.179800	0.6715
Wheat-NSE FMCG	None	15.68138	0.0469	15.26907	0.0346
	At most 1	0.412309	0.5208	0.412309	0.5208
Yellow Peas-NSE FMCG	None	8.302252	0.4337	8.226393	0.3562
	At most 1	0.075859	0.7830	0.075859	0.7830

Source: Author's Calculations

Table 5.4 Results of ARDL Bound Test for Guar Gum and Guar Seed-FMCG Stock Index Return

Variables	F-statistics	Lower Bound	Upper Bound
Guar Gum- NSE FMCG	2.53	3.62	4.16
Guar Seed-NSE FMCG	2.50	3.62	4.16

Source: Author's Calculations

These results are somewhat consistent with Lehecka (2014), who investigates the co-integration between food price index and stock index and the results shows weak indication of co-movement among these variables.

5.1.2 Co-integration between Energy Commodities and NSE Energy Index

As discussed earlier, before applying Johansen co-integration test, Augmented Dickey Fuller test has been employed in order to check the order of integration. The null hypothesis of ADF test is that the series has a unit root.

Table 5.5: Results of Augmented Dickey Fuller Test for Energy Commodities and NSE Energy Index

Variables	Level		First Difference	
	t-statistics	Probability	t-statistics	Probability
Crude Oil	-1.992833	0.2901	-22.26091	0.0000
Natural Gas	-2.470760	0.1232	-24.46685	0.0000
NSE Energy	-0.993093	0.7572	-23.59602	0.0000

Source: Author's Calculations

Table 5.5 represents the result of unit root test for energy commodities and NSE Energy index. It has been clearly stated that the null hypothesis that crude oil, natural gas and NSE energy index has unit root, is accepted while it has been rejected at 1% level of significance for first differenced series. Further the optimal lag length for the series under study has been calculated by using Vector Autoregressive Model (Table 5.6).

Table 5.6: **Optimal Lag Length for Pairs of Individual Energy Commodities and NSE Energy Index**

Pairs of Variables	Optimal Lag Length
Crude Oil-NSE Energy	1
Natural Gas- NSE Energy	1

Source: Author's Calculations

Since the variables are unit root at level, now Johansen Co-integration Test has been conducted to find out whether the variables under study followed any kind of common stochastic trend. Both the eigenvalue and trace statistics represented in Table 5.7 clearly indicates that there is no co-integration among the variables under study. It means crude oil -NSE energy index as well as natural gas -NSE energy index pairs do not follow common trends in the long run. Ghosh and Kanjilal (2016) draw similar findings by examining the co-integration between the crude oil prices and stock prices by using Rank Co-integration Method. The results are similar with the studies suggesting absence of co-integration between energy commodities and stock market (Hammoudeh and Aliesa, 2004; Maghyereh and Kandhari, 2007; Apergis and Miller, 2009; Le and Chang, 2015).

Table 5.7: Johansen Co-integration Test Results for Energy Commodities and NSE Energy Index

Variables		Trace Statistics		Maximum Eigenvalue	
	No. of CEs	Trace Stat	p-value	Eigen Stat	p-value
Crude Oil-NSE Energy	None	7.961393	0.4695	6.704051	0.5247
	At most 1	1.257341	0.2622	1.257341	0.2622
Natural Gas- NSE Energy	None	10.45282	0.2475	8.300667	0.3489
	At most 1	2.152156	0.1424	2.152156	0.1424

Source: Author's Calculations

5.1.3 Co-integration between Precious Metals and NSE Index

In the beginning, it is required to apply unit root test on time series data to find out the suitable techniques to study the co-integration among the variables in order to avoid spurious results.

Table 5.8: Results of Augmented Dickey Fuller Test for Precious Metals and NSE Index

Variables	Level		First Difference	
	t-statistics	Probability	t-statistics	Probability
Gold	-1.634099	0.4644	-20.84023	0.0000
Silver	-1.800112	0.3805	-21.70420	0.0000
NSE Index	-2.045709	0.5744	-23.48238	0.0000

Source: Author's Calculations

Here, the Augmented Dickey Fuller (ADF) test has been employed to check the property of stationarity in each time series in order to find out the order of integration. The results of ADF test has been presented in Table 5.8 which clearly indicate that NSE stock index, gold and silver are non stationary at level and stationary at first difference. Therefore, the pre-condition to apply Johansen Co-integration has been fulfilled and the study has been proceeded further to decide the optimal lag length to examine the long run relationship among the variables.

The appropriate lag length has been selected on the basis of Akaike Information Criteria (AIC). AIC is considered to be superior to other information criteria (Mishra, 2014). The optimal lag length selected for Gold and NSE index is k= 1 and for silver and NSE index is k= 2 (Table 5.9).

Table 5.9: **Optimal Lag Length for Pairs of Individual Precious Metals and NSE Index**

Pairs of Variables	Lag Length
Gold-NSE Index	2
Silver- NSE Index	1

Source: Author's Calculations

Table 5.10: Johansen Co-integration Test Results for Energy Commodities and NSE Energy Index

Variables		Trace Statistics		Maximum Eigenvalue	
	No. of CEs	Trace Stat	p-value	Eigen Stat	p-value
Gold-NSE Index	None	4.591301	0.8506	3.736398	0.8861
	At most 1	0.854903	0.3552	0.854903	0.3552
Silver- NSE Index	None	3.546606	0.9366	3.545424	0.9040
	At most 1	0.001182	0.9718	0.001182	0.9718

Source: Author's Calculations

In the next step, Johansen Co-integration Test has been applied. Maximum eigenvalue and trace statistics results are shown in Table 5.10. It indicate that long run co-integration relationship does not exist among Precious Metals and NSE index. The results are highly consistent with Kaliyamoorthy and Parithi (2012), Srinivasan (2014) and Bhuvaneshwari and Ramya (2017). It can be clear from the existing literature that co-integration between the gold and stock market has been inconclusive, especially in the context of Indian economy.

5.1.4 Co-integration between Industrial Metals and NSE Metal Index

Firstly ADF test has been applied in order to study the presence of unit root among the variables.

Table 5.11: Results of Augmented Dickey Fuller Test for Industrial Metals and NSE Metal Index

Variables	Level		First Difference	
	t-statistics	Probability	t-statistics	Probability
Aluminum	-2.960307	0.1445	-24.06894	0.0000
Copper	-2.103801	0.2434	-24.79893	0.0000
Lead	-2.463485	0.1251	-25.45794	0.0000
Nickel	-2.551256	0.1040	-25.66451	0.0000
Zinc	-0.997861	0.7555	-23.47789	0.0000
NSE Metal Index	-2.234524	0.1943	-14.05651	0.0000

Source: Author's Calculations

The results are given in Table 5.11, clearly indicates that all the variables i.e., aluminum, copper, lead, nickel, zinc and NSE metal index are non-stationary at level. All the series are integrated at order I(1). These results satisfy pre-condition for applying Johansen Co-integration Test.

Table 5.12: **Optimal Lag Length for Pairs of Individual Industrial Metals and NSE Metal Index**

Pairs of Variables	Optimal Lag Length
Aluminum-NSE Metal	1
Copper- NSE Metal	3
Lead- NSE Metal	3
Nickel- NSE Metal	4
Zinc-NSE Metal	3

Source: Author's Calculations

Then, the lag length for each pair of the metal commodities and NSE metal index has been selected by using VAR lag length selection criteria. The results presented in Table 5.12, indicate k=1 lag for aluminum-metal index, k=3 for copper- metal index, lead-metal index and Zinc-metal index and k=4 for nickel-metal index.

Table 5.13: Johansen Co-integration Test Results for Industrial Metals and NSE Metal Index

Variables		Trace Statistics		Maximum Eigenvalue	
	No. of CEs	**Trace Stat**	**p-value**	**Eigen Stat**	**p-value**
Aluminum-NSE Metal	None	19.37377	0.1239	10.80296	0.1640
	At most 1	8.570810	0.3498	8.570810	0.3498
Copper- NSE Metal	None	11.82471	0.1655	6.680949	0.5275
	At most 1	5.143759	0.2331	5.143759	0.2331
Lead- NSE Metal	None	12.48138	0.1353	14.26460	0.4942
	At most 1	5.524245	0.1870	3.841466	0.1870
Nickel- NSE Metal	None	19.34385	0.1251	14.09897	0.5310
	At most 1	5.244882	0.2201	5.244882	0.2201
Zinc-NSE Metal	None	6.412427	0.6468	5.441082	0.6854
	At most 1	0.971345	0.3243	0.971345	0.3243

Source: Author's Calculations

The study has been proceeded further to explore the linkage between the metal commodities and stock market by testing co-integration among them. The results are presented in Table 5.13 Maximum Eigenvalues and Trace statistics clearly indicates the absence of co-integration relationship between Aluminum-metal index, copper-metal index, lead-metal index, nickel-metal index and zinc-metal index. The results of presence of co-integration between metal commodities and base metal stock index is consistent with the results of Cheviallier and Leepo (2014) and result indicating absence of co-integration between both is highly consistent with Hammoudeh et al. (2014).

5.2 Causal Relationship

Granger causality test examines whether the one period lagged value of time series improve the predictability of current and future value of other time series (Ciner, 2001). The first part of the analysis is based on VAR model to find out whether lag of one variable help explaining the present values of another variable (Granger, 1969). In case of two variables $\{X_t, Y_t)$ strictly follow stationary bivariate process, the variable $\{Y_t\}$ is granger caused by $\{X_t\}$, if past values of variable $\{X_t\}$ contains information about the future values of variable $\{Y_t\}$ that is not contained only in the past values of variable $\{Y_t\}$ (Jain and Ghosh, 2013; Kang et al., 2013; Lehecka, 2014; Shiva and Sethi, 2015; Coronado et al., 2016; Kisswani and Elin, 2017). There appears to be close association between the prices of two financial markets, but there is no consensus on direction of influence (Coronado et al., 2016). The granger causality test is taking into account the concept of predictability while estimating the direction of influence among the variables. This test describes the lead and lagged relationship between the variables (Kang et al., 2013; Lehecka, 2014). It is required to estimate the causal relationship between stock market and commodity market further to find out the direction of relationship between them (Hammoudeh and Aliesa, 2004). In this study, Toda Yamamoto approach of granger causality test introduced by Toda and Yamamoto (1995), has been applied in order to identify causal relationship between the variables. Toda and Yamamoto approach for granger non-causality is preferred over traditional methods due to certain reasons. First this method is valid regardless of the order of integration and existence of co-integration at any arbitrary order.

Secondly, it lessen the preconceptions allied with co-integration and unit root test as this method does not required to pre-test co-integration properties. TY method is preferred over general VAR modeling where the long run information is often sacrificed due to the mandatory process of first differencing and pre-whitening. To deal with these problems, TY proposed augmented level VAR modeling (Toda and Yamamoto, 1995; Jain and Ghosh, 2013; Ghosh and Kanjilal, 2016; Lehecka, 2014; Mishra, 2014; Dutta, 2017).

5.2.1 Causal Relationship between Agricultural Commodities and NSE FMCG

In order to find out the causal relationship between the agricultural commodities and NSE FMCG index, Toda and Yamamoto (1995) method of Granger Non-causality Test has been applied. As discussed earlier, before applying further tests, it is required to examine the order of integration for each variable used in this study. The result of augmented dickey Fuller (ADF) test has been shown in Table 5.1. The results suggest I(1) order of integration for each agricultural commodity as well as stock market index.

The analysis of Toda and Yamamoto Granger Non-Causality Test begins with the estimation of Vector Autoregressive (VAR) model by using weekly closing price of individual agricultural commodities and NSE FMCG stock index. Akaike Information Criteria (AIC) is used to select the lag length. The results are already presented in Table 5.2. The augmented VAR of order p= K (lag length) + d_{max} (maximum order of integration of variables) is selected in the further step. The null hypothesis for this test is that there is no granger causality. Therefore any rejection of null hypothesis implies the possible existence of granger causality between the variables tested. The results of Toda Yamamoto Granger Causality test are reported in Table 5.14. The results suggest that the null hypothesis of no granger causality from agricultural commodities to NSE FMCG index has been rejected at 5% level of significance for three out of sixteen commodities and null hypothesis of no granger causality from NSE FMCG index to agricultural commodities has been rejected for two commodities while in case of remaining twelve commodities, the null hypothesis of no granger causality has been accepted for both the directions. In summary, with the exceptions of barley, cottonseed, jeera, mustardseed and wheat, granger causality test could not find much causal relationship between the agricultural commodities and NSE FMCG index.

Table 5.14: Toda and Yamamoto Granger Causality Test Results for Agricultural Commodities and NSE FMCG Index

Independent Variable	Dependent Variable	Chi-Square	df	Prob.
NSE FMCG Index	Barley	12.05482	5	0.0340
Barley	NSE FMCG Index	7.591713	5	0.1802
NSE FMCG Index	Cottonseed	2.392857	5	0.7925
Cottonseed	NSE FMCG Index	17.63655	5	0.0034
NSE FMCG Index	Crude Palm Oil	3.429435	5	0.6341
Crude Palm Oil	NSE FMCG Index	5.899869	5	0.3161
NSE FMCG Index	Guar Gum	0.675993	5	0.9843
Guar Gum	NSE FMCG Index	3.733533	5	0.5884
NSE FMCG Index	Guar seed	0.095372	1	0.7575
Guar seed	NSE FMCG Index	0.110689	1	0.7394
NSE FMCG Index	Gur	4.213284	5	0.5191
Gur	NSE FMCG Index	4.576662	5	0.4697
NSE FMCG Index	Jeera	6.910360	5	0.2274
Jeera	NSE FMCG Index	12.37848	5	0.0300
NSE FMCG Index	Mustard Seed	0.268548	1	0.6043
Mustard Seed	NSE FMCG Index	4.754375	1	0.0292
NSE FMCG Index	Pepper	6.030947	5	0.3032
Pepper	NSE FMCG Index	1.769598	5	0.8800
NSE FMCG Index	RBD Palm Oil	7.838537	6	0.2502
RBD Palm Oil	NSE FMCG Index	5.537165	6	0.4770
NSE FMCG Index	Rubber	2.494602	5	0.7773
Rubber	NSE FMCG Index	5.577055	5	0.3496
NSE FMCG Index	Soya Oil	0.202496	2	0.9037
Soya Oil	NSE FMCG Index	0.133971	2	0.9352
NSE FMCG Index	Soy Bean	2.862677	2	0.2390
Soy Bean	NSE FMCG Index	0.219723	2	0.8960
NSE FMCG Index	Turmeric	0.918272	2	0.6318
Turmeric	NSE FMCG Index	2.332437	2	0.3115
NSE FMCG Index	Wheat	12.19648	6	0.0577
Wheat	NSE FMCG Index	3.234238	6	0.7789
NSE FMCG Index	Yellow Peas	0.222711	2	0.8946
Yellow Peas	NSE FMCG Index	1.079917	2	0.5828

Source: Author's Calculations

Johnson and Soenon (2014) support the findings related to the existence of lead lag relationship between agricultural commodities index and stock market index. The results of unidirectional relationship between commodity market and stock market are similar with the findings of Nirmala and Deepthy (2013). On the contrary, Lehecka (2014) contradicts the results of this study and found bi-directional causal relationship between food market and stock market.

5.2.2 Causal Relationship between Energy Commodities and NSE Energy Index

Toda and Yamamoto method of Granger causality has been applied in this study in order to find out the causal relationship between the energy commodities (Crude oil and natural gas) and NSE Energy index. Before applying this test, it is required to reveal the order of integration for each variable under study. For this purpose, ADF test of unit root is applied. The results presented in table 5.5 clearly indicates I(1) order of integration for each of the variable.

Further in order to determine the optimal lag length of the pairs of energy commodities and energy stock index, AIC criteria under VAR system has been used. The results presented in table 5.6 suggest k=1 for both crude oil-NSE energy and natural gas and NSE energy.

Table 5.15: Toda and Yamamoto Granger Causality Test Results for Energy Commodities and NSE Energy Index

Independent Variable	Dependent Variable	Chi-Square	df	Prob.
NSE Energy Index	Crude Oil	2.00E-05	1	0.9964
Crude Oil	NSE Energy Index	0.469554	1	0.4932
NSE Energy Index	Natural Gas	0.030634	1	0.8611
Natural Gas	NSE Energy Index	0.814119	1	0.3669

Source: Author's Calculations

Furthermore augmented level Vector Autoregressive model of order p = k (lag length) + d_{max} (maximum order of integration) has been estimated in order to run Toda and Yamamoto method of Granger causality. The results of Toda and Yamamoto test represent in Table 5.15 indicate that the null hypothesis of no granger causality between the energy commodities (crude oil and natural gas) and NSE energy index has been accepted. It clearly implies that causal linkage does not present between the energy commodities and related sectoral indices. This is another interested finding as the literature supports the granger causality effect of oil price on the stock market (Huang et al., 1996; Sadorsky, 1999; Nwala, 2007). These findings are highly consistent with the literature that argues against the existence of causal relationship between the energy commodities and NSE energy index (Gormus, 2012; Johnson and Soenon, 2014).

5.2.3 Causal Relationship between Precious Metal Commodities and NSE Index

The first part of the analysis is based on unit root test to find out the order of integration of the data series under study. The results of ADF test of unit root is presented in table 5.8. It clearly depicts that all the data series are integrated at order I(1).

Further VAR model is applied to reveal the impact of lag of one variable on the current values of some other variables. The result of optimal lag length has been presented in table 5.9. The results depict that the best possible lag length for gold-NSE index is k=2 and for silver-NSE index is k=1.

Table 5.16: Toda and Yamamoto Granger Causality Test Results for Precious Metal Commodities and NSE Index

Independent Variable	Dependent Variable	Chi-Square	df	Prob.
NSE Index	Gold	2.212140	2	0.3309
Gold	NSE Index	2.890236	2	0.2357
NSE Index	Silver	1.558959	1	0.2118
Silver	NSE Index	0.623131	1	0.4299

Source: Author’s Calculations

Further Toda and Yamamoto method of Granger non-causality test has been applied by estimating the VAR augmented level model of order $p = k+d_{max}$ in order to uncover the causal relationship between precious metal commodities and NSE index. The results presented in table 5.16 clearly exhibit that the null hypothesis of absence of granger causality in any of the direction has been accepted for both gold and silver.

The results are highly consistent with Kaliyamoorthy and Parithi (2012), Baig et al. (2013), Johnson and Soenon (2014), Srinivasan (2014) and Bhuvaneshwari and Ramya (2017). The findings related to causality between gold and stock market contradict the work done by Bhunia and Das (2012).

5.2.4 Causal Relationship between Base Metal Commodities and NSE Metal Index

As discussed earlier, before going ahead with the granger causality test, it is required to test the presence of unit root for the variables under study. The results presented in the table 5.11 suggest that the series are stationary at level. The variables are stationary at first difference or it can be said that the variables are integrated at order I(1). Further, VAR Akaike Information Criteria has been applied to find out the optimal lag length for the variables under study. The results are presented in the table 5.12. The lag length selected for aluminum-NSE metal index is k=1, k=3 for copper-metal index, lead-metal index and Zinc-metal index and k=4 for nickel-metal index.

Table 5.17: Toda and Yamamoto Granger Causality Test Results for Base Metal Commodities and NSE Metal Index

Independent Variable	Dependent Variable	Chi-Square	df	Prob.
NSE Metal Index	Aluminum	0.025977	1	0.8720
Aluminum	NSE Metal Index	0.739291	1	0.3899
NSE Metal Index	Copper	0.100738	3	0.9917
Copper	NSE Metal Index	4.765259	3	0.1898
NSE Metal Index	Lead	3.069279	3	0.3811
Lead	NSE Metal Index	2.388265	3	0.4958
NSE Metal Index	Nickel	2.829283	4	0.5868
Nickel	NSE Metal Index	5.468474	4	0.2425
NSE Metal Index	Zinc	1.931842	3	0.5867
Zinc	NSE Metal Index	3.706622	3	0.2949

Source: Author's Calculations

In the next step augmented level VAR for order $p = k+d_{max}$ has been estimated to test the causality between the variables under study. The results shown in table 5.17 depict the acceptance of null hypothesis of no causality between base metals and stock market. The results are highly consistent with Johnson and Soenon (2015) who did not find evidence of lead and lag relationship between the industrial metals and stock market.

The result discussed above concludes that there is no co-integration and causal relationship between commodity market and stock market. However studies done so far examined the relationship between stock and commodities and a common conclusion is that there is linkage between both the markets. But the same problem in emerging markets like India may have some different implications due to some unique characteristics such as greater volatility and speculative activities in Indian Financial Markets, which are different from developed countries. The results suggest that commodity market is not directly linked with stock market in the long run and thus have no predictive power to forecast stock returns. It suggests that investors can invest in both markets for the sake of diversification of their portfolio.

Chapter 6

RETURN SPILLOVER, VOLATILITY SPILLOVER AND DYNAMIC CONDITIONAL CORRELATION BETWEEN COMMODITY MARKET AND STOCK MARKET

6.1 Return and Volatility Spillover

Spillover refers to the flow of information across two financial markets (Maitra and Dawar, 2018). It describes the effect of variations in the return or volatility of one market to the other markets (Bouri, 2015). A number of theories given in studies done so far that explain the transmission of volatility or spillover between commodities and equity market. The first root of spillover comes from the theory that the variations in prices of commodities has negative effect on the profits of companies, using these commodities as a raw material because the companies do not want to transfer increasing expenditure onto their customers, hence the profits of the companies shrink (Broadstock et al., 2012). Due to increase in the number of financial investors in commodity market, commodities are considered as financial assets just like stocks and bonds. The theories of asset substitution play an important role here to explain the spillover effect between commodity market and stock market. The positive shock in the stock market motivates the investors to invest more in the stock market and sell their holding in other financial markets. Commodities are considered as safe haven because of their low correlation with the stock market. The third theory that explains the concept of spillover very well is the hedging effectiveness. Unexpected changes in the prices of stock market can persuade the investors to change their position in commodity market in order to maintain same hedge ratio (Demirer et al., 2015; Maitra and Dawar, 2018). The recent literature suggests that the spillover between commodities and stock market exists because of financialization of commodity market (Hammoudeh et al., 2014).

6.1.1 Return and Volatility Spillover between Agricultural Commodities and FMCG Stock Index

To investigate the return and volatility spillover between agricultural commodities and FMCG stock index, sixteen bivariate VAR (1) GARCH (1,1) model has been estimated.

Table 6.1.1: Results of VAR(1)-GARCH(1,1) between Agricultural Commodities and FMCG Index

Variables	Barley		Cottonseed		Crude Palm Oil		Guar Gum		Guar Seed		Gur	
	Stock	Commodity	Stock	Commodity	Stock	Commodity	Stock	Commodity	Stock	Commodity	Stock	Commodity
Mean Equation												
Stock (1)	-0.026	0.1242*	-0.021	-0.195	-0.0361	0.0307	-0.0261	-0.1191	-0.0264	-0.1367	-0.0262	0.00098
Commo (1)	0.0005	0.2428*	0.025*	-0.467*	-0.0621	0.2502*	-0.0021	-0.4284*	-0.0019	-0.2217*	-0.0228	-0.0006
Variance Equation												
C	0.00001*	-0.00002	0.000012*	-0.00239	0.00001*	-0.00004*	0.00001*	0.000042	0.00001	0.00058	0.00001	0.00005
$(\varepsilon_{t-1}^{Stock})^2$	0.00029*	-0.000001	0.000029*	0.00057	0.00002*	0.0000046*	0.00002*	-0.00003	.00002*	-0.00003	.00002*	-0.000003
$(\varepsilon_{t-1}^{commo})^2$	0.000000	0.00013*	-0.00000	0.00043*	0.000005*	0.000056*	7.02e-09*	0.00184*	0.0000	0.00218*	0.00000	0.00023*
h_{t-1}^{Stock}	0.9355*	0.2314*	0.9344*	3.5986	0.9368*	0.0167	0.9356*	-1.8113	0.935*	-2.888	0.9355*	0.0301
h_{t-1}^{commo}	-0.00005	0.4659*	0.000028*	0.7427*	-0.001375	0.9605*	0.000009	0.9335*	0.00001	0.9345*	-0.0006	0.6199*
	Jeera		**Mustardseed**		**Pepper**		**RBD Palm Oil**		**Rubber**		**Soybean**	
Mean Equation	Stock	Commodity	Stock	Commodity	Stock	Commodity	Stock	Commodity	Stock	Commodity	Stock	Commodity
Stock (1)	-0.0262	0.0369	-0.0311	-0.0118	-0.0273	0.0118	-0.0281	-0.0107	-0.0349	0.0020	-0.0270	-0.048
Commo (1)	0.00011	-0.2753*	-0.0405*	0.0215	-0.0450	0.2422*	-0.0654	0.2262*	0.0476	0.1976*	0.0342	0.2510*
Variance Equation												
C	0.00001*	0.00028	-0.000005	0.00222*	0.00001*	-0.00006*	0.00001*	-0.00004*	.00009*	-0.00028	.00001*	0.00005*
$(\varepsilon_{t-1}^{FMCG})^2$	0.00002*	0.000045	0.000029*	0.0000001	0.00002*	-0.0000005	0.00002*	0.00000008	.00002*	0.00009*	.00002*	0.0000017
$(\varepsilon_{t-1}^{Agri})^2$	0.000008	0.00021*	-0.000002*	0.000010*	-0.000001	0.00016*	-0.00001	0.00004*	-4.7e-7*	0.00023*	-0.0000	0.00006*
h_{t-1}^{FMCG}	0.9355*	-0.2256	0.9352*	0.000031	0.9352*	0.0400	0.9367*	0.04033*	0.9403*	0.1860	0.936*	-0.0824
h_{t-1}^{Agri}	0.00014	0.499996*	0.0034*	0.5615*	0.00108	0.8181*	-0.00113	0.96548*	-0.002*	0.8245*	-0.0009	0.90251*
	Soyoil		**Turmeric**		**Wheat**		**Yellow Peas**					
Mean Equation	Stock	Commodity	Stock	Commodity	Stock	Commodity	Stock	Commodity				
Stock (1)	-0.0026	-0.0040	-0.0263	0.0905*	-0.0262	-0.0042	-0.0262	-0.0183				
Commo (1)	-0.00075	0.1143*	-0.0337	0.3371*	-0.0002	0.1349*	0.0028	0.169*				
Variance Equation												
C	0.00001*	-0.000018*	0.00001*	-0.00002	0.00001*	0.000037*	0.00001*	0.00014*				
$(\varepsilon_{t-1}^{FMCG})^2$	0.00002*	0.000004*	0.00003*	-0.0000002	0.0003	0.0000023	0.00003	0.000003				
$(\varepsilon_{t-1}^{Agri})^2$	0.000001	0.000031*	0.0000	0.00014*	-0.00001	0.00006*	0.00000	0.000087*				
h_{t-1}^{FMCG}	0.9355*	0.01042	0.9354*	-0.0390	0.9357*	-0.03237	0.9355*	-0.00271				
h_{t-1}^{Agri}	0.00008	0.9474*	-0.00018	0.90568*	0.001	0.7320*	0.00036	0.6232*				

Source: Author's Calculations

Each process contains two endogenous variables agricultural commodity return and FMCG stock index return and the results are presented in Table 6.1.1. The parameters h_{t-1}^{agri} and h_{t-1}^{FMCG} symbolizes conditional variance for agricultural commodities and FMCG stock index returns respectively at time t-1. It measures the long run persistence of shocks in the market. In the similar way, ε_{t-1}^{agri} and ε_{t-1}^{FMCG} stands for error term which represents the impact of unexpected shocks on the agricultural commodities and FMCG stock index respectively at time t-1. It indicates short term persistence of shocks in both the markets (Jouini, 2013; Mensi et al., 2013).

Regarding the mean equation, the results are presented in Table 6.1.1. It depicts that agricultural commodities are significantly affected by their own past own value except gur and mustard seed. These findings provide the evidence of short term predictability in agricultural commodities price fluctuations. This finding is consistent with Mensi et al. (2013) indicating the rejection of efficient market hypothesis in few agricultural commodities. For FMCG stocks, findings are different. The current returns of FMCG stock index are not affected by past returns. It indicates that there is no evidence of short term predictability in FMCG stock index return fluctuations. The results are in line with Jouini (2013).

Further the results of return spillover across agricultural commodities and FMCG stock index return indicate that out of 16 agricultural commodities-FMCG stock index return pairs, only four pairs show unilateral return spillover effect. The information through return is significantly transferred from agricultural commodities to FMCG stock index in case of barley and wheat with the estimated coefficients of 0.124217 and -0.004245 respectively, while the return spillover in reverse direction holds true for cottonseed and mustard seed with the estimated coefficients of 0.025271 and -0.040557 respectively. The results confirm the findings of Toda and Yamamoto Granger Causality test.

Turning next to the conditional variance equation, the results revealed the ARCH and GARCH coefficients are statistically significant for all agricultural Commodities and FMCG index. For the agricultural commodities returns, the results confirm that the current conditional volatility of agricultural commodities return is sensitive to past own conditional volatility. It is important to note that the magnitude of GARCH coefficient is close to unity in case of RBD palm oil, crude palm oil, guarseed, guargum, turmeric and pepper implies a high degree of volatility persistence in these commodities. The results also point out that conditional volatility of these commodities fluctuate gradually more than that of other remaining commodities as the magnitude of GARCH coefficient is relatively large in case of these commodities. Further the current conditional volatility of agricultural commodities is least sensitive to the past unexpected shocks as the associated ARCH coefficient is quite low. This implies that past volatilities of agricultural commodities has more power to forecast the current volatility as compare to the past shocks. For the FMCG stock index returns, GARCH coefficients is statistically significant and close to unity with respect to each agricultural commodity while the magnitude of ARCH coefficient is quite low and statistically significant. It implies that the current conditional volatility of FMCG index fluctuates gradually under the unexpected innovations or shocks but it moves rapidly over time. These results are consistent with the findings of Jouini (2013); Mensi et al. (2013) and Sadorsky (2014).

Regarding the shock spillover between agricultural commodities and NSE FMCG index, the results state that eight out of sixteen agricultural commodities-FMCG index pairs show significant transmission of volatility and shocks from one to another. The crude palm oil-FMCG index pair shows the evidence of bi-directional shock spillover. The spillover effect is positive in both the directions. It implies that past crude palm oil and FMCG index shocks have very weak but significant impact on the volatility of FMCG index and Crude Palm oil with the estimated coefficients of 0.0000538 and 0.000469 respectively. In addition, the shock spillover effect also exists across Rubber-FMCG index pair. The effect is negative from rubber to FMCG index with the coefficient of -0.0000479 while it is positive from FMCG index to rubber with the observed coefficient of 0.000915. Further the results depict that past guargum and Mustard seed shocks have significant impact upon the FMCG index volatility with the coefficient of 0.000000702 and -0.00000196 respectively. The shock spillover effect is uni-directional and statistically significant from FMCG index to Soya oil with the coefficient of 0.0000470. Further analysis regarding the volatility spillover across agricultural commodities and FMCG index depicts that the past fluctuations in the volatility of cotton seed, mustard seed and rubber prices have significant impact on the volatility of FMCG index with the estimated coefficients of 0.000286, 0.003462 and 0.001161 respectively. The volatility spillover effect also exists in the reverse direction from FMCG index to agricultural commodities in barley and RBD palm oil with the estimated coefficients of -0.231474 and 0.040336 respectively. For other commodities and FMCG index pair, the results indicate that these commodities behave independently from the past unexpected shocks and fluctuations in volatilities of FMCG index prices and vice versa.

6.1.2 Return and Volatility Spillover between Energy Commodities and Energy Stock Index

The results of mean equation for energy commodities and energy stock index return presented in Table 6.1.2 indicate that the current returns of energy commodities and energy stock index are not affected by their own past returns. It indicates that there is no evidence of short term predictability in both energy commodities and energy stock index pairs. Further mean spillover results depicts that both the markets do not get return spillover from each other in short term.

Table 6.1.2: Results of VAR(1)-GARCH(1,1) between Energy Commodities and Energy Stock Index

		Crude oil		**Natural Gas**	
		Stock	Commo	Stock	Commo
Mean Equation	Stock(1)	0.0126	-0.0313	0.0171	0.0124
	Commo(1)	0.0164	-0.0072	-0.0076	-0.0203
Variance Equation	C	-0.00008*	-0.0002	-0.00004	0.00017
	$(\varepsilon_{t-1}^{Stock})^2$	0.00017*	0.000007	0.00017*	-0.000006
	$(\varepsilon_{t-1}^{commo})^2$	-0.00003	0.00024*	-0.000004	0.00091*
	h_{t-1}^{Stock}	0.916*	0.0562*	0.917*	-0.0131
	h_{t-1}^{commo}	0.0002*	0.961*	-0.0091*	0.752

Source: Author's Calculations

For energy commodities and NSE Energy index, the results reveal that ARCH and GARCH coefficients represented by ε_{t-1} and h_{t-1} are statistically significant for crude oil, natural gas and Energy index. It implies that past own shocks and volatility is important to predict the current volatility in energy commodities and energy index. The magnitude of GARCH coefficient is close to 1 for crude oil with the estimated coefficient of 0.961194. It indicates the long run persistence of volatility in the market. The current conditional volatility of energy commodities is least sensitive to its own past unexpected shocks as the ARCH coefficient for crude oil, natural gas and energy index is quite low and estimated coefficients are 0.000241 and 0.000192 respectively. The results of energy stock index are quite similar to the energy commodities.

The GARCH coefficient is very close to unity in energy commodities with respect to both crude oil and natural gas with the estimated coefficients of 0.916073 and 0.917781 respectively while the ARCH coefficients are less with respect to crude oil and natural gas with the estimated coefficients of 0.000173 and 0.000174 respectively. It is important to note that the conditional volatility of these commodities and energy stock index fluctuate gradually over the period of time than that of conditional shock as the magnitude of GARCH coefficient is quite large as compare ARCH coefficients. Turning next to the shock spillover between the energy commodities and energy index, the results presented in Table 6.12 indicate that both energy commodities and energy index behaves independently from the past unexpected shocks in the energy index and energy commodities respectively. Further regarding the volatility spillover across energy commodities and energy index, the results state that there is bi-direction volatility transmission between crude oil and energy index. The spillover effect is very weak and positive in both the directions. It implies that past fluctuations in the volatility of crude oil have very weak but significant impact on the current conditional volatility of energy index and vice versa with the estimated coefficient of 0.02079 from crude oil to energy index and 0.05623 in the reverse direction. For the natural gas-energy index pair, the results indicate the absence of volatility and shock spillover effect.

6.1.3 Return and Volatility Spillover between Precious Metal Commodities and NIFTY Stock Index

The results of return spillover effect between precious metal commodities and NIFTY Stock index are presented in table 6.1.3. The mean equation of precious metal commodities and NIFTY stock index return indicate that the current returns of precious metal commodities and NIFTY stock index returns are not affected by their own past returns. It indicates that there is no evidence of short term predictability in both precious metal commodities and NIFTY stock index. Further mean spillover results depicts that both the markets generally do not get return spillover from each other in short run.

Table 6.1.3: Results of VAR(1)-GARCH(1,1) between Precious Metal Commodities and NIFTY Stock Index

		Gold		Silver	
		Stock	Commo	Stock	Commo
Mean Equation	Stock(1)	0.0183	0.0233	0.0211	0.0723
	Commo(1)	-0.0311	0.0827*	0.00284	0.0493
Variance Equation	C	-0.00001*	-0.00002*	-0.00010*	0.000007
	$(\varepsilon_{t-1}^{Stock})^2$	0.00011*	-0.0000008	0.000107*	-0.000002
	$(\varepsilon_{t-1}^{commo})^2$	-0.000006*	0.00004*	-0.000003	0.00007*
	h_{t-1}^{Stock}	0.952*	0.0021	0.969*	-0.0008
	h_{t-1}^{commo}	0.106*	0.949*	0.024*	0.924*

Source: Author's Calculations

The results for precious metal commodities and NIFTY index depict that ARCH and GARCH coefficients are statistically significant for gold silver and NIFTY index. It implies that past own shocks and volatility is important to predict the current volatility in precious metal commodities and NIFTY index. The magnitude of GARCH coefficient is close to 1 for gold and silver with the estimated coefficient of 0.949529 and 0.923715 respectively. It indicates the long run persistence of volatility in the market. The current conditional volatility of energy commodities is least sensitive to its own past unexpected shocks as the ARCH coefficient for gold and silver is quite low with the estimated coefficients of 0.0000360 and 0.0000702 respectively. The results of NIFTY stock index are quite similar to the precious metal commodities. The

GARCH coefficient is very close to unity in NIFTY index with respect to both gold and silver with the estimated coefficients of 0.951528 and 0.96983 respectively while the ARCH coefficients are very low with respect to gold and silver with the estimated coefficients of 0.000107 and 0.000107 respectively. It is important to note that the conditional volatility of these commodities and energy stock index fluctuate gradually over the period of time than that of conditional shock as the magnitude of GARCH coefficient is quite large as compare to ARCH coefficients.

Further the results related to the volatility transmission across precious metal commodities and NIFTY index state that past gold and silver shocks have significant impact upon the NIFTY index volatility with the estimated coefficient of -0.00000686 and -0.00000254 respectively. The shock spillover effect is uni-directional, very weak and negative. Further analysis regarding the volatility spillover across precious metal commodities and NIFTY index depicts that the past fluctuations in the volatility of gold and silver prices have significant impact on the volatility of NIFTY index with the estimated coefficients of 0.106594 and 0.0204464 respectively. The volatility and shock spillover effect does not exist in the reverse direction the results indicate that NIFTY index behave independently from the past unexpected shocks and fluctuations in volatilities of precious metal prices.

6.1.4 Return and Volatility Spillover between Base Metal Commodities and Base Metal Stock Index

The results of return and volatility spillover effect between base metal commodities and metal stock index are presented in table 6.1.4. The mean equation of base metal commodities and base metal stock index return indicate that the current returns of base metal commodities and base metal stock index are not affected by their own past returns. It indicates that there is no evidence of short term predictability in both base metal commodities and base metal stock index. Further mean spillover results depicts that both the markets do not get any return spillover from each other in short term.

Table 6.1.4: Results of VAR(1)-GARCH(1,1) between Base Metal Commodities and Base Metal Stock Index

		Aluminum		**Copper**		**Lead**	
		Stock	Commo	Stock	Commo	Stock	Commo
Mean Equation	Stock(1)	0.066	-0.0024	0.0471	-0.00005	0.0652	-0.0105
	Commo(1)	-0.021	0.0134	0.0582	-0.065	-0.006	-0.0572
Variance Equation	C	-0.0002*	-0.00003*	-0.00021*	-0.00008*	-0.00019	-0.0002*
	$(\varepsilon_{t-1}^{Stock})^2$	0.00029*	0.000002	0.00028*	0.00002*	0.00028*	0.000001
	$(\varepsilon_{t-1}^{commo})^2$	0.00001	0.00005*	0.000024*	0.00009*	0.000009	0.00016*
	h_{t-1}^{Stock}	0.948*	0.0034*	0.924*	0.0137*	0.937*	0.0238*
	h_{t-1}^{commo}	0.0402	0.973*	0.0633*	0.948*	0.0217*	0.972*
		Nickel		**Zinc**			
		Stock	Commo	Stock	Commo		
Mean Equation	Stock(1)	0.057	0.0184	-0.0115	0.0363		
	Commo(1)	0.0161	-0.0742	0.00031	-0.0116		
Variance Equation	C	-0.0002*	-0.00010*	-0.00020*	-0.0004*		
	$(\varepsilon_{t-1}^{Stock})^2$	0.00028*	0.000008*	0.00028*	-0.00006		
	$(\varepsilon_{t-1}^{commo})^2$	0.00003*	0.00012*	-0.000002	0.00005*		
	h_{t-1}^{Stock}	0.942*	0.0149*	0.949*	0.0019*		
	h_{t-1}^{commo}	0.0182	0.975*	0.0238	0.988*		

Source: Author's Calculations

For the conditional variance equation of base metal commodities and Metal stock index, the results present that ARCH and GARCH coefficients are statistically significant for all base metal commodities and metal stock index. It implies that past own shocks and volatility is important to predict the current volatility in base metal commodities and metal stock index. The magnitude of GARCH coefficient is close to 1 for aluminum, copper, lead nickel and zinc with the estimated coefficient of 0.97348, 0.948958, 0.972581, 0.975258 and 0.987967 respectively. It indicates the long run persistence of volatility in the base metal commodities. The current conditional volatility of energy commodities is least sensitive to its own past unexpected shocks as the ARCH coefficient for aluminum, copper, lead nickel and zinc is quite low with the estimated coefficients of 0.0000470, 0.0000897, 0.000165, 0.000121 and 0.0000489 respectively. The results of metal stock index are quite similar to the precious metal commodities. The GARCH coefficient is very close to unity in NIFTY index with respect to aluminum, copper, lead, nickel and zinc with the estimated coefficients of 0.948617, 0.924796, 0.937296, 0.942836 and 0.94911 respectively while the ARCH coefficients are very low with respect to base metals with the estimated coefficients of ranges from 0.000280-0.000286. It is important to note that the conditional volatility of these commodities and energy stock index fluctuate gradually over the period of time than that of conditional shock as the magnitude of GARCH coefficient is quite large as compare to ARCH coefficients.

Regarding the shock spillover effect across base metals and metal stock index, the results reveal that there is bi-directional shock transmission in copper-metal index pair and nickel-metal index pair. It implies that past shocks in copper and nickel have significant impact on the volatility of metal stock index and vice versa with the estimated coefficients of 0.0000241 and 0.0000313 from copper and nickel respectively to metal stock index and 0.0000245 and 0.00000888 from Metal stock index to copper and nickel respectively. The spillover effect is very much weak in both the directions for both pairs. Further the results related volatility spillover effect indicates that there is bi-directional volatility transmission in copper-metal stock index pair and lead-metal stock index pair. The volatility is transmitted from copper and lead to metal stock index with the estimated coefficient of 0.063374 and 0.021736 and in the reverse direction with the estimated coefficient of 0.01375 and 0.023801. In addition, the current conditional volatility of metal stock index also depends upon the past fluctuations in the volatilities of Aluminum and zinc with the estimated coefficients of 0.003377 and 0.001896 respectively. As can be seen from the results, the estimated coefficient of conditional volatility is quite high as compare to the estimated coefficient of conditional shock but still the magnitude of cross market shock and volatility is quite less as compare to the own lagged shock and volatility.

6.2 Dynamic Conditional Correlation

Before going ahead with DCC (1,1) GARCH (1,1) model, all the series need to be filtered in order to remove the potential linear structure between the commodity-stock pairs (Cho and Parhizgari, 2008 and Dajcman and Festic, 2009) and to make the residuals white noise (Singhal and Ghosh, 2016). Further the residuals of VAR equation are used to run DCC GARCH Model.

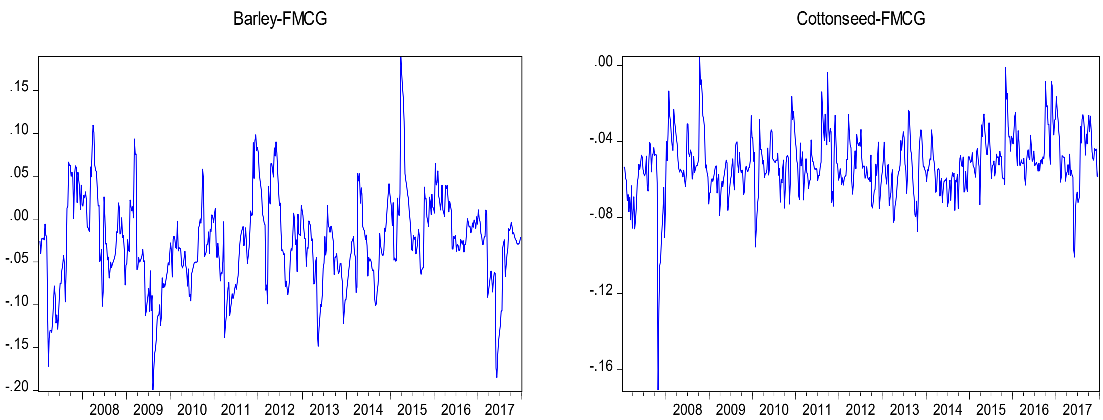
Table 6.2.1: Results of DCC-GARCH for Agricultural Commodities and FMCG Stock Index

Variables	Barley		Cottonseed		Crude Palm Oil		Guar Gum		Guar Seed		Gur	
	FMCG	Agri	Stock	Agri	Stock	Agri	Stock	Agri	Stock	Agri	Stock	Agri
α	0.0343*	0.5683*	0.0288*	0.5800*	0.0412*	0.1204*	0.0409*	0.2831*	0.0348*	0.2975*	0.0347*	0.3813*
β	0.9466*	0.3737*	0.9535*	0.1747*	0.9095*	0.8510*	0.9076*	0.7464*	0.9460*	0.7903*	0.9458*	0.3938*
Θ_1	0.0317		0.0174		0.0202*		0.000023		0.1434		0.0393*	
Θ_2	0.8425		0.6962*		0.9700*		0.9319*		0.9130*		0.7453*	
	Jeera		**Mustardseed**		**Pepper**		**RBD Palm Oil**		**Rubber**		**Soybean**	
α	0.0407*	0.5308*	0.0416*	-0.0002	0.0338*	0.3049*	0.0403*	0.0707*	0.0351*	0.2155*	0.0404*	0.2686*
β	0.9076*	0.0242	0.9299*	0.7557*	0.9469*	0.5519*	0.9366*	0.8973*	0.9445*	0.7112*	0.9101*	0.4807*
Θ_1	0.0601		0.0092		0.0052		0.0234*		0.0147		0.0114	
Θ_2	0.9932*		0.8260*		0.9853*		0.7449*		0.8666*		0.9558*	
	Soyoil		**Turmeric**		**Wheat**		**Yellow Peas**					
α	0.0396*	0.0725*	0.0354*	0.1438*	0.0340*	0.3652*	0.0340*	0.1512				
β	0.9371*	0.8713*	0.9453*	0.8099*	0.9469*	0.5252*	0.9469*	0.5556*				
Θ_1	0.0207*		0.0609		0.0210		0.1317*					
Θ_2	0.8476*		0.5818*		0.9596*		0.5162*					

Source: Author's Calculations

6.2.1 Dynamic Conditional Correlation between Agricultural Commodities and FMCG stock index

The estimation results are presented in Table 6.2.1 and it has been found that in case of univariate GARCH model, the coefficients of ARCH and GARCH are statistically significant for most of the agricultural commodities. The sum of ARCH and GARCH coefficients, representing past shocks and volatilities respectively, is close to one indicates that shocks to conditional variance are highly persistent. The ARCH and GARCH coefficients of FMCG stock index is very close to one and statistically significant with respect to all agricultural commodities represents that current conditional volatility of FMCG index fluctuates gradually under the unexpected innovations or shocks. The results are consistent with the univariate GARCH results. Further the DCC estimates for the agricultural commodity-FMCG stock index pairs are presented in the Table 6.2.1 summarizes that Theta 1 associated with the short run persistence of shocks is statically significant only for crude palm oil, gur, RBD Palm oil, Soya oil and yellow peas. The long run persistence of shocks is represented by Theta 2 coefficient and it has been found that Theta 2 coefficient is statistically significant for all agricultural commodity-FMCG stock index pairs. Secondly the magnitude of Theta 2 coefficient is more than the Theta 1 coefficients indicates the long run persistence of volatility in the market. It also suggests that the conditional variances are mean reverting (Dajkman and Festic, 2012).



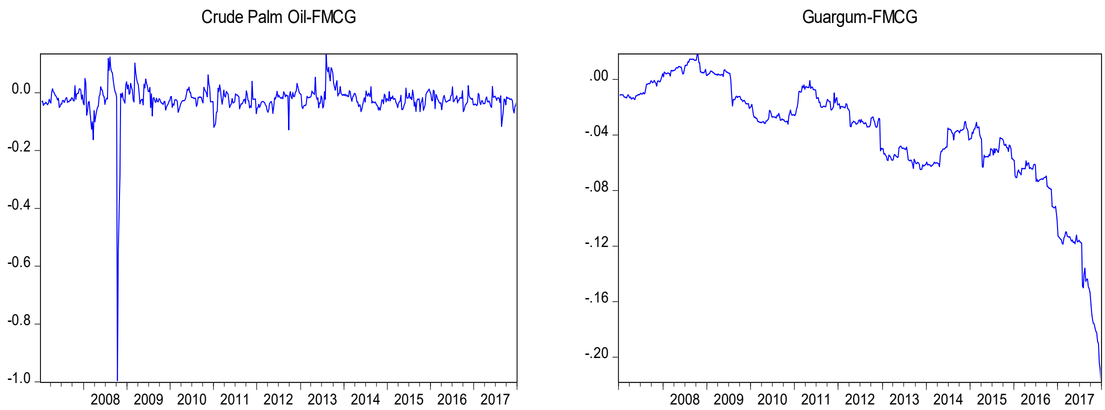
Panel A **Panel B**

Figure 6.2.1: Dynamic Conditional Correlation between Barley and cottonseed-FMCG Stock Index Prices

Source: Author's Calculations

Further to assess the evolution of conditional correlation between the agricultural commodities and FMCG stock index, Figure 6.2.1 represents the results of dynamic conditional correlation between Barley and cottonseed-FMCG stock index pairs. X Axis represents years and Y Axis represents the Dynamic Conditional Correlation between the commodity-stock pairs.

It has been noticed that in both the panel A and panel B correlation is highly volatile. Secondly for almost all cases, the correlation drops during the US crisis 2008. There is drop in correlation again during 2010-2011 due to the impact of Euro zone crisis on the Indian Financial markets, then in 2014-15 due to the ripple effect arises because of slowdown in china and then again in 2016-17 due to the impact of demonetization. Thirdly the correlation starts increasing immediately after the crisis period.

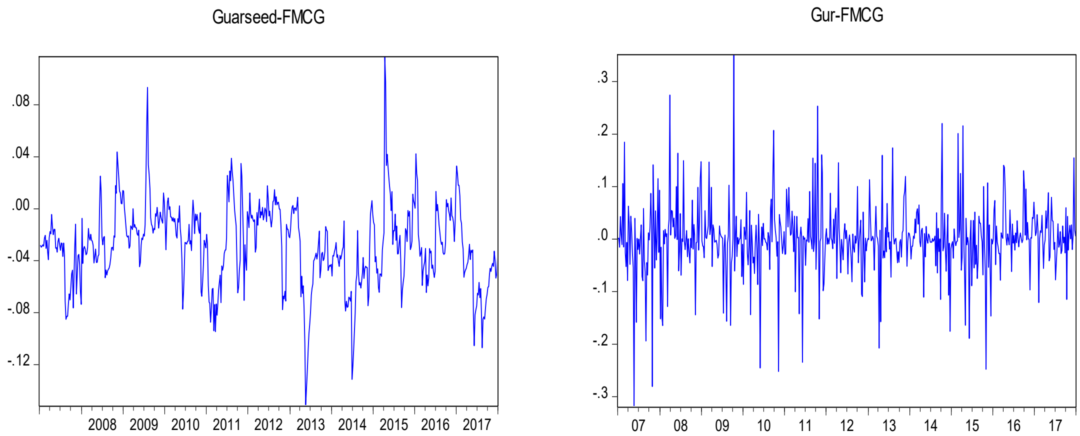


Panel A **Panel B**

Figure 6.2.2: Dynamic Conditional Correlation between Crude Palm Oil and Guargum-FMCG Stock Index Prices

Source: Author's Calculations

Figure 6.2.2 indicates that in case of crude palm oil (Panel A), the correlation is less volatile and become stable after the financial crisis 2007-08. In case of guar gum (Panel B), there is decline in correlation throughout the study period. The correlation again exhibit drop during 2010-2011 due to the impact of Euro zone crisis on the Indian Financial markets, then in 2014-15 due to the ripple effect because of the slowdown in china and then again in 2016-17 due to the impact of demonetization. Thirdly the correlation between the commodities and FMCG stock prices starts rising slightly.

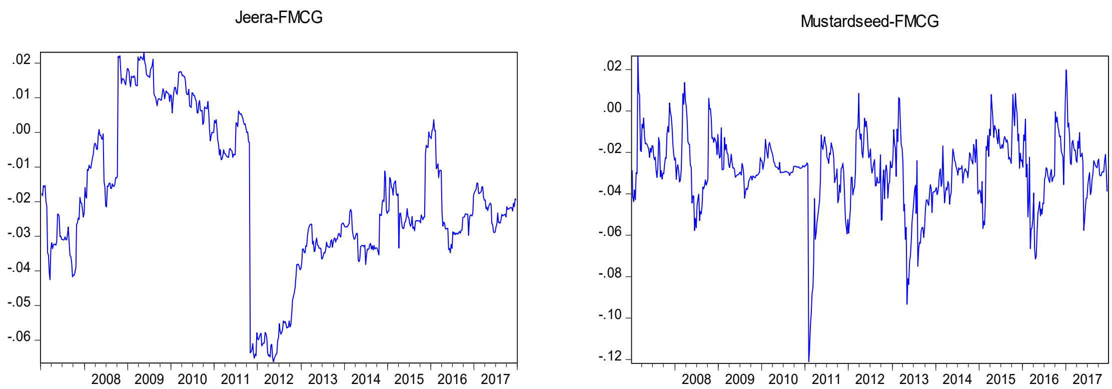


Panel A **Panel B**

Figure 6.2.3: Dynamic Conditional Correlation between Guar Seed and Gur-FMCG Stock Index Prices

Source: Author's Calculations

Figure 6.2.3 exhibits that in case of both panel A and panel B, the correlation between commodities and FMCG Stock index pair is unstable. Secondly for both panels, the correlation drops during the global crisis 2008. The correlation again exhibit drop during 2010-2011 that may happen due to Euro zone crisis which affects Indian financial markets negatively, then in 2014-15 due to the ripple effect because of the slowdown in china and then again in 2016-17 due to the impact of demonetization. Thirdly there is increase in correlation immediately after the period of uncertainty.

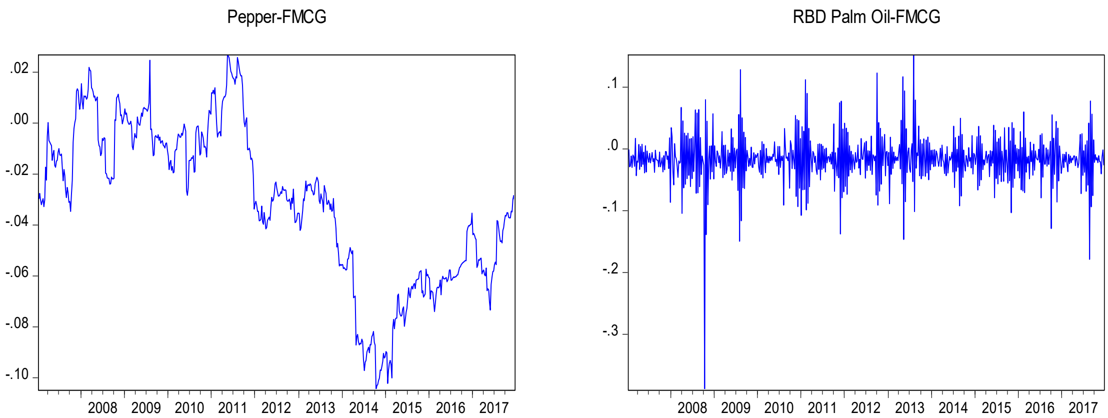


Panel A **Panel B**

Figure 6.2.4: Dynamic Conditional Correlation between Jeera and Mustard Seed-FMCG Stock Index Prices

Source: Author's Calculations

Figure 6.2.4 exhibits that in case of both panel A and panel B, the correlation between commodities and FMCG Stock index pairs drops during the financial crisis 2008, then again it drops in 2010-2011, 2014-15 and 2016-17 due to the financial distress in the country. The correlation is increased immediately after the crisis.

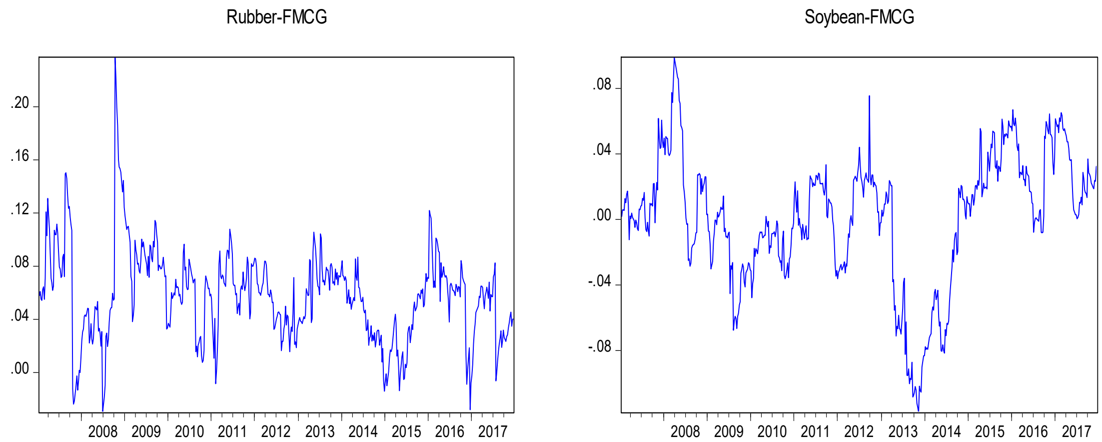


Panel A **Panel B**

Figure 6.2.5: Dynamic Conditional Correlation between pepper and RBD Palm Oil-FMCG Stock Index Prices

Source: Author's Calculations

Figure 6.2.5 indicates that in case of panel A, the correlation between pepper and FMCG stock index pair is highly volatile. There is decline in the correlation during the period of financial distress. Then the correlation starts increasing immediately after the shocks.

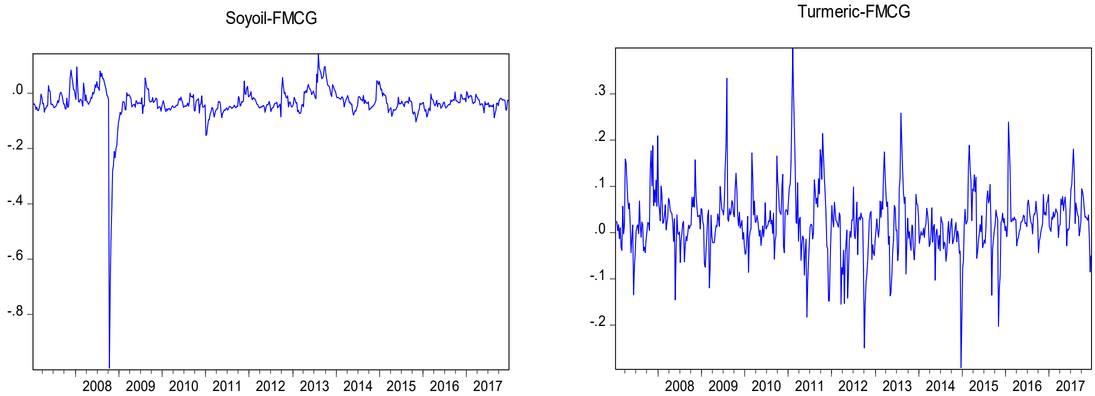


Panel A **Panel B**

Figure 6.2.6: Dynamic Conditional Correlation between Rubber and Soybean-FMCG Stock Index Prices

Source: Author's Calculations

In panel B, there is sharp decline in the correlation between RBD Palm oil and FMCG Stock index during the financial crisis 2008 and then correlation become stable immediately after the crisis throughout the study period. Figure 6.2.8 indicates that in panel A and panel B, there is decline in correlation during the financial crises and the correlation starts increasing after the crisis.

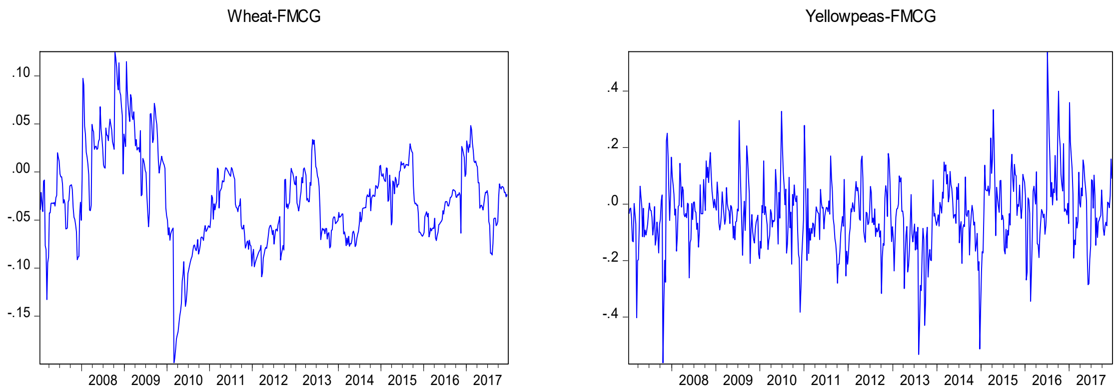


Panel A **Panel B**

Figure 6.2.7: Dynamic Conditional Correlation between Soy Oil and Turmeric-FMCG Stock Index Prices

Source: Author's Calculations

Figure 6.2.7 indicates that in case of panel A, there is sharp decline in the correlation between soy oil and FMCG Stock Index pair during the financial crisis 2008 and then correlation become stable immediately after the crisis throughout the study period. In case of panel B, there is decline in correlation turmeric and FMCG Stock pair during the financial crises and the correlation starts increasing after the crisis.



Panel A **Panel B**

Figure 6.2.8: Dynamic Conditional Correlation between Wheat and Yellowpeas-FMCG Stock Index Prices

Source: Author's Calculation

Figure 6.2.8 indicates that in panel A and panel B, there is decline in correlation during the financial crises and the correlation starts increasing after the crisis.

6.2.2 Dynamic Conditional Correlation between Energy Commodities and Energy stock index

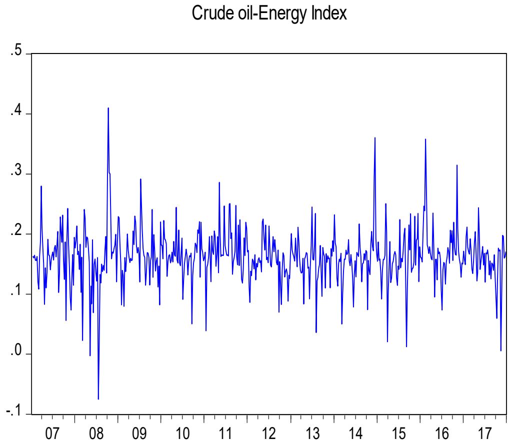
The results of dynamic conditional correlation between energy commodities and energy index are presented in Table 6.2.2.

Table 6.2.2: Results of DCC-GARCH for Energy Commodities and Energy Stock Index

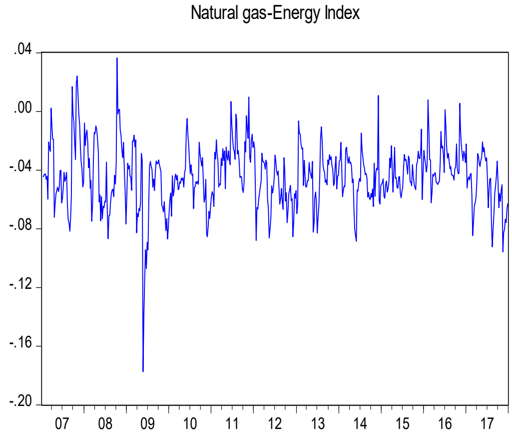
		α	B	Θ_1	Θ_2
Crude Oil	Stock	0.138*	0.815*	0.219*	0.529*
	Commo	0.107*	0.863*		
Natural Gas	Stock	0.156*	0.778*	0.120	0.837*
	Commo	0.214*	0.585*		

Source: Author's Calculations

The univariate GARCH results for energy commodities and energy stock index are quite similar to the agricultural commodity and FMCG stock index pairs. The ARCH and GARCH coefficients are statistically significant for crude oil, natural gas and energy index return with respect to both crude oil and natural gas. The sum of ARCH and GARCH coefficients is close to 1 indicating the long run persistence of past conditional volatility and shocks. Further the DCC estimates for the energy commodity-energy stock index pairs are presented in the Table 6.2.2 summarizes that Theta 1 associated with the short run persistence of shocks is significant for crude oil-energy index pair. The long run persistence of shocks is represented by Theta 2 coefficient and it has been found that Theta 2 coefficient is statistically significant for both energy commodity-energy stock index pairs. Secondly the magnitude of Theta 2 coefficient is more than the Theta 1 coefficients indicates the long run persistence of volatility in the market. It also suggests that the conditional variance is mean reverting (Dajkman and Festic, 2012).



Panel A



Panel B

Figure 6.2.9: Dynamic Conditional Correlation between Energy Commodities and Energy Stock Index Prices

Source: Author's Calculations

The time-varying conditional correlations for energy commodity-energy stock index returns are presented in Figure 6.2.9. For Crude oil-energy stock index pair (Panel A), it has been found that during the financial crisis 2007-08, Euro zone crisis 2010-11, china market slowdown 2014-15, demonetization and imposition of GST in India 2016-17, there is decrease in conditional correlation. The correlation starts rising immediately after the crisis during the whole study period. For natural gas-energy index pair (Panel B), the findings are quite different. The correlation is less volatile and become relatively stable, regardless the fluctuations in the financial markets. The results are in line with Creti et al. (2013).

6.2.3 Dynamic Conditional Correlation between Precious Metal Commodities and NIFTY stock index

The results of dynamic conditional correlation between precious metal commodities and NIFTY index are presented in Table 6.2.3. The univariate GARCH model results indicate that the coefficients of ARCH and GARCH are statistically significant and close to one for gold, silver and NIFTY stock index with respect to both gold and silver, implies the long run persistence of past shocks and volatility in the precious metal commodities and NIFTY stock index. Further the DCC estimates for the precious metal commodities-NIFTY stock index pairs are presented in the Table 6.2.3

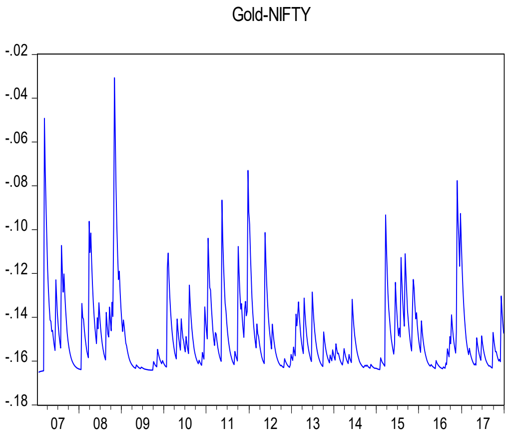
summarizes that Theta 1 associated with the short run persistence of shocks is insignificant for both gold-NIFTY stock index and silver-NIFTY index pairs. The long run persistence of shocks is represented by Theta 2 coefficient and it has been found that Theta 2 coefficient is statistically significant for both the pairs. Secondly the magnitude of Theta 2 coefficient is more than the Theta 1 coefficients indicates the long run persistence of volatility in the market. It also suggests that the conditional variance is mean reverting (Dajkman and Festic, 2012).

Table 6.2.3: Results of DCC-GARCH for Precious Metal Commodities and Precious Metal Stock Index

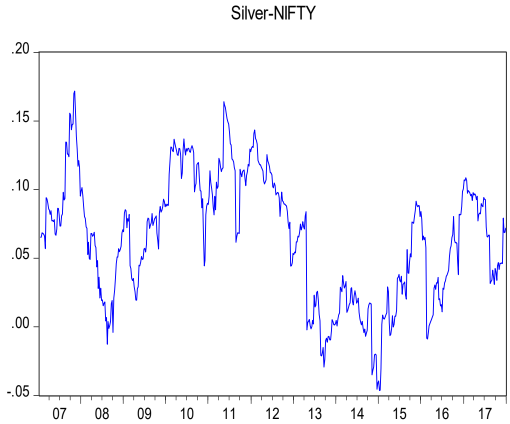
		A	B	Θ_1	Θ_2
Gold	Stock	0.089*	0.902*	0.00035	0.889*
	Commo	0.083*	0.873*		
Silver	Stock	0.089*	0.901*	0.010	0.963*
	Commo	0.089*	0.869*		

Source: Author's Calculations

The evolution of dynamic conditional correlation in precious metal commodities and NIFTY stock index pair is presented in Figure 6.2.10. It has been found that the time varying correlation is highly negative in gold-NIFTY stock index pairs (Panel A) throughout the study period. The correlation between gold and NIFTY stock index decrease during the crisis and increase immediately after the crisis.



Panel A



Panel B

Figure 6.2.10: Dynamic Conditional Correlation between Precious Metal Commodities and Precious Metal Stock Index Prices

Source: Author's Calculations

The results are consistent with the findings of Baur and McDermott (2010); Creti et al. (2013). For silver-NIFTY stock index pair (Panel B), the results are relatively different. The correlation volatility increases immediately after financial crisis 2008, followed by positive correlation till 2012. The correlation volatility is negative for silver in the year 2014-15 due to china market slowdown as discussed previously.

6.2.4 Dynamic Conditional Correlation between Base Metal Commodities and Base Metal stock index

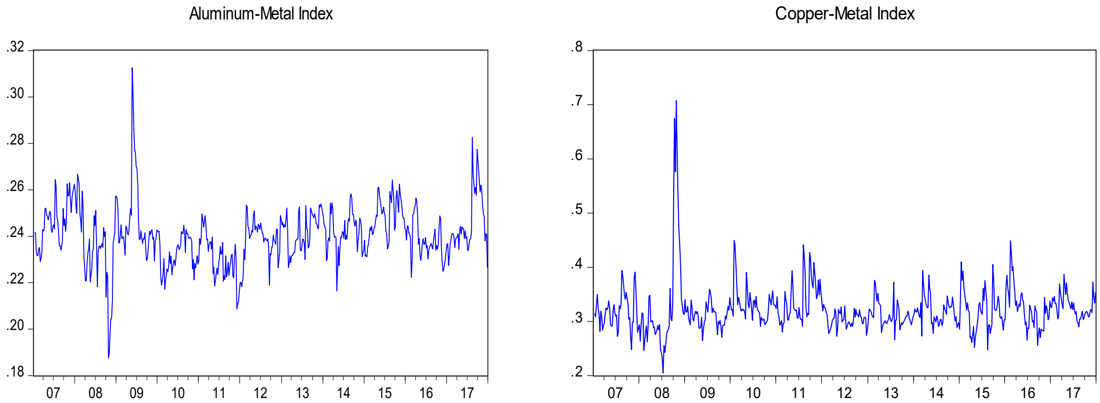
The results of dynamic conditional correlation between Base metal commodities and Base Metal index are presented in Table 6.2.4.

Table 6.2.4: Results of DCC-GARCH for Base Metal Commodities and Base Metal Stock Index

		A	B	Θ_1	Θ_2
Aluminum	Stock	0.132*	0.817*	0.00002	0.997*
	Commo	0.0501*	0.931*		
Copper	Stock	0.130*	0.822*	0.1398	0.832*
	Commo	0.105*	0.831*		
Lead	Stock	0.133*	0.816*	0.0051*	0.989*
	Commo	0.0652*	0.927*		
Nickel	Stock	0.132*	0.818*	0.031*	0.912*
	Commo	0.0459*	0.947*		
Zinc	Stock	0.130*	0.823*	0.0265*	0.876*
	Commo	0.0368*	0.957*		

Source: Author's Calculations

The univariate GARCH model results indicate that the coefficients of ARCH and GARCH are statistically significant and close to one for aluminum, copper, lead, nickel, zinc and metal stock index with respect to all base metal commodities, implies the long run persistence of past shocks and volatility in the base metal commodities and metal stock index. Further the DCC estimates for the base metal commodities-metal stock index pairs are presented in the Table 6.2.4 summarizes that Theta 1 associated with the short run persistence of shocks is significant for lead, nickel and zinc. The long run persistence of shocks is represented by Theta 2 coefficient and it has been found that Theta 2 coefficient is statistically significant for all the metal commodities and metal stock index pairs. Secondly the magnitude of Theta 2 coefficient is more than the Theta 1 coefficients indicates the long run persistence of volatility in the market. It also suggests that the conditional variance is mean reverting (Dajkman and Festic, 2012).



Panel A **Panel B**

Figure 6.2.11: Dynamic Conditional Correlation between Aluminum and Copper- Base Metal Index Pairs

Source: Author's Calculations

The evolution of dynamic conditional correlation in precious metal commodity and NIFTY stock index pair is presented in Figure 6.2.11 and 6.2.12. Firstly the correlation between metal commodities and metal stock index is positive throughout the study period. Secondly financial crisis 2007-08 has strong impact on the correlation between these pairs. The correlation tends to decrease during the financial turmoil period and showing increased immediately after the financial crisis. The impact of other crisis has not been seen on the links between metal commodities and metal stock index pairs. The correlations remain quite stable after the crisis period, regardless the fluctuations in the stock market. The similar conclusion is drawn by Partaliduo et al. (2016).

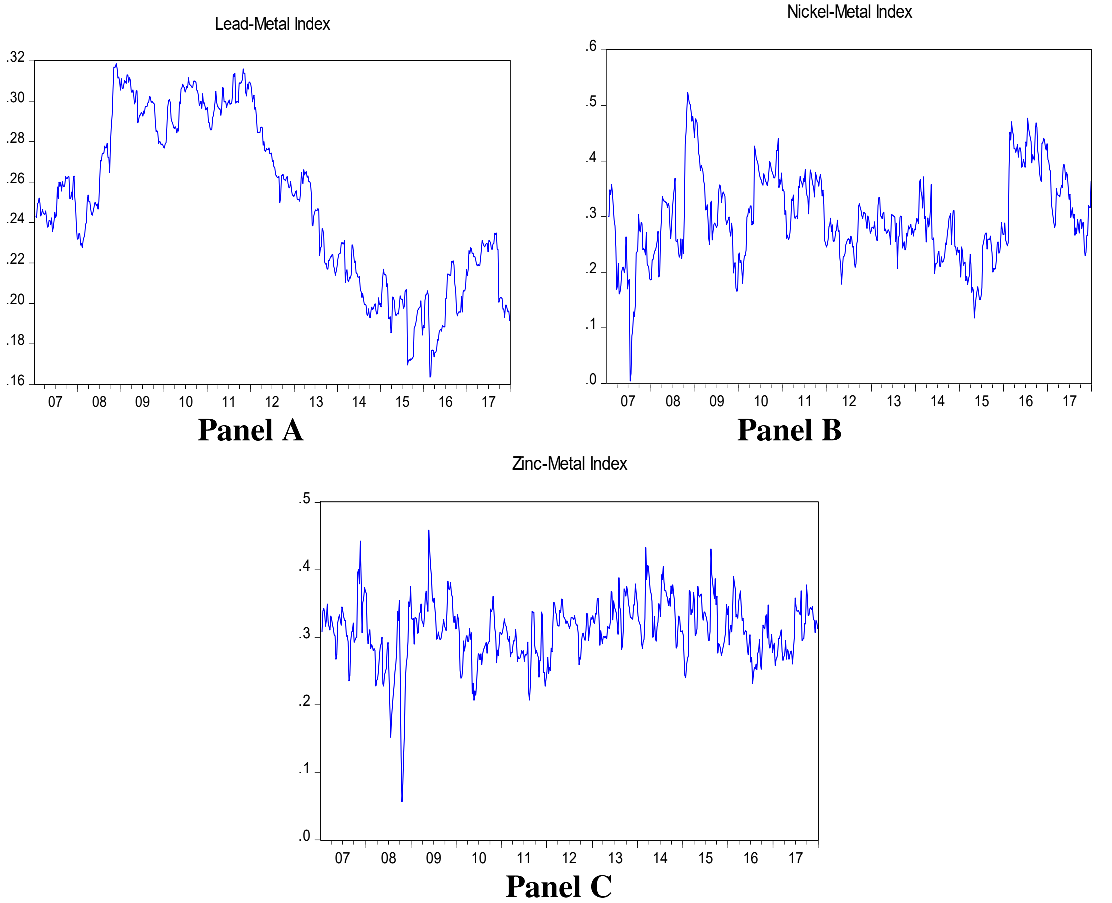


Figure 6.2.12: Dynamic Conditional Correlation between Lead, Nickel and Zinc-Base Metal Stock Index Pairs

Source: Author's Calculations

The results discussed above indicate that the magnitude of volatility spillover effect is quite high as compare to the shock spillover effect. The analysis depicts that the magnitude of cross market ARCH and GARCH coefficients is much smaller as compare to the magnitude of past own ARCH and GARCH coefficients, which implies that the past own shocks and volatilities are more important to forecast current volatility. It further implies that commodities and stock indices do not belong to similar group, rather these should be taken separately and to improve the overall risk adjusted performance of a portfolio, it is better to add both commodities and stocks. Further the results indicate that the correlation between almost all agricultural commodities and FMCG stock index is negative during the crisis. The correlation is less volatile and become stable after the financial crisis 2007-08 in three out sixteen commodities which are crude palm oil, RBD Palm oil and soy oil. In case of precious metals and FMCG Stock index, the correlation between these two is negative, highlights the safe haven role of precious metals. The negative correlation between crude oil and stock market might be due to the adverse effect of rising crude oil prices on the equity prices through either discount rate cash flows or inflation effect. Metals show positive correlation with the stock market in this study. It may be due to the ability of these assets to attract more financial speculation. The increase in metal price is an indicator of economic growth in the country due to which there is rise in correlation between metal commodities and stock market. Overall results related to the dynamic conditional correlation between commodity market and stock market depicts that the correlation between both the markets decreased during financial crises especially in stock market. It suggests that commodities act as best portfolio diversifier during financial crisis in financial market. The results obtained in this study are different from the developed economies because the Indian commodity market is not like global commodity market. It is still segmented and kept away the investment from large financial institutions and banks.

CHAPTER 7
FINDINGS, CONCLUSION AND SUGGESTIONS

The aim of this study is to examine the seasonality, co-integration, causal relationship, volatility spillover and dynamic conditional correlation between commodities and their related stock indices. The secondary data has been collected from the official website of MCX, NCDEX and NSE. Econometrics tools like Generalized Auto-regressive Conditional Heteroskedasticity Test, Johansen Co-integration Test, Toda and Yamamoto Test of Granger Causality Test, VAR-GARCH and Dynamic Conditional Correlation-GARCH models have been used to analyse the data. Based on the results and interpretations, the key findings and conclusion has been presented in this section. Based on the results, the suggestions are also provided for investors, brokers and policy makers.

7.1 Findings of the Study

The major findings of this study are given below:

7.1.1 Monthly Seasonality in Commodity Market and Stock Market

One of the objectives of this study is to examine the monthly seasonality in commodity market and stock market. Current study tried to examine whether the commodities and their related stock indices follow the efficient market hypothesis or there are chances to earn abnormal return from these markets.

However, going into deeper insights, the key findings from the results are given below:

- There is absence of monthly seasonality in three out sixteen agricultural commodities which are crude palm oil, RBD palm oil and soy oil.
- NSE FMCG index returns are negative and statistically significant in the month of February.
- April and September effect is present in the mean return of five out of sixteen commodities. July and August effect is present in three out of sixteen commodities followed by January, February, October and November effect

which is present in the mean return of two series. Further the coefficient of March and December months are statistically significant for only one commodity.

- The results indicating the presence of monthly seasonality in the volatility of commodities and stocks indicate that the seasonal effect is absent in the volatility of four out of sixteen commodities which are crude palm oil, RBD palm oil, soya oil and yellow peas.
- The results indicate the presence of monthly seasonality in energy commodities and energy stock index. The seasonal effect is present in the volatility of natural gas while it is absent in the volatility of crude oil and energy stock index.
- There is presence of monthly seasonality in the mean return and volatility of gold and silver while it is absent for NIFTY stock index.
- Monthly seasonality is present in the mean return of two out of five base metal commodities which are copper and zinc and in the volatility of three commodities which are aluminum, copper and Nickel.
- The seasonal effect is present in the mean return while absent in the volatility of metal stock index.

7.1.2 Co-integration between Commodity Market and Stock Market

The second objective of this study is to examine the long run co-integration between the stock market and commodity market. Basically main theme behind the co-integration between two markets is that the variables in the long run move jointly regardless of variables themselves drifted too apart themselves during long run. The divergence between these variables is considered to be constant. So this is defined as co-integration (Hall and Henry, 1989; Ahmed et al., 2017). There are large numbers of studies that explored short term affect, but ignore the aspect of long run on the behavior of commodity market and stock market together.

- The overall results related to the long run relationship between the stock market and commodity market reveal that generally prices in these two markets of India are not unified. There is no long run interdependence between commodities and their related stock indices.

7.1.3 Causal Relationship between Commodity Market and Stock Market

One of the objectives of this study is to examine the causal relationship between commodity market and stock market. The studies done so far explored the causal relationship mainly between the commodities and overall stock price index and very few studies paid attention on the sectoral level (Dutta, 2017).

- The overall results related to causality between commodity market and stock market reveal that with the exception of five agricultural commodities (barley, cottonseed, jeera, mustardseed and wheat), granger causality test could not find causal relationship between the commodity market and stock market.

7.1.4 Return and Volatility Spillover across Commodity Market and Stock Market

The fourth objective of this study is to study the return and volatility spillover between the commodity market and stock market.

- The overall results related to the volatility spillover between commodity market and stock market clearly indicate that past own shocks and fluctuations in the volatility of commodity market and stock market are more important, while predicting current conditional volatility as the magnitude of impact of past own volatility is quite high as compare to cross market volatility coefficients. The results are consistent with the findings of Arouri et al. (2012); Jouini (2013); Mensi et al. (2013) and Bouri (2015).
- Secondly, conditional volatility of commodities fluctuates very slowly over time as the magnitude of GARCH coefficient is relatively large.
- Further the results related to shock and volatility spillover indicate that out of 25 commodity-stock pairs, current conditional volatility of stock market depends upon the past shocks and fluctuations in the volatility of five commodities which are mustard seed, rubber, gold, silver and copper.
- The shock transmission from commodity market to stock market is statistically significant in crude palm oil, guargum and nickel, implies that past shocks in these commodities have significant impact on the current conditional volatility of their related stocks.

- In addition, the current conditional volatility of these stocks is also affected by past conditional volatility of cotton seed, crude oil and lead. The spillover effect is also found in the reverse direction from stock market to commodity market. The volatility and shock spillover effect is significant from metal stock index to copper.
- The current conditional volatility of crude palm oil, rubber, soya oil and nickel depends upon the past shocks in their related stock indices and the current conditional volatility of barley, RBD palm oil, aluminum, lead and zinc depends upon the fluctuation in the past volatility of their related stock indices.
- The results related to absence of volatility spillover in maximum pairs of commodity-stock are quite surprising because FMCG, Energy and metal companies are consumer of agricultural, energy and metal commodities respectively.

7.1.5 Dynamic Conditional Correlation across Commodity Market and Stock Market

- Results of dynamic conditional correlation between commodity market and stock market indicate that the correlation between the stock and commodity market is highly volatile throughout the study period.
- During the financial crises, the correlation between the commodity market and stock market decreased.
- The correlation between these two markets rises immediately after the financial crisis
- The results further depict that there is negative correlation between the agricultural commodities and FMCG stock index. The results are in line with Demiralay and Ulusoy (2016); Nguyen et al. (2015).
- In the precious metals especially in gold, the correlation is mostly negative.
- There is negative correlation between crude oil and energy index prices.
- Last but not the least, metal commodities show positive correlation with stock market.

7.2 Conclusion

Co-integration between commodities and stock market is recent topic which received a lot of attention from researchers, investors and policy makers especially after financial crises 2007-08. The past literature lacked a study which studies the impact of change in commodity price on the sectoral stock index prices from Indian perspective. This study is first to empirically examine the co-integration between individual commodities and their related sectors' stock index. The objective wise conclusion drawn from above discussed findings is given below:

7.2.1 Monthly Seasonality in Commodity Market and Stock Market

Seasonality in the commodity market occurs due to imbalance between demand and supply. Agricultural commodities follow seasonal patterns from planting to harvest. Before the harvesting, the price goes up because of less supply as compare to demand. The prices go down immediately after the harvesting because of ample supply. The scarcity of supply not only increases the price of the commodity, but there is also an increase in the volatility in the commodity market also during this time period.

- Seasonal patterns are observed in Barley Commodity in the month of April. The harvesting of barley is started in the month of April. Due to less supply during the month of April, there is increase in price of the commodity. The volatility is high in Barley in the month of March. As discussed earlier, the scarcity of commodity increases the volatility in the commodity prices. The sowing season starts from October. It can be the reason for seasonality in volatility of barley during October, November and December.
- The results suggest that cotton seed returns are negative in the months of April, September, October and November. The results are in line with the findings of Seamon et al. (2001). Cotton seed oil cake is the by-product of cotton. The prices of cotton are lowest during predominant harvest period from September to November. The seasonality in volatility in cottonseed oilcake is observed in the months of May, June, July, August, October, November and December. The results are consistent with Hudson and Coble (1999). The volatility is at its peak during October. The volatility is observed in these months because of "priori expectations" according to which during

crop development months, the fluctuations in the price of cottonseed is high. The new information disseminates in the market and creates instability in the current price.

- There is absence of monthly seasonality in return of crude palm oil. The seasonality in volatility is present in crude palm oil in the months of February, April and December. The fluctuations in the price of crude palm oil largely depend on the supply scenario of oil producing companies such as Malaysia and Indonesia. The crude palm oil production is lower in the month of February and after that the production starts increasing gradually and reaches at the peak during October. Then again production gradually decline towards December.
- The return and volatility seasonal patterns of guar gum and guar seed are similar because guar gum is the main product of guar seed. Any fluctuation in the guar seed prices causes variations in the price of guar gum also. The study indicates the presence of July effect in both the commodities. Similar results are drawn by Soni (2012). The possible explanation for this result may be the less supply of these commodities during the sowing season which in turn causes rise in prices of these commodities. These commodities are found to be highly volatile. One reason can be the over-speculation and manipulation activities in these commodities. The herding behavior of big firms as well as small traders might be the underlying cause of high volatility and price rise.
- Result indicates that in case of mustard seed, the seasonality in return is found in the months of January and February and the seasonality in volatility is found in the month of June, August and December. The sowing season of mustard seed is October to November and it starts growing in the months of November, December, January and February. The harvesting period is February to March. The presence of seasonality in volatility during January and February may be due to the priori expectations as discussed earlier.
- In case of pepper, the seasonality in mean return is found to be statistically significant in the month of April and seasonality in volatility is found in the months of July, August, September, November and December. It might be due to the fact that pepper has high degree of seasonality during a year especially

from June to December due to festival season that creates excess demand during this time period. The results of this study confirm the findings of Maitra (2018).

- In case of soybean June, July and August are considered as weak month because of harvesting.
- For wheat, the results indicate the presence of seasonality in the months of January, March and April. The results are in line with the findings of Meera and Sharma (2016). The harvesting season of wheat is March-April. The crop is arrived to the market immediately after the harvesting. There is heavy arrival of wheat during the harvesting and the impact of highest arrival of wheat on the prices is negative.
- For FMCG stock index, the findings suggest that there is existence of seasonality in the month of February. The results are in line with Elango and Pandey (2008). The possible justification for this finding is that March is the month during which the investors have to file their tax and the investors will pay 25% of taxes in the month of February and remaining at the end of financial year. This could create bearish trend in the market and the prices fell down during February.
- Findings suggest that seasonal effects are absent in crude palm oil, RBD palm oil and soy oil. One of the possible justifications is that India is amongst major importers of palm oil and soy oil due to which these commodities are less sensitive to the government interventions as compare to other agricultural commodities.
- In case of crude oil, the findings suggest that there is presence of monthly effect in the return in the month of February. It might be due to the spring anticipation of busy summer driving season.
- In case of natural gas, the results indicate the presence of monthly effect in return in the months of April, May, November and December. The results drawn in this study are similar with the findings of Fladmark and Grimstad (2013). The demand of natural gas is high during summer season (April and May). It might be due to the increased usage of air conditioner during summer season. The increased demand of natural gas during winter (November and

December) might be due to the increased usage of natural gas for heating purpose. The energy stock index mean returns are negative during November indicates the negative impact of increased natural gas prices on the energy companies' stock price.

- In case of gold, the results indicated the presence of seasonality in the months of January, February, April, August and November. In case of silver, the seasonal effects are present in the months of January and February. It might be due to the festivals during these months.
- The results related to monthly seasonality in base metal indicated the absence of seasonal variations in most of the commodities. The results are consistent with the finding of Geman and Smith (2012) and Thiagarajan (2018). The possible explanation for these results is that the base metal commodities do not have seasonal variations in the supply. The minor seasonal variations are found which might occur due to the slight variations in construction activity. Unlike agricultural commodities, base metals do not follow seasonal patterns. The metals are mostly affected by global growth outlook rather than any other commodity grouping. The other possible explanation may be the indirect dependence of metal price on the price behavior of energy commodities as these commodities are used for the purpose of mining and refining of metals.

These results have important implications. The similar seasonal effect commodities and their related stock indices suggest the integration between these markets. The findings of this study imply that the monthly effect is not similar in both commodity market and stock market. It suggests that the inefficiencies in the market due to which it becomes easy for the investors to earn abnormal returns by taking opposite positions in both the markets.

7.2.2 Co-integration between Commodity Market and Stock Market

- The results of this study indicate that there is absence of long run co-integration between commodity market and stock market. The results are consistent with Nath and Verma (2003); Hammoudeh and Aliesa (2004); Kumar and Shollapur (2012) and Srinivasan (2014).

- The findings suggest that commodity market does not contain any significant information to forecast stock prices in India in the long run. This implies that when a common stochastic distress occurs in any one of the markets, both the markets do not move together in the long run.
- These findings also seem to recommend that commodity market is not directly linked with stock market and thus have no stock returns predictive power; independent markets do not seem to move together. Therefore in case of absence of co-integration relationship between both the markets, the variables move indiscriminately away from one another.
- If two markets are independents or not co-integrated with each other in the long run, investors can invest in both the markets for the sake of diversification of their portfolio. There is no transmission of shocks from one market to another in case of turmoil in any one of the markets.

7.2.3 Causal Relationship between Commodity Market and Stock Market

- Results of this study confirm the absence of causal relationship between commodity market and stock market. Secondly, there is uni-directional causal relationship between some of the agricultural commodities (Barley, cottonseed, jeera, mustardseed and wheat) and FMCG stock index.
- Barley and Wheat are the two cereal commodities currently traded at National Commodities and Derivatives Exchange of India. India is major producer, consumer and exporter of these commodities. The broken mustardseed and cottonseed have also been exported from India in large amount. Last but not the least, bulk production of jeera is used for export purpose.
- The uni-directional causality in these commodities and stock pairs might be due to the fact that the domestic and global demand together has influenced the Indian Commodity Market for Barley, Cottonseed, Jeera Mustardseed and wheat. When there is insufficient supply of commodity as compare to demand then the price may be move to high value due to which the speculators or the investors seeking large profits in equity market are attracted towards commodity market and continue to buy while ignoring the commodity fundamentals. When there is negative shock in any one of the market, the

speculators cut down their investment in the other market in order to avoid more risk, due to which prices fell down in that market also.

- The presence of uni-directional relationship from one market to another indicates that the informational efficiency exists in the second market. If the causal relationship does not exist in both the directions, it implies that both the markets are independent of each other. So investors can reduce risk exposure by diversifying their portfolio across the different markets. If the causality exists in both the directions, policy makers may intervene more effectively in the desired directions to take action within reasonable time horizon.
- From the investor's perspective, the above results recommend that since there is no causal relationship between the commodity market and stock market, these stocks and commodities can be used as diversification tool in the portfolio. However this same thing cannot be said about the commodities that are having causal relationship with the NSE FMCG index and unlike the common perception, the investors should be careful while including these commodities in their portfolio. As the causal relationship does not exist in any of the directions, it suggests that the policy makers are required to do more efforts to increase integration between both the markets so that they can intervene effectively in the desired direction to take action within reasonable time during the period of uncertainty. The results are consistent with the findings of Reddy and Sebastin (2009); Yamori (2010) and Gormus (2012).

7.2.4 Volatility Spillover across Commodity Market and Stock Market

- The results suggest that the shock spillover from commodity market to stock market is statistically significant for crude palm oil, guargum and nickel. Further the results related to shock and volatility spillover indicate that out of 25 commodity-stock pairs, current conditional volatility of stock market depends upon the past shocks and fluctuations in the volatility of five commodities which are mustard seed, rubber, gold, silver and copper. In addition, the current conditional volatility of stock index prices is also affected by past conditional volatility of cotton seed, crude oil and lead. One plausible reason for the volatility linkage in some of the commodity-stock pairs is that the trading volume is high in these commodities as compare to others. The rising inflow of funds into the commodity market has changed the pattern of co-integration and volatility linkage between stock market and commodity market. The swift expansion and increased trading of commodity futures increased the exposure of commodities to financial shocks and it makes the market more sensitive to financial investors' sentiments which in turn increase the volatility spillover across the markets. Zhu et al. (2014) and Adams and Gluck (2015) has given similar justification for these results.

- One of the justifications for existence of negative transmission of volatility from commodity market to stock market is that rise in commodity prices increase the production cost of the companies which are using these commodities as raw material. The profits and therefore expected rate of return of the companies will shrink. The increase in volatility of commodity prices is due to increase in demand of commodities in the emerging economies. The volatility in commodity prices also affects the stock prices via the channel of inflation. Therefore, the relationship between the stocks and commodities is negative. The results are consistent with the findings of Killian (2009), Arouri et al. (2012), Broadstock et al. (2012), Meijden and Lansink (2015) Ghosh and Kanjilal (2016).
- The possible explanation for existence of positive volatility spillover from commodity market to stock market is that the increased financialization in the commodity market has changed this interpretation to some extent. In addition to the market fundamentals, the other thing that increased the linkage between commodities and equities is the investors' sentiments and market speculation. A new class of financial investors came into sight in financial markets who regard commodities as an asset class just like stocks and bonds. Those who came under new class of investors, trades in various markets unlike existing investors, due to which the risk sharing in financial markets is improved in normal times. At the time of financial market stress, they transfer the shocks, crashes and economic weaknesses from one market to another. Further the investors take position in both the markets in order to hedge their risk. The positive linkage between commodity market and stock market is found after

the financial crisis. The reason behind this is that the investors become more careful and started responding more to the shock in these markets after the period of uncertainty. The similar conclusion is drawn by Buyukshan and Robe (2014), Silvennoinen and Thorp (2013), Lehecka (2014), Demirer et al. (2015), Du and He (2015), Girardi (2015), Nguyen et al. (2015), Oztek and Ocal (2017) and Maitra and Dawar (2018).

- Further most of studies focused on the volatility spillover from the commodity market to equity market and explained this phenomenon through a number of theories, but the spillover in the reverse direction has not been explained yet. One possible reason for these results is that the high volatility in equity market is a sign of the presence high risk facing investors. Therefore, the commodity market is also affected, if the speculative investors are also actively trading in the commodity market also. Secondly the rising stock prices are also an indicator of rising raw material consumption due to the increase in production activity. The similar justification is given by Jouini (2013).
- The results related to absence of volatility spillover in maximum pairs of commodity-stock are quite surprising because FMCG, Energy and metal companies are consumer of agricultural, energy and metal commodities respectively. It may be due to the fact that these companies have executed effectual hedging strategies against the fluctuations in the prices of raw material due to which these firms are able to manage the linkage between these markets.
- The magnitude of volatility transmission effect is quite high as compare to the shock spillover effect. The analysis depicts that the value of cross market ARCH and GARCH coefficients is much smaller comparative to the value of own one period lagged ARCH and GARCH coefficients, which suggests that the past own shocks and volatilities are more important to forecast current volatility. It further implies that commodities and stock indices do not belong to a similar group, rather these should be taken separately and to improve the weighted performance of a portfolio. Therefore, it is better to add both commodities and stocks.

7.2.5 Dynamic Conditional Correlation across Commodity Market and Stock Market

- Further the results of dynamic conditional correlation across commodity market and stock market indicate that the correlation between the stock and commodity market is highly volatile throughout the study period. Firstly, the volatility in the Indian financial markets is high during the FY 2007-08. It might be due to the financial crisis 2007-08. The Radiff Report (2008) suggests that there was huge negative gap in the SENSEX and NIFTY immediately after the announcement of Reserve Bank of India to increase the cash reserve ratio and REPO rate during this crisis. There was decrease in funds invested by foreign institutional investors in stock market as they wanted to shift their funds from risky emerging economies to the stable developed economies. Secondly in the year 2010-11, there is huge volatility persisted in the stock market which might be due to European debt crises. There was also decrease in the foreign funds in the Indian stock market during the crisis. Further there is increase in volatility during 2014-15. It might be due to the fact that there is decrease in the foreign investment in the stock market of India because of the ripple effect which occurred due to the slowdown in China. Then in the year 2016, there is crash in Indian financial markets due to the demonetization by Government. The major crisis in the Indian commodity market is the NSEL scam. During this period there is huge fall in the turnover of all commodity exchanges. It might have significant impact on the volatility of commodity market and stock market.
- During the financial crises, the correlation between the commodity market and stock market decreased. It might be due to the flight to quality phenomenon which states that during the time of financial stress, investors reduce their investments in risky asset class and shift these funds towards safer asset classes. Similar justification is given by Creti et al. (2013), Demiralay and Ulusoy (2016).
- The correlation between these two markets rises immediately after the financial crisis which might be due to the herding behavior of investors which states that participants replicate the trading strategies of other investors as they

become more cautious immediately after the crisis leading to the divergence of commodity prices from their fundamental value and hence there is increase in correlation between the markets. The prospects of recovery of the stock market from the financial stress due to strong economic growth and steady improvement in the currency, might also increased the confidence of the investor in the market, caused positive linkage between the stock market and commodity market. Similar conclusion is drawn by Zhu et al. (2014) and Demiralay and Ulusoy (2016).

- Thirdly the reason behind the booms and bursts in the correlation between commodity market and stock market is the increased financialization of commodities. The process of increase in the investment of commodities through financial instruments is known as financialization which states that due to the herding behavior of investors, they move funds in and out of commodities that lead to increase the volatility in the market. The change in the trading position of investors causes excess variability in the prices of financial securities.
- The results further depict that there is negative correlation between the agricultural commodities and FMCG stock index. Similar results are recommended by Jebabli et al. (2014), Nguyen et al. (2015) and Demiralay and Ulusoy (2016). Agricultural commodities are more volatile and sensitive to the shocks as compare to other commodities due to the fact that the production of agricultural commodities takes time and if the stock is not available, the supply alone cannot respond much to the price changes. The volatility of crude palm oil, RBD palm oil and soyoil is less comparative to other agricultural commodities. It might be due to less sensitivity of these commodities to the government interventions as compare to other commodities trading on Indian commodity market.
- In the precious metals especially in gold, the correlation is mostly negative, highlights the safe haven role of gold. Gold act as a stabilizing agent at the time of financial stress in the traditional asset classes like stock market through hedging by reducing the chances of fall in expected return from negative market shocks. The results of this study confirm the findings of Baur

and McDermott (2010), Creti et al. (2013) Harpa (2013) and Demiralay and Ulusoy (2016).

- The negative correlation between crude oil and stock market might be due to the adverse effect of rising crude oil prices on the equity prices through either discount rate cash flows or inflation effect. The results are consistent with the findings of Bouko and Alagidede (2016). The correlation pattern of crude oil and natural gases are opposite to each other. The possible reason can be the close substitution between the crude oil and natural gas. The advancement in technology now allows the customers to switch between these two energy commodities. If the variation in the price is high in one of the commodities, the investors can switch to the other commodity to hedge their risk because of substitution effect in the real market.
- Last but not the least, metal commodities show positive correlation with the stock market in this study. It might be due to the ability of these assets to attract more financial speculation. Metal price rising is the indicator of economic growth in the country due to which there is rise in correlation between the metal commodities and stock market. Similar conclusion is drawn by Nguyen et al. (2015), Partaliduo et al. (2016) and Shalini and Parsanna (2016).

The overall results related to co-integration between stock market and commodity market indicates that there is monthly seasonality in commodity and related stock indices. Secondly there is absence of co-integration and causal relationship between commodity market and stock market. Last but not the least, there is weak volatility spillover and correlation in most of the commodity-stocks pairs. It suggests that both the markets are inefficient. The flow of information is not transmitted from one market to the other market. The reason for these results is the less participation of retail investors in the commodity market which might be due to lack of knowledge and expertise. Moreover, the commodity market is running without any institutional investors, thus lacking desired liquidity and depth in the commodity market. Developing an appropriate strategy to increase integration between commodity market and stock market is one of the growing concerns among policy markers. The results of this study will help policy makers in framing their policies and strategies that can build confidence of investors towards commodity market and thereby increase integration between commodity market and stock market. This study has a lot many insights for the investors to gain from. The linkage between prices of raw material and their related stock indices will provide useful information to the investors about the possible substitution strategies between commodities and stocks. This study will help in increasing the confidence of investors in commodity market and stock market by providing optimal weights and hedge ratios, calculated on the basis of results of this study. Investors can use these weights and ratios to hedge their portfolio risk effectively.

7.3 Suggestions

For the retail investors, the key issue is whether there exists long run co-integration between the commodity market and stock market even though their price might diverge too apart individually in the short run. It is well known fact that investors can reduce their risk by swapping from stock portfolio to portfolio with stocks and commodities. From the policy point of view, Policy makers should make regulatory changes to promote deeper financial integration among these markets

7.3.1 Suggestion for investors and Brokers

This study will be useful to the investors and brokers. An understanding of the concept of volatility spillover across different markets is required for the market professional and investors such as hedgers, portfolio managers, financial analysts and asset allocators. It is required for the investors to amend their portfolio to make it better resist during the period of financial uncertainty.

If an investor is holding equities of a particular company and desire to hedge his position adjacent to the unexpected fluctuations in the commodity market. The main motive of investor is to reduce the chances of getting risk without sacrificing the projected return. The optimal weights and hedge ratio can help the investors to fulfill this motive.

Table 7.1 reports the optimal weight and optimal hedge ratio for individual Agricultural commodity-stock index pairs. The optimal weights of agricultural commodities and FMCG stock index pairs vary from 0.031% for guargum-FMCG to 91.5% for gur-FMCG. These results indicate that for the guargum commodity, the optimal weight of guargum commodity holding in the 100 rupees portfolio is 0.031% with the remainder of 99.969% in FMCG stock index while in case of gur, the optimal weight of gur commodity in 100 rupees portfolio is 91.5% with the remainder of 8.5% in FMCG stock index.

Table 7.1: Optimal Weights and Hedge Ratio for Agricultural Commodities and FMCG Index

Portfolio	Optimal Weights	Hedge Ratio
Barley-FMCG index	0.832	-0.0278
Cottonseed- FMCG index	0.0366	-0.271
Crude Palm Oil- FMCG index	0.375	-0.0685
Guargum- FMCG index	0.00031	0.903
Guarseed- FMCG index	0.2999	-0.0508
Gur- FMCG index	0.915	0.223
Jeera- FMCG index	0.602	0.0109
Mustardseed- FMCG index	0.453	-0.0283
Pepper- FMCG index	0.194	-0.0491
RBD Palm Oil- FMCG index	0.395	-0.044
Rubber- FMCG index	0.518	0.068
Soybean- FMCG index	0.474	0.0124
Soyoil- FMCG index	0.477	-0.0459
Turmeric- FMCG index	0.474	-0.036
Wheat- FMCG index	0.727	-0.0271
Yellowpeas- FMCG index	0.396	-0.0324

Source: Author's Calculations

The weight percentage of commodities is higher than FMCG Stock index in the portfolio for barley, jeera, rubber and wheat. In the remaining commodities, the percentage of stock index in the portfolio is more than commodities. It implies that in most of the commodity stock pairs, the investors are required to have more stocks than agricultural commodities in portfolio to reduce chances of getting risk without sacrificing the projected return.

The hedge ratio results indicate that the positive value of hedge ratio in agricultural commodity-stock index portfolio ranges from 0.0105 to 0.903 for jeera and guargum respectively. These results suggest that 100 rupees long position in jeera should be shorted by about one rupee in FMCG index, while 100 rupees long position in guargum can be hedged for 90 rupees in FMCG index. It further implies that among all the agricultural commodity-stock pair with positive hedge ratio, the cheapest hedge is long position in jeera and short position in FMCG index. The low values of hedge ratio considered as highly effective hedge. Arouri et al. (2011) found the similar results in their study. The negative sign of hedge ratio indicates that a short position should be taken in commodity and long in the stock market (Sadorsky, 2014). The negative hedge ratio ranges from -0.0271 (wheat) to -0.271 (cottonseed). It indicates the 100 rupees short position in wheat and cottonseed can be hedged for 2 rupees and 20 rupees in FMCG stock index respectively.

Table 7.2 shows the optimal weights and hedge ratio for energy commodities and energy stock index. The optimal weight of holding crude oil in energy commodity-stock index portfolio of 100 rupees is 36.9% with the remainder 63.1% in FMCG stock index. For natural gas, the optimal weight of holding natural gas in the portfolio is 17.4% with the remainder 82.6% in energy stock index. The results are in line with Arouri et al. (2012).

Table 7.2: Optimal Weights and Hedge Ratio for Energy Commodities and Energy Stock Index

Portfolio	Optimal Weights	Hedge Ratio
Crude Oil-Energy index	0.369	0.214
Natural Gas- Energy index	0.174	-0.072

Source: Author’s Calculations

Overall the findings suggest that investors holding energy commodities and stocks should have more stocks than energy commodities to reduce their risk with same expected return.

The hedge ratio results indicate that in case of crude oil commodity, 100 rupees long position in crude oil can be hedged for 21.4 rupees in energy stock index. While the optimal hedge ratio for natural gas-energy stock index is -0.072 which indicate that 100 rupees short position in natural gas can be hedged for 7.2 rupees in energy stock index.

Table 7.3 shows the optimal weights and hedge ratio for precious metal commodities and NIFTY index. The optimal weight of holding gold in precious metal commodity-NIFTY index is 54.3% with the remainder of 45.7% in the NIFTY index. For silver, the optimal weight of holding silver is 26.1% in the portfolio with the remainder 73.9% in NIFTY index. The results suggest that investors holding gold and NIFTY index portfolio should have more gold in their portfolio, while in case of silver, the investors should have more stocks to increase the weighted performance of portfolio.

Table 7.3: Optimal Weights and Hedge Ratio for Precious Metal Commodities and NIFTY Stock Index

Portfolio	Optimal Weights	Hedge Ratio
Gold- NIFTY index	0.543	-0.128
Silver- NIFTY index	0.261	0.114

Source: Author's Calculations

The hedge ratio results for precious metal commodity and NIFTY index indicates that a 100 rupees short position in gold can be hedged for 12.8 rupees long position in NIFTY index, while for silver-NIFTY index portfolio, a 100 rupees long position in silver can be hedged for 11.4 rupees in NIFTY index.

Table 7.4 presents the optimal weights and ratio of portfolio of base metal commodity-metal stock index. The results indicate that the optimal weight for holding metal commodity-metal index vary from 0.247 for nickel and 0.654 for aluminum. The optimal weights for aluminum, copper, lead and zinc are more than 50% indicate that the investors holding base metal commodities and Metal stock index portfolio, should have more commodities than stocks.

Table 7.4: Optimal Weights and Hedge Ratio for Base Metal Commodities and Base Metal Stock Index

Portfolio	Optimal Weights	Hedge Ratio
Aluminum- Metal index	0.654	0.192
Copper- Metal Index	0.619	0.259
Lead-Metal Index	0.520	0.248
Nickel-Metal Index	0.247	0.435
Zinc-Metal Index	0.589	0.273

Source: Author's Calculations

The results for hedge ratio in base metal commodities and metal stock index indicates that the hedge ratio ranges from 0.192 (aluminum) and 0.432 (Nickel) which implies that a 100 rupees long position in aluminum can be hedged for 19.2 rupees in metal stock index while 100 rupees long position in nickel can be hedged for 43.2 rupees in metal stock index. Among all the pairs of metal commodity and stock index, the most effective hedge is long position in aluminum and short position in Metal index.

Overall the results suggest that making commodities a part of portfolio with different financial assets can improve its weighted performance and it also permits to hedge the commodities risk more effectively. The results also imply that the optimal weights and hedge ratios are different across sectoral indices.

The results exhibit the absence of co-integration between commodity market and stock market. Therefore the investors can reduce their risk by diversifying their portfolio in both commodity and equity. The results related to the non-existence of causal relationship between the commodity market and stock market is helpful for the stock investors to design optimal portfolio and hedging strategies in the presence of different commodities

7.3.2 Suggestions for Policy Makers

- There is absence of Cointegration between commodity market and stock market in India. The co-integration between stock market and commodity market is required to extend the benefits of stock market to the participants of commodity market too in order to boost up the confidence and involvement of investors in the commodity. In the absence of co-integration between commodity market and stock market, SEBI has to formulate effective strategies to increase integration between both financial markets.
- There is existence of risk spillover in some of the commodity-stock pair which might be due to the fact that trading volume is high in these commodities. Therefore, in order to increase the association between commodity market and stock market, the policy makers should take necessary measure to increase the confidence of retail participants in the commodity market. The trading volume can be increased in the commodity market by providing the new and innovative products to the investors. The government can reduce the transaction cost to increase the trading in the financial markets. Further the financial education programs need to be introduced with practical training to enhance financial literacy.
- The risk return strategies need to be introduced which should be guaranteed by policy maker. In the absence of these strategies, the informed investors and financial analysts may move in the opposite direction to hedge their risk, due to which there is increase in the instability in commodity market and stock market. This study provides optimal weights and hedge ratios which can be provided by SEBI to the investors in order to lessen the financial instability in the stock and commodity prices and to raise the investors' participation in commodity market which in turn increase the co-integration between commodity market and stock market.

7.3.3 Limitations and Future Scope

- The scope of this study is limited to only one emerging country that is India. Further studies can be conducted to study and compare the co-integration between commodity market and stock market in other emerging countries.

- This study does not take into account the impact of exchange rates on the linkage between commodity market and stock market. Further studies can examine the association between commodity market, stock market and exchange rates.