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Spillover from Crude Oil to the Agriculture Commodities and Pakistan Stock Exchange

by

Asfandiyar Khan

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This work is dedicated to my beloved parents and family members who have encourage me to achieve this milestone. I would also like to dedicate this work to my respected supervisor "Dr. Nousheen Tariq Bhutta" for her support and guidance in each step of this study.

CERTIFICATE OF APPROVAL

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Abstract

This study aims to investigate the spillover affect from crude oil (WTI) to ten major Agricultural Commodities and Pakistan Stock Exchange. The study employs daily closing data from 1st January 2000 to 31st August 2020. There are three methodologies employed in the study; ARMA GARCH model to capture the volatility spillover and return; (b) T GARCH model to analyse the Asymmetric behaviour; (c) DCC and ADCC model to examine the time varying conditional correlation and to investigate the asymmetric effect on the correlations. There observed positive and significant mean spillover from crude oil to the all the commodity markets while for PSX it is found insignificant. However, there exists significant volatility spillovers from Crude oil to corn, rice, soybean, soybean meal, wheat and PSX, while for rest of the markets it is insignificant. The results of T GARCH model show insignificant connection between the crude oil and PSX only, while for rest of the variables there exists positive and significant relationship, which indicates bad news create more volatility than good news. DCC GARCH model results show that there exists positive impact of the past residual shocks on conditional correlation on the markets except rice and PSX because there found insignificant result in 1, while in 2 there is positive and significant impact on all the markets except oats and rubber for which this model is not applicable. The ADCC model shows a significant asymmetric effect on the correlation only for cocoa and cotton and PSX markets while for rest of the markets it shows insignificant result.

Keywords: WTI, Commodity Market, Pakistan Stock Exchange, Return and Volatility Spillovers, Asymmetric behaviour, Time Varying Correlation

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Abbreviations

ADCC	Asymmetric Dynamic Conditional Correlations
ARMA-GARCH	Autoregressive Moving Averages GARCH
DCC	Dynamic Conditional Correlations
E-GARCH	Exponential Generalized Autoregressive Conditional Heteroscedastic
EMH	Efficient Market Hypothesis
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GJR-GARCH	Glosten-Jagannathan-Runkle GARCH
MV-GARCH	Multivariate GARCH
PSX	Pakistan Stock Exchange
WTI	West Texas Intermediate

Chapter 1

Introduction

Fluctuations in oil prices not only have a significant impact on business, but also on trade markets and the overall economy. Pakistan is considered an oil importing country and imports large quantities of crude oil from international oil exporting countries every year. Pakistan's trade is generally based on the agricultural and industrial sectors. As Pakistan's population grows, it is becoming clear that oil and its related products are in high demand in the industrial and agricultural sectors, as well as in the consumption of oil. Rising international oil prices have openly affected a country's economy. depreciates domestic currency and caused of inflation in the country. Therefore, instability in oil prices affects the individual, the organization as well as the entire economic age. In this study, in order to find out the connection between oil market and agricultural commodity markets, commodity markets are selected on the basis of their high concentration and consumption and increasing demand all over the world.

Fluctuations in oil prices have also affected the Pakistan stock market positively or vice versa. Higher oil prices reflect higher input costs and this particularly affects firms' profits, while lower oil prices reflect lower input costs and higher profits. In addition, a decrease in the value of the shares may reduce the company's profits. The high input costs of an organization due to inflation can lead to pressures such as acquisitions, contracts or partnerships in the decision-making process. For these reasons, the standard of living of the economy has declined,

especially for those who have fixed income. Fluctuations in oil prices lead to create inflation in the country. Market investors who invest in stock exchanges also observe the inflation rate in the country because this inflation rate has effect on their investment and returns.

There is a continious debate on crude oil prices for oil importing countries specially the variation in crude oil (WTI) prices is a matter of concern for the economies like Pakistan, whose maximum imports are related to oil products. In Pakistan, three main sectors electricity, transpotation and industry are mostly dependent on oil inputs. So, due to this high demand on oil consumption in Pakistan, the variations in the oil prices are directly affecting the comsuption level, balance of payment, capital market, production cost and country as a whole. There are many studies available which have explored the integration of agricultural commodities, crude oil, and stock market (Nazlioglu et al., 2013)

The volatility spillover from WTI market to commodities markets are less researched. In the last few decades, huge fluctuations in the commodity prices have been observed. The sharp rise in WTI prices play an vital role in commodity markets before global financial crisis (Saadi Sedik and Cevik, 2011). As the crude oil (WTI) prices have increased so rapidly until the 2008 and after 2008 followed a quick decline throughout the financial crisis. Now the same fluctuations are recently observed as was in 2008 to 2009.

Luo and Ji (2018) explored the linkage of realized volatility of major 5 Chines agricultural commodity futures and US crude oil futures by employing DCC-GARCH and VAR model. Using intraday high frequency data from the period of 2006 to 2015. Their study also includes realized volatility that is decomposed in to negative and positive portions to recognize the asymmetric behavior of volatility linkage. The result of the study indicate volatility spillover from WTI market to commodities market, but low magnitude of volatility spillover is found. Results indicates for negative volatility, interdependency is increased in comparison to positive volatility, indicating that across the markets, volatility spillover has an asymmetric effect. Overall result concludes that there exist leverage effect in the market and bad news create more volatility than good news.

Chong and Miffre (2009) used weekly data by choosing a time span from 1981 to 2006 including 1356 observation to analyze conditional correlations among twenty-five commodity futures and thirteen fixed-income and stock indices by applying a Dynamic conditional correlation (DCC) model. The result confirmed the correlations among S&P500 (stock market index of U.S.) and eleven commodities during the time of extreme volatility in stock markets, suggest advantage of diversification for the long institutional investors. Moreover, the results also suggest that risk decreases more in case of unstable interest rate by the addition of commodity futures to the portfolios of Treasury-bill.

During recent years, agricultural commodities and oil prices show co-movement. This co-movements has directed the researchers to observe two likely transmission mechanism between agricultural commodities and crude oil prices. The first connection is created on straight influence from oil price to agricultural commodity price. So there is a lot of literature available on this linkage that is shown belove.

To understand the volatility and price dynamics of agricultural commodities, crude oil (WTI) has received significant attention in food and energy prices from 2006. Prices of the commodities markets have experienced large swings and sharp fluctuations over the last many decades due to fluctuation in macroeconomic uncertainties, financial crises and economic turmoil, and introduction of innovative regulation to combat climate Variations. The deterioration in WTI prices in 2014 revive the the importance in investigating the linkage among agricultural commodities and crude oil markets. To understand time-varying relationship among these markets provide path for assets valuation, investment allocations, policy recommendation, policy implementation and risk management.

The main purpose of this research is to examine the volatility transmission from crude oil (WTI) market to the selected agricultural commodity markets and Pakistan Stock Exchange. The information flow from one market can significantly positively or negative affect the other market prices globally. So, it assists the investor to invest in multiple markets and make portfolio investment. In the financial markets, volatility is very essential tool for the investors before making any investment decision.

1.1 Theoretical Background

1.1.1 Efficient Market Hyphothesis

In finance one of the fundamental concepts is market efficiency. There is an important debate among stock market investors, whether the market is performing well and it absorbs all the incoming information in the form of unexpected stock prices. The EMH states that the market always responds to the prompt retrieval of information from any part of the world and adjusts the stock prices according to the available information. Simply, stock prices in the financial markets are the result of information available to investors.

The theory of market performance has been the subject of intense scientific research and focused debate for the past 50 years. It has led finance and economics as a key theory explaining the fluctuations in asset prices. Efficient market theory is based on the pioneering documents of King and Cootner (1965) and Samuelson (1965), but the theory is formulated by (Fama, 1965). According to Fama (1965), the efficient market exists in three forms, weak, semi-strong and strong.

Fama et al. (1969) observed how stock prices adjust as new information arrives. Evidence suggests that any market decision, including information, has a small effect on share prices at the end of the distribution month, but much faster after the date of announcement. The study confirms the fact that the market is always efficient as prices of stock respond rapidly according to the entrance of any news in market. Malkiel and Fama (1970) argued that the market for resources should be efficient and that is possible only when asset prices reflect the information available. Fama (1998) conducted a study in support of EMH, and found that instability in market is almost as common the way information appear, as it is the reaction of past movement in the current event. The unusual return of the events. As with rational changes in technique, most long-term inconsistencies end up showing consistency with market efficiency theory.

According to Samuelson (1965) and Mandelbrot (1966) market is always efficient because asset prices react according to any new happening in the market.

The study of Chavannavar and Patel (2016) find the association between NSE 50 stock and Nifty to check whether share prices change according to the new entrance of information in market and past prices effects today's return. The findings indicate that stock prices swing as any information arrives, which specifies that in both weak and semi-strong form, Indian stock markets showing reliability with Market Efficiency Theory.

This study strongly supports the Efficient Market Theory. The crude oil and agriculture market is an important component in the global financial market which plays an important role in the overall economy of any country and provides an opportunity for investors to invest. The inflow of information from any market has a great effect on asset prices as well as investor capital Asymmetric information is also common in the financial markets and has an effect on investor returns. This study highlighted the Crude oil, Agriculture markets and Pakistan Stock Exchange. so any change in the crude oil market has a great influence on the prices of agriculture products worldwide and Pakistan Stock Exchange and also it is the prime focus of the study to capture the spillover from Crude oil to the agriculture market and Pakistan Stock Exchange.

1.2 Gap Analysis

There are a lot of literatures available on different agricultural commodities, crude oil (WTI) and Pakistan Stock Exchange in the previous literature but collectively there is no study available specifically on these ten major commodities in the past literature including cocoa, coffee, corn, cotton, oats, rice, rubber, soybean, soybean meal and wheat and Pakistan Stock Exchange. These are the most needed and daily base used items all over the world. This study will use different methodologies to find the volatility spillover among the Crude oil, agricultural commodity markets and Pakistan Stock Exchange i.e. ARMA GARCH, EGARCH, Dynamic Conditional Correlation and GJR/T GARCH. Also, in the agricultural sector a lot of researches are conducting on daily bases on these commodities to improve

its production capacity and taste due to their increasing importance in the world economy.

1.3 Problem statement

Variation in crude oil prices influence the agricultural commodities market and stock markets. Fluctuations in oil prices not only have a significant impact on business, but also on trade markets and the overall economy (Ansar and Asghar, 2013; Boleslawski et al., 2012; Fatima and Bashir, 2014; Ji and Fan, 2012; Nazlioglu and Soytas, 2011; Wang and McPhail, 2014). In this study, in order to find out the connection between oil market, agricultural commodity markets and Pakistan stock exchange, commodity markets are selected on the basis of their high liquidity, concentration, consumption and increasing demand all over the world.

1.4 Research Questions

Following four research questions are raised by keeping in view the study Gap:

Research Question 1

Is there any spillover from crude oil (WTI) prices to agriculture commodities prices and Pakistan Stock Exchange?

Research Question 2

Is there asymmetric behaviour exists between crude oil (WTI) prices, agriculture commodities prices and Pakistan Stock Exchange?

Research Question 3

Does there exist time varying correlation between the crude oil (WTI), agricultural commodities markets and Pakistan Stock Exchange?

Research Question 4

Does the correlation among crude oil (WTI) prices, agriculture commodities prices and Pakistan Stock Exchange show asymmetric behaviour?

1.5 Research Objectives

Following are the research objectives of the study :

Research objective 1

To find the mean and volatility spillover from crude oil (WTI) prices to agriculture commodities prices and Pakistan Stock Exchange.

Research objective 2

To capture the spillover from crude oil (WTI) prices to agriculture commodities prices and Pakistan Stock Exchange under the consideration of asymmetric behaviour.

Research objective 3

To explore the time-varying correlation among oil market, agriculture market Prices and Pakistan Stock Exchange.

Research objective 4

To explore the asymmetric behaviour of conditional correlation among crude oil (WTI) prices, agriculture commodities and Pakistan Stock Exchange.

1.6 Significance of the Study

The international Crude oil prices have experienced a high volatility and broader fluctuations in last several decades. In industrial transportation, production, transaction, and other various sectors are heavily influenced by WTI prices as well as country overall economy also effect by fluctuation in the prices of oil. There is sudden change observe in oil prices during Iraq war (2005) which result in inflation and effect the prices of agricultural commodities. In 2006, many events such as Israel war, Lebanon war, Iraq war and many others geographical clashes pushed up the price of crude oil to $75 per barrel.

Furthermore, in 2007 the growing issues in Turkey and crisis in US result in price movement of oil to $92.22 per barrel. Consequently, in mid of 2008 the price

of WTI move to its highest level of $147.02 per barrel. However, following in next few months (in the end of December 2008), the price of crude oil shown a decrease and the prices falls to around $100 per barrel. Then again during 2010 fluctuation is observe in crude oil prices as it ups and down between $70 and $88 per barrel.

For the investors, Pakistan Stock Exchange and agricultural commodities is an important to make portfolio investment beyond traditional securities. We know that the value of commodities increasing very sharply and the prices move opposite to stocks prices so during volatile period many risk managers depends upon agricultural commodities. The agricultural products trading required more money, expertise and time, and specially was limited to the professional and experts people in primary stages. In current period there is a lot of options and chances to be a part of commodities market. Particularly, in agricultural commodity markets, during the weather-related or specially in summer related transactions grains can be highly volatile. Those investors who are attracted with agricultural sector, the high population growth and connected with a limited supply, can be beneficial from growth in commodities prices.

The investors willing to enter in the agricultural commodity sector should be aware of the energy sector that how the during crisis like any variation in manufacturing imposed by Organization of Petroleum Exporting Countries (OPEC), and new innovations in technology in the substitude sources of energy like biofuel, wind power and solar energy etc. The new technological advances intent to change the WTI as a leading source of energy.

1.7 Plan of the Study

Introduction, Theoretical Background, Gap Analysis, Research Questions and Objectives and Significance of the Study is discuss in chapter 1. Literature review regarding previous work about Crude oil and Agricultural market and hypothesis of the study. Various methodologies are employed in the study that is presented in chapter 3. Data Analysis and interpretation are briefly discussed in chapter 4. In

last, conclusion, recommendations, limitation and future directions of the study are discuss in chapter 5.

Chapter 2

Literature Review

This study aims to find the linkage or relationship among crude oil (WTI), ten major agricultural commodity markets and Pakistan Stock Exchange that how much crude oil affect or has an association with agricultural sector and Pakistan Stock Exchange, also finds that which one commodity has more linkage and which one is lesser. Oil is a very important factor which is mostly affecting worlds economy, any variation in the oil prices largely affect economic variable and brings high changes in every sector. For this determination the researchers have evaluated the impact of the crude oil prices on stock market and Consumer Price Index (CPI) and Pakistan Stock market. For this purpose, the researchers obtained the secondary data on KSE-100 Index and CPI for 20072012. To explore this relationship the researchers analysed the impact of crude oil prices by using multi regression method in EViews. First of all, the stationarity of collected data is checked by using augmented dickey fuller test and then applied Johansen cointegration.

To investigate the influence of price fluctuation in globally, especially the impact of oil on the stock returns of Pakistan stock exchange Hanif (2020) examined two PSX indices such as Islamic and conventional and three global markets such as currency exchange, gold and oil and using monthly data for the period of 2009 to 2020. The study used the techniques including stationarity, descriptive statistics, correlation, Johnsen cointegration and regression analysis to find the relationship between these markets. The results found in the stock return process at PSX positive significance of the oil price at 1% level, for the both indices Islamic and

conventional. Further the remaining markets currency exchange and gold also have a negative significant relationship but at a higher degree. In addition, there found demand-pull inflation hypothesis for Pakistan market.

Kang et al. (2017) used data from 2002 to 2016 and employed spillover index technique and the multivariate DECO-GARCH model to study the influence of spillover between 6 commodity futures markets i.e. crude oil (WTI), rice, gold, silver, wheat, corn. The result of the study revealed that (a) correlation among the returns of commodity futures markets is expanded sharply during the period of market decline, fading the advantage of worldwide portfolio diversification for investors; (b) return and volatility spillovers is found bi-directionally across the markets of commodity futures, which is highly noticeable after the crisis period, indicating the robust influence of spillovers during the period of financial crisis; (c) both silver and gold are the main sources of spillover to other markets. Although, four commodity futures markets are found to be spillovers receivers throughout recent market decline period.

Using daily data from 1997 to 2014 Sarwar et al. (2020) examined the volatility spillover between stock market returns (namely Shanghai, Bombay and Karachi) employing bivariate BEKK-GARCH model. The study divided the data before and after the crisis to investigate the volatility spillover in different period. The results found that there exist the significant impact of historical shocks and volatility of one market on the current volatility of the selected markets. Further in Karachi stock market there found bidirectional spillover and unidirectional in the Shanghai stock market and found mixed evidence in the Bombay stock market.

Jebabli et al. (2014) examined that in economic literature, price fluctuations move from one market to another. The time period for this study is selected since 19802012, the data is collected on monthly basis.However, literature is separated by an association between energy and financial markets. With current fluctuations in market conditions, interest groups, policy makers and investors are mostly focusing on the food market. The aim of this study is to capture the shocks between financial markets, energy and international food and fluctuations over past many

years and to give some insight into the performance of and deliberately articulate its allegations for portfolio management.

The study presented new time varying parameter VAR (TVP-VAR) models with a stochastic volatility approaches which produce exciting elasticity with a parsimonious description. A generalized vector autoregressive framework is used in the study which forecast-error variance decomposition is invariant to the selected variables ordering for the valuation of the directional and total volatility spillover. The results show that the volatility spillover rises significantly during and after the crisis of 2008. Whenever stock market becomes net transmitter of the volatility shocks while the crude oil (WTI) becomes net receiver. The shocks to MSCI or crude oil (WTI) markets have short-run and immediate influences on the foods market which are highlighted during the period of financial crisis. Furthermore, the results found a diverse portfolio of the foods commodity with stocks or crude oil (WTI) significantly rises its risk-adjusted performance (Jebabli et al., 2014).

The study of Lamouchi and Alawi (2020) examined the relationship between the energy stock markets, oil spot prices and future prices in Dubai for the period from 2010 to 2018. The study used multivariate GARCH model to find the connectedness among the markets. To check the volatility transmission by using HAR model the study also considered the corresponding markets of U.S. The study found a weak correlation in Dubai markets than of U.S. Further, the results found a volatility transmission between the oil spot market and future, and also between the energy stocks markets and oil spot market, while there only found unidirectional impact from energy to oil future market.

Focusing on fourteen industrial sectors including daily data of 2240 observations from 1992 to 2005 a work done by Jayasinghe and Tsui (2008) explored that a lot of literatures of exchange rate disclosure of the stock returns do not discourse the main three related features at once. These are sensitivity of volatility of the stock returns to the volatility of changes in the foreign exchange market; the association between exchange rate variations and volatilities of stock returns and sensitivity of the stock returns to exchange rate variations. In this study a bivariate GJR-GARCH model to investigate the overall aspects of the sectoral

index exchange rate in Japanese industries. The fourteen sectors are selected for sample data. The results found a positive and significant evidences of return and asymmetric conditional fluctuations in its exchange rate. Furthermore, return in several sectors are closed associated with the exchange rate changes. The results also found evidences for asymmetries and averaged-out exposure argument. The results have straight implication for consultants to make the investment decisions and strategy for currency hedging.

To examine the influence of international oil prices shocks on the commodity markets in china, consist of corn, wheat, soybean, natural rubber, cotton, and bean pulp a study conducted by Zhang and Qu (2015) use daily data from 2004 to 2014 including 2257 observations. In this study not only kept separated the global oil price shocks into negative and positive categories to describe the different impacts on the commodity markets in a continuous procedure, but further also inspected that how jump behavior affects these commodity markets. The study examined that the global oil prices were divided by jump behavior and volatility clustering and on the spot, global oil price shocks had different type of impacts on the commodity markets. Furthermore, the impact of the shocks on most commodity markets was proportional. Natural rubber, corn, strong wheat, soybeans, cotton and bean pulp, crude oil prices were heavily impacted.. In this used two models the ARJI-GARCH and the ARMA model and have chosen six commodities Includes bean pulp, natural rubber, corn, strong wheat, cotton and soybeans.

The study of Habiba and Zhang (2020) examined the volatility transmission between the sectoral shocks return and OPEC-oil in Pakistan. To find the relationship the study used daily data from 2003 to 2017 and employed a bivariate VAR-GARCH model. The results found that there exists negative significant spillover impact from oil to the energy, agricultural and machinery sectors, while found a significant impact from stock return to oil market.

Ansar and Asghar (2013) investigated that oil is a far most and key economic factor for the world economy and that is why any discrepancy in oil market brings a high variation in each economic sector. So, for this purpose the researchers mostly focus to analyze the influence of the oil prices on the Stock market of Pakistan

(KSE-100 Index) and Consumer Price Index (CPI). For this determination the analyst and researchers obtained the secondary data on KSE-100 Index and CPI since 2007 to 2012. To examine the impact of oil prices the analysts and researchers applied the multi regression method and evaluated the data in EViews. To check the stationarity of data Augmented dickey fuller test is applied and then Johansen cointegration Test. The results of cointegration test shows that there is positive significant association among the CPI, KSE-100 Index and oil prices.

Another research done by Agnolucci (2009) using daily data from 1991 to 2005 and applying GARCH techniques, suggests that the crude oil (WTI) futures contract mentioned at the NYMEX is the greatest active traded tool in energy sector. This study goes to compare the predictive ability of the two main approaches which will be applied to predict volatility. Although the key purpose of this research is to find that which one model is most suitable to predict the volatility for the crude oil futures contract, evaluated on the bases of regression-based and statistical criteria. This study further examines whether the future fluctuations of crude oil are affected by the asymmetric effects and also whether the distribution of errors affects the parameters of GARCH model and whether the fluctuations allowing for a long term period of time increases the forcast gained through GARCH model.

Using monthly data from 2008 to 2013 and employing bivariate BEKK-GARCH model Gomes and Chaibi (2014) examined the conditional and mean variance between oil prices and stock markets. The study found maximum a bidirectional significant transmission of volatility and shocks between the stock markets (21 national stock indices and two broad indices) and oil prices.

Employing two techniques (a) GARCH (1,1) model (b) VAR model a study of Asogwa (2016) estimated the price volatility of selected crops as well as to explore the short-term association. There is no long-run connection between crude oil (WTI) prices and any individual food prices volatility. So, VAR model is used instead of VECM to explore the short-term association. The VAR model found a significant and positive short-term connection between crude oil prices and selected foods prices volatility except wheat and rice prices volatility. Further the findings

were confirmed through impulse response function. The Granger causality test found a unidirectional causality from crude oil prices to sorghum, soybean and maize prices volatility but does not found the same result for wheat and rice volatility.

Employing two methods (a) Granger causality (b) panel cointegration; a research done by Saban Nazlioglu (2012) Nazlioglu and Soytas (2012) investigated the dynamic connection between the prices of world oil and 24 agricultural commodities by choosing time framework from 1980 to 2010 including monthly data. The result of the study shows that variation in the prices of oil has strong influence on the agricultural commodity prices. In addition, the findings also confirmed a positive effect of dollar on agricultural prices and conclude that prices of oil has a significant influence on numerous agricultural commodities prices which is quite strong and is contrary to the previous findings.

A study conducted on the agricultural commodities and energy in Germany is conducted by López (2014) explored price and volatility risk creating relationship between the agricultural commodities and energy prices and their dynamics over time. Study utilizes weekly data from 2003 to 2012 by using dynamic conditional correlation (DCC) GARCH and multivariate multiplicative volatility model to find volatilities with long and short relationship. The finding of the study indicated that prices move together in long run and preserve a symmetry linkage, but the level of crude and rapeseed oil is not influenced by the biodiesel in the short run. However, rapeseed is influenced by biodiesel only in long run.

Additionally, connection of volatility between biodiesel, crude oil and rapeseed is found to be weak, while this relationship is increasing for rapeseed and crude oil over the years. The result also confirms a low correlation among the volatilities of biodiesel and rapeseed as well as asymmetric effect is found by the volatilities of rapeseed and biodiesel in response to market shocks (López, 2014) .

Muhammad (2016) examined volatility spillover and shock dependence between equity markets and crude oil for the period from 2009 to 2014. The study used cointegration BEKK-GARCH model and unit root tests because these are most fitted parameters to find the relationship between the variables. Through

cointegration test found that there is no long run connection between the stock market and crude oil. BEKK-GARCH model found that there is significant impact of volatility and shocks on Pakistan Stock Exchange. Further the study found unidirectional volatility transmission and bidirectional persistence between the equity prices of Pakistan and crude oil prices.

To examine the intraday price disclosure and volatility spillover linkage among CSI 300 index and Chinese index futures a work done by Li (2015) utilizes intraday data from 2010 to 2015 and employ (a)information share (IS) analysis (b) VAR-GARCH model. The results show that index futures plays a leading part in contributing to price disclosure, with a normal 67% of info share yearly. The price control of the futures market is found to be strong, is reduced in the existence of severe controlling trading edges that were set in place as a reply to the crisis. Additionally, the result of volatility spillover documents substantial return and volatility shocks translate from stock market to futures market and also asymmetric effect is observed between the two markets.

Sekhar (2003) find the relationship among the six agricultural commodities including wheat, rice, suger, cotton, coconut oil and groundnut oil. The price volatility spillover of the commodity markets adopts high importance in the context of current discussion concerning agricultural commodities trade liberalisation in India. Arguments against the agricultural commodities trade liberalisation are mostly based on the problems of higher volatility in the global markets. In this reseach applied monthly data collected from UNCTED, IFS AND ERSUSDA and the analysis period for domestic sector is from 1980-2001 and for international sector is from 1970 to 2001. The results found that the global agricultural commodities prices are consistently greater variable than of domestic prices. Further this research results that the intra-year variability is to much greater in the domestic market while the inter-year variability is larger in global markets. In this paper the existing bound rate of duty is commonly found adequate except in case of suger and soybean oil.

Using annual time series data collected from Energy Information Administration of U.S. since 2000 to 2013. Asogwa (2016) estimated the price volatility

of selected crops the GARCH (1,1) model is applied. There is no long-run connection between crude oil (WTI) prices and any individual food prices volatility. So, VAR model is used instead of VECM to explore the short-term association. The VAR model found a significant and positive short-term connection between crude oil prices and selected foods prices volatility except wheat and rice prices volatility. Further the findings were confirmed through impulse response function. The Granger causality test found a unidirectional causality from crude oil prices to sorghum, soybean and maize prices volatility but does not found the same result for wheat and rice volatility (Sekhar, 2003).

A study based on six agricultural commodities and the oil market exchange rate (rupees/doller) and markert return of Pakistan equity market a research done by Ayub (2018) employing mean and volatility spillover GARCH-M methodology of Bhar (2007) for the period of 1997-2017 the data of infospread from oil to agriculture commodities and exchange rate is reserved on monthly frequency. For the similar period the mean and volatility spillover from Crude oil to equity returns is obtained on daily frequency. The results of the study shows that the volatility is transmitted to the returns of different agricultural commodities including palm oil, wheat and cotton and to the exchange rate. Additionally, the spillover is detected from crude oil to equity market, sugar, palm oil and exchange rate. The findings of the study proposes that the variations in the worlds crude oil market are transmitted to returns and volatility spillover of exchange rate, agricultural commodities market, and stock market in Pakistan.

Using GTAP (Global Trade Analysis Project) model to measure the expected future affects of global and national biofuels policies on food prices and agricultural market in Pakistan Ali et al. (2013) made this study on the first generated ethanol produce from sugarcane, maize and sunflower (ethanol), biodiesel and sugar beet generated from oil seeds using the data of 2004. The findings indicate that globally directives on biofuels will highly affect the production, trade and prices of key feedstock crops like maize, rapeseed, soybean and sugarcane, specially in the Brazil, EU and USA. In Pakistan Global biofuels developments are predicted to rise the prices of soyabeen, sugarcane, rapeseed and maize. Through rise in trade

balance Pakistan will be benefiting in agricultural sector under the global scenario. Under three-producers biofuels scenario, substantially the production and price of sugarcane will increase in Pakistan. Under this situation, in agricultutral trade Pakistan will face significant loss. Therefore, net-buyers for food-securty may be threatened. As a result the income will increase of feedstock farmers. Higher crude oil prices will significantly affect commodities market by increase in production of agricultural and boifuel production costs.

Using data from 2000 to 2016 and utilize Panel-VAR model Taghizadeh-Hesary et al. (2018) investigated the relationship between foods and energy prices for the case of 8th Asian countries economies like PRC, Bangladesh, india, Indonesia, Sri Lanka, Japan, Viet Nam and Thailand. The result shows that food prices is highly effected by energy price (oil price). The results found through impulse response function,food price responds positive and significant to all shocks from oil price. Moreover, variance decomposition test results that share of oil price in the foods prices are higher. Additionaly, in 2nd period 4.81% and in 20th period 62.49% of the foods prices volatility is clarified by oil prices movement. Since for food security inflation in the oil prices is harmful, mainly in the weak economies,in this sector this would be essential to differentiate energy consumptions, from high dependence on the fossil fuel to an optimal connection of non renewable and renewable energy resources. Furthermore, the results captured the influence of biofuel price on the foods prices is statistically positive and significant but clarifies less than 2% of foods prices alteration. However, in the advanced countries through growing demand for biofuel, in the vulnerable economies, there is more chances to increase the prices of commodities and endangering food security.

Another study focusing on energy and food sector a study conducted by Yahya et al. (2019) examined the spillover impact between the crude oil (WTI) and agricultural commodities markets by applying Diebold and Ylmaz (2009, 2012) spillover framework to returns of the markets and EGARCH filtered volatility. The collected data is categorized in two subsamples: pre-2006 subsample from 1986 to 2005 and post-2006 subsample from 2006 to2016. The results found that there is a minor information transmission between commodities markets and crude

oil market in the pre-2006 subsample, however, the crude oil market grow up as a net receiver of informationsin post-2006 subsample. Further, the results found bidirectional and asymmetric movement of informarion between the agricultural commosdities and crude oil markets that becomes more stronger in the period of financial turmoil. Concequently, volatility spillover arises in the period of high decline in crude oil (WTI) prices, such as accured in 2008 and then in 2014. Additionaly, the study found a comprehensive understandings of relationship between the undetlying commodities, that may contribute in portfolio designs, policly recommendation, decisions of risk management.

The impact of price volatility in oil market is increasing to the markets of non-energy commodities. Through exchange of the fossil fuel through biofuels and the hedging strategy against the inflation made by high prices of oil and association between the agricultural commodities markets, metal market and crude oil (WTI) market has been inrcreased. The study explores the effects of the crude oil market on non-energy markets for the pre- and post-financial crises. In order to introduce the US dollar index as an extraordinary shock, the study explored the volatility and price rise in commodity markets through bivariate GARCH model with different correlation construction according to time. These studies have shown that crude oil has a positive and significant impact on the non-energy commodity sector. Consequently, the overall correlation is increased after the crisis, that directs the consistency of markets prices trend was largely affected through economic recessions. Furthermore, the infuence of U.S dollar Index on agricutural commodity markets decreased after the 2008 financail crisis (Ji and Fan, 2012).

Khalfaoui et al. (2015) investigated the relationship among the crude oil and stock markets of G-7 counties. Here the mean spillover and volatility spillover of crude oil (WTI) and the prices of stock markets on multifull time perspects. The research proposed new methods including multivariate GARCH model and wavelet analysis.

Further, the research syndicate a bivariate GARCH-BEKK model with wavelet multi resolution analysis to find the multiscale features of volatility and mean

spillover between the time series. The study proposed the multi scale behavior for hedge ratio to decide an optimal portfolio allocation. The findings given a storge evidences of significant volatility spillover among the stock markets and crude oil and found the time-varying correlation between many markets pair. Further, the findings of wavelet coherence show that the crude oil markets were mostly leading. Additionally, the decomposed volatility spillover allows the stake holders to make their hedging strategies (Khalfaoui et al., 2015).

To explore the global food and energy inflation in Pakistan a work of Jaffri et al. (2013) use data from 1993 to 2012 on CPI inflation and employ Dickey Filler (ADF) test to verify the statistic of the collected data before using the Common List Square (OLS) technique. The results show that global food prices, energy price indices and inflation in industrial inputs have significantly and positively affected inflation in Pakistan over a long period of time.. The empirical estimation captured long turn pass through of foreign energy and food inflation flow to domestic inflation are steady by recently developed researches for the developed countries. Furthermore, the study recommended sensible use of monetary policy with fiscal policy to gain a stroge grip on pass through of foreign inflation to domestic inflation in Pakistan.

There has been a lot of researches conducted on different variations in the exchange rate of stock market returns, which do not talk about three related aspects at the same time, namely: Sensitivity to stock market returns. Sensitivity of the stock market to fluctuations in the exchange rate Sensitivity to fluctuations in the stock market And the relationship between the exchange of stock returns and the exchange rate fluctuations.

The study uses the data from 1992 to 2000 having 2240 for each sector and applied a bivariate T-GARCH model to explore the features of exchange rate behavior of sectoral indexes in the Japanese industrial sector. Fourteen sectors is selected as a sample data, and found significant and positive evidence of visible return and its asymmetric conditional volatility of exchange rate exposure. further, returns in multifullsectors are correlated with exchange rate variation. The study also found a support for the averaged-out exposure and asymmetries arguments.

This research has a significant implications for the investors and managers in making investment decisions and hedging strategies (Jayasinghe and Tsui, 2008).

In the economic literature the price shocks transmission from one market to another has been examined for a log time in literature. Though, with the association between energy and financial markets. Recent varialtion in the financial market condition, interest groups, investors and policy makers are mostly focused to foods makets.

The study conducted by Jebabli et al. (2014) This study investigated the shocks transmission among financial markets, energy markets and international foods to give some insight to the volatility behavior in last many years and for fortfolio management analyze its implication through using Time Varying Parameter VAR model (TVP-VAR) with stochastic volatility approach to give a high elasticity with a frugal specifications. Additionaly, it resort a generalize Vector Autoregressive Framework to capture-error variances decomposition is invariant to the variables assembling for the valuation of directional and total volatility spillover. Furthermore, the results analyzed that there exists the volatility spillover from WTI and global stock markets to the food market. The shocks hava a short-turm and immediate influence on the food market from WTI which are highlighted during the period of financial crisis.

The NYMEX quoted that in the enegy sector crude oil is the mosted traded instrument. In this study two approaches are used namely to capture the volatility spillover namely: GARCH-type model and implied volatility model. All the monthly prices are taken in U.S. dollar for the period from 19802012. Food and energy prices are obtained from the International Monetary Fund (IMF). Although this research aims to evaluate these two models and decide that which one is most suitable and reasonable to capture the volatility for crude oil furtures contracts. According to regression and statistical based criteria, the study investigated that whether the volatility of WTI futures are impacted by asymmetric effects and whether the parameter of GARCH model are affected by distribution of errors and whether allows for a time-varying long-turm. mean and volatility gives any enhancement through analyzed gained from GARCH models (Agnolucci, 2009).

To investigate the current dynamics of the stock market fluctuations between the Chinese crude oil (WTI) and commodity market within the spectrum of the generalized forecast error variance decomposition (GFEVD) the study of He et al. (2020) proved that oil (WTI) market fluctuated positively over the Chinese bulk commodity market and voalatility spillover is sensitive to fluctuations and high geo-political or financial dealings. The results explain that the net surge in crude oil markets is mostly positively significant and is determined by short-run mechanisms (within a week). Additionally, from china undefined financial aspects such as the stock disaster happed in 2015 and market-oriented reform (MOR) as formed in 2013 has an adverse effect on oil-commodity, the volatility spillovers by med-term components (week-month) and components of long-term (month-year).

Furthermore, the spillover impact from oil market on commodity market in china is heterogeneous. The steel ore, metal, energy, coal coke commodity sector is largely affected by crude oil (WTI) prices, so, the agricultural commodities and nonmetal building materials are less affected. The conclusions implement very important implications for the policy maketrs and also for the investors (He et al., 2020).

Olasunkanmi and Oladele (2018) examined the impact of prices shocks of crude oil on the prices of commodities markets like wheat, maize, soybean and exchange rate for the period since 1997 to 2016, using monthly based data of the Nigerian market. Data for crude oil prices are taken from the Central Bank (CB) Statistics Bulletin and Food Statistics for Goods is collected from the website of Food Agricultural Organization (FAO). Here used the dummy variables were used to obtain structural intervals in the prices of agricultural commodities. Without breaks estimated the Linear ARDL and Non-linear ARDL. By implying Wald Statistics Asymmetric test exposed evidence of asymmetric affect in all cases that negative and positive shocks having the same magnitude did not have an equal influence on the prices of selected commodities. The study results significantly positive influence of the oil prices in all the cases. Sharp rise in the prices of oil market lead surge in prices of agricultural commodities. Also, exchange rate (depended variable) shows a positive significant linkage with the commodity markets.

All the tests and results concluded that the prices of crude oil market overall have a positive and significant impact on the prices of commodity market.

The work of Candila and Farace (2018) described the volatility dynamics of different exchanges trading agricultural commodities. Over the past decades substantially the volatility of commodity prices has fluctuated, with a high increase of volatility for the period of 2005 2008. To understand the components of volatility is very important in hedging decision, assets derivative valuation, risk management and assets allocation. The previous study focused mostly on descriptive models that did not evaluate the price volatility and the established relationship between its drivers. Therefore, the unconditional fluctuations are made in the study by contacting the low frequency deterministic component of the fluctuations from the macroeconomic variable.

To explore the connectedness of crude oil maket and commodities maekets of china, the study used GARCH-MIDAS model proposed by (Engle, 2002). To model different fluctuations over some period through a combination of daily GARCH (1,1) process and a MIDAS polynomial that applies to low-frequency macroeconomic data this model is fitted. Using sample time period from 1986 to2015 for the crude oil, while the sample data for Brent price is selected from 1988 to 2015. To explore the best fit of the model the realized volatility is used, afterward the monthly order is selected. The influence of monetary factor, market segment, global economic cycle, convenience yield, speculation activity and the state of six higher traded commodities is tested of chines economy. These being; Gold, Soybean, Wheat, Silver, intenational Heating oil and Crude Oil. The results show that economic data models support predictive volatility for the long horizon. In addition, the effects of real interest rates, the global economic cycle, uncertainty and convenience production on the Chinese market are increasing the ability to explain the dynamics of unconditional price fluctuations over the past decades.

Exploring the price volatility of crude oil is critical, because through several channels the prices of crude oil prices affects the economy. Galyfianakis et al. (2017) use a Vector Auto Regression (VAR) model in the article to capture influence of international crude oil on the basic industrial production, financial and

commodities markets. The study find that the U.S. economy had a large impact on crude oil prices. Furthermore, after a high negative shocks there is a huge increase in the price fluctuations of crude oil. The study further found that the oil price variations are not fully effected by the short-tem interest rate. The negative relationship between industrial production and crude oil prices has been shown to corroborate the claim of economic theoreticians that there exist a close link between economic activity and shock in oil prices. Therefore, the study indicates that there exists Granger Causality between the endogenous variables and crude oil used in the framework of Granger Causality.

Using a quantile-on- quantile approach Hau et al. (2020) examined the volatility interdependency between international crude oil maket and chinas agricultural commodity market . Further stochastic volatility in mean model is applied in the study to estimate the conditional volatility and the time-varying parameter. The results show a heterogeneous dependency between global crude oil market fluctuations and China's agricultural market fluctuations. Generally the net volatility spillover show an increasing with high quintile of agricultural market volatility and the dependency of volatility is proportional to the stable market conditions. The weekly based sample spam is selected from the futures listing to end of 2019 using GARCH.LM and stochastic volatility AR(1). In addition, more or less quintals of global crude oil fluctuations use a certain influence, while crude oil fluctuations do not affect agricultural fluctuations as per the norms of the crude oil market. Furthermore, a high stability is detected in the dynamics of the fluctuations, and the effects of the fluctuations on the return show considerable time variability. Therefore, these results can have significant implications for policy makers and portfolio managers in a variety of financial and economic situations. The largest comsumer of crude oil in the world is China, using about 65,651 million tonnes.

Recently changes in Common Agricultural Policy (CAP) for the EU dairy industry saw a shift to greater orientation. Adapting this reorientation the price of diary EU industry is sharply increasing, to secure formers revenue and to guarantee stable prices for the consumers and processors, developing the need to create a proper risk management tools.

Accordingly recently changes in Common Agricultural Policy (CAP) in EU dairy industry a research conducted by Bergmann et al. (2016) examined that there is a apparent threat by the cheaper substitutes that may replaced these commodities, like palm oil become more volatile as a diary commodity price. Over the last many decades palm oil production is almost doubled worldwide, while butter production remained comparatively flat and as a feedstock Palm oil serves for biodiesel. Hence creating a new linkage among agricultural commodities market and crude oil (WTI) Prices and volatility transmission affects between World butter prices and EU, as well as among the prices of palm oil, butter and crude oil. After and before the Luxembourg agreement, are analyzed. As Vector auto regression (VAR) model is used to propose the effects of price transmission affects between these markets.

The study examines the spillover effect from oil market to the six commodity markets including wheat, corn, rice, cotton, palm and suger, the data period is selected from 1997 to 2017. These are mutually combined with a multivariate GARCH model to capture the possible volatility transmission. The findings show a strong volatility and price transmission effect between World butter prices and EU, and EU butter shocks price and volatility transmission impacts between the prices of World butter EU. Further the shocks of EU spills to palm oil volatility. Furthermore, there exists more evidences of spillover from the oil prices to World butter prices (Bergmann et al., 2016).

Another research collaborated the short and long run association between the food price volatility and oil prices as well as the causal linkage between these markets. Here Asogwa (2016) applied the annual food price volatility index from FAO for the period from 2000 to 2013 and applied data from 2000 to 2013 for crude oil price from U.S. Energy Information and Administration (EIA). The co-integration approach found that there exists a long run relationship of price volatility among the international crude oil and domestic foods.

The vector error correction model has shown a mostly positive and significantly shorter run-of-the-mill connection between food price fluctuations and oil prices. Investigations by Ginger revealed a one-way effect, ranging from the price

of oil to the price of food, but not the other way around. It is highly recommended that interventions and policies that will reduce food price uncertainty such as trade policies, market improvement, growth and investment research among others be made. Therefore, in order to mitigate the effects of the shock of oil market prices, it is important that the government subsidizes the cost of better oil pumps, find alternative energy sources and become less dependent on oil for fertilizer production (Asogwa, 2016).

The research of Kumar (2017) examined a high volatility and fluctuations in last several periods of international Crude oil prices. International crude oil has a very significant role in the industrial transaction, production, transportation and indirectly effects the economy as well. Due to Iraq war in 2005 the inflation-adjusted international crude oil prices show a sudden change In 2006, many events such as Israel war, Lebanon war, Iraq war and many others geographical crashes lead the prices of crude oil to $75 per barrel. Moreover, the ongoing problems in 2007 in Turkey and subprime crisis in the US took up the price to $92.22 per barrel. Therefore, in mid of 2008 the price of international crude oil reached to $147.02 per barrel to its ultimate point. However, following in next few months, the price of crude oil shown a decline and the price dropped down to about $100 per barrel in the end of December 2008. Similarly, crude oil prices revel fluctuations between $70 and $88 per barrel during in 2010.

Using time span from 2000 to 2009 Serra (2011) explored the relationship between the selected markets by employing a recently proposed semi parametric GARCH model by Long et al. (2011). The analysis is proposed on price linkage among crude oil, sugar and ethanol prices in Brazil. The results reveal an existance of a strong volatility association in the prices of these markets. Parametric estimates of the conditional covariance matrix may lead to false results that can be upgrade using non-parametric techniques.

Liu et al. (2019) explored the dynamics and nature of volatility spillover among the commodity markets and crude oil market from 2008 to 2009 during financial crisis. To explore the short, mid and long-term spillover impacts this study applies a flexible bivariate hetero-geneous auto-regressive model. The study

finds a bi-directional spillover of the short-term volatility between the commodity markets and crude oil market during the crisis period. So, Compared to mid and long-term volatilities of corn , in post-crisis period are transmit to crude oil volatility. Overall, the results find less integration in crude oil and agricultural commodity markets the crisis of 20082009.

Employing a univariate TARCH model and use data from 1959 to 2014 da Silveira et al. (2017) examined the inventory effect and volatility persistence in grain futures market . Also this study uses a rolling window of 1008 observations over four years to examine daily based growth of inventory effect and persistence of volatility on soybean and corn futures relation. In short, the results of this study finds exist a highly persistence conditional volatility in both the markets. The study also finds a stronge evidences of seasonality, maturity period and inventory effect on the volatility dynamics of corn and soybean. Additionally, the findings show that in recent years the persistence of volatility is for short period of time, which produce a small reduction in long-run persistence of volatility of both markets in long run.

The primary currency used in global market for crude oil trade is the US dollar; as the recent extensive depreciation in US dollar resulted a consistent increase in the prices of crude oil. Further, the exchange-rate and crude oil prices have shown to be leptokurtic and skewed, and tail dependence or an asymmetric structure. To investegate the dependence structure between US doller exchange rate and oil price a study done by Chong and Miffre (2009) employ dynamic copula-based GARCH and use weekly data from 1990 to 2009 including 1045 observations. The finding of the study concludes that, within the crude oil market the positive feedback trading activities are statistically significant, but from the asset allocation perspective this evidence does not improve economic benefits. Finally,based on copula-based GARCH models a high risk-averse investors generate a higher fee for switching from a static strategy to a dynamic strategy.

Aloui et al. (2008) made this study to shed light on volatility spillover between the stock markets and crude oil. Used dialy data from 1989 to 2007 and applied alternative two approaches the stock market returns and Crude oil volatility

shocks,the first approach is invented on a multivariate generalized autoregressive conditional heteroskedasticity (GARCH)-type process and the second is based on the two-step technique suggested by Cheung and Ng (1996). Using daily data from 1989 to 2007, the research variables are six major stock indexes, Brent crude oil cash prices and West Texas Intermediate (WTI). In general, the results show that the price volatility had a negative impact on the behavior of stock market. Also, detected some persistence and asymmetry on oil price are found. These findings are consistent with the past studies and for the international portfolios management have many implications and for hedging risk on crude oil and international equity markets.

Including 41 major industrial, metal and agricultural commodities traded in main three futures exchange markets of China a work of Ao and Chen (2020) use data from 2006 to 2015 to investigate the maturity impact. The results found a helpful proof of the maturity impact in the future contract for many commodity products after controlling for seasonality and fixed effect of products but not for industrial nor metal product. According to this research, its the first complete study to detect the maturity impact on Chinese futures contracts.

Wang et al. (2016) investegated the dynamic correlation and volatility spillover among international crude oil and chief commodity stock markets through employing GARCH-class models. The research emphases on the dynamics connection of nine major oil-importing countries and seven exporting countries. The results are based on sample and non-sample evidence which suggests that dynamic correlation and fluctuation between a country's stock market and international crude oil has an effect on the ratio of selected oil exports and imports of the selected country to the world market. Furthermore, this risk can be greatly improved by investing in the stock markets of oil-exporting counties instead of importing them into the country's stock market.

Applying monthly data from January 2005 to September 2015 and explored the regime shifts between Lowand High volatility regimes Al Hayky and Naim (2015) employ Markov Switching Model to investigate the dynamic association between crude oil prices and Kuwaits Stock Market Index. The study examines

how the stock market index reacts differently to changes in oil prices in different governments. There is a high volatility regime, a significant and positive connection is the stock market index and crude oil prices. Secondly, low fluctuations. No correlation was found between the stock market index and crude oil prices in the system. The study also identified four transition episodes of high fluctuations during (2005, 2006, 2008, 2013). The results can be used by policy makers to mitigate the negative effects of crude oil prices on the GCC region's stock markets.

Alekhina and Yoshino (2018) studied the connection among the fundamental macroeconomic indicators of oil exporting country and the world crude oil prices through a vector autoregressive (VAR) approach. They emphasize the need to focus on the economy, which is OPEC's non-oil exporter and whose oil accounts for a significant portion of the country's total budget and export earnings. This study examines the mechanism of change in the price of crude oil in this economy from the export aspect and through the financial channel, keeping in view the element of monetary policy.The findings show that the international crude oil deviations have a positive and substantial effect on the GDP of crude oil exporting country, interest rate, exchange rate and CPI inflation rate. Additionally, to evaluate the rule of monetary policy for this energy exporter countries, this study experiments the Taylor equation and related Taylor rule, as well as the international crude oil prices gap, later this may have a positive and significant effect on the main policy rate. The results show that the Taylor rule describes the post-financial crisis monetary policy of this economy comparatively well. So finally, for the monetary policy makers, this study reflects future research and lessons from this economy.

Focusing on international crude oil production in Nigeria the study of Usoro et al. (2020) investigated the concentration to transmit volatility analysis This research is interested through the shortfalls in quantities of the global crude oil produced in past, being given a high dependency on global crude oil and its contribution to the nations economic development. In 2016, in the prices of global crude oil market the country experienced an extreme instability and decreasing production size due to destruction in the oil facilities and due to other corrupt practices in the sector. This study aims to examine the volatility of international crude

oil production, through an assumed contributor in the economic decline observed in past in Nigeria. The is obtained for the crude oil from the NNPC Statistical Bulletin. Alteration is fitted with ARCH (2) model of the crude oil series. Also, ARCH (3) and GARCH (3,3) models are close-fitting to the alteration of the error found from ARIMA (0,1,1). ARCH and GARCH models have shown evidence of volatility in the series. Although, the Nigerian governments negotiation and intervention with the Niger Delta Militants to close operational attacks on the oil facilities produced significant outcomes. Furthermore, this is found that the two economic variables (production and price) are volatile.

For making an investment decision the global crude oil price volatility plays an important role for the oil companies. Different political and economic backgrounds could drive oil companies in Asia, Europe and North America to make different tactical investment decisions. Real options methodology has been used to evaluate the impact of the crude oil price volatility on deliberate investment of the crude oil companies in the three regions.

Zhu and Singh (2016) Used data from 1991 to 2005 collected from Bloomberg database and found that the regional differences exists. North America shows a U-shaped reverse curve connection between the oil companies and crude oil price volatility. The same result found for Asia, while in Europe found a positive significant correlated linear relationship. These diverse regional results and uncertainty of the crude oil price could provide government and companies crucial information to make policy and investment decisions based on the according regions.

The oil shocks have an important impact on the prices in crude oil exporting countries for both international and domestic sector. Basher et al. (2017) derived shocks driving crude oil prices from a fully-identified structural model of the oil market. The study explored the Non-Liner Association in major oil-exporting countries with the return of the stock market to the multi-factor Markov switching framework. Oil demand shocks in Canada, the United Arab Emirates, Russia, Kuwait and Saudi Arabia have had a significant positive effect on stock returns. Iosynchronous crude market shocks affect stock returns in Russia, Norway, the United Arab Emirates and Saudi Arabia.The Speculative crude oil shocks influence

the stock returns in Russia, Canada, UAE and Kuwait. Flow oil-supply shocks matter for the Kuwait, UAE and UK. The oil shocks only has no impact on Mexico stock returns. These findings shed an important light on the investor sentiment toward the association between stock market and oil shocks in the crude oil exporting countries.

Abdelfatteh and Algia (2016) Algia et al. (2016) captured an innovative articulation between the traditional financial factors, the emergence of new financial fundamentals and physical fundamentals of the crude oil market, to clarify the crude oil (WTI) price volatility during the period of 1995 to 2013. First vector error correction model (VECM) classifies a co-integration association among crude oil (WTI) spot prices, the inventory and import of the crude oil (WTI) in the U.S, the 5-years interest rate of U.S and the U.S dollar index. An another model with the introduction of future prices at two months and KCFSI index. The findings of the study shows a miner intercorrelation of import and inventory of the crude oil (WTI) in the U.S. with a short-term oil prices. The KCFSI index and primer of speculation effects the crude oil (WTI) price dynamics in the short and long-term. The two main financial factors (5-years U.S. interest rate and dollar index) are found to be weakly exogenous in the long run.

Bein and Mehmet (2016) collaborated the relationship between the crude oil (WTI) and stock markets for the Nordic countries (Finland, Denmark, Iceland, Sweden and Norway,) and highest importing European country Germany and highest exporting country Russia using daily data for the period from 1995 to 2015. The results show that there exists different correlation between the importing and exporting countries. Also, the results show that two high oil exporting countries Russia and Norway have higher integration with crude oil (WTI) and Brent oil indices, which shows that these markets are less. Additionally, opposing to the past literature verifying negative connection between the crude oil (WTI) and stock market.

According to this study the results, although the negative relationship was evident up to the prior period of the global financial crisis (GFC), mainly starting from the GFC period (particularly for the crude oil importing countries), the

noticed a significant time-varying interrelationship that sustained until the end of the sample study. Furthermore, the during the financial turmoil in 2015, the time-varying correlation response was very high pronounced. Additionally, the results show that the two price indices WTI and Brent, applying the Markov regime-switching autoregressive (MRS-AR) approach to model periods of low volatility (stable period) and high volatility (turbulence). The Markov model exposed that in regime 0 (1998-2002, 2008-2009, and 2015), which is scaled as the highest volatile kperiod for the crude oil market, the probability reached close to 1. The study noticed that in the period of GFC and int prior period to the GFC, the time varying correlation was very strong (Bein and Mehmet, 2016).

The diversity of crude oil in the stock market and the high impact of exchange rates have sparked a heated debate among researchers. The study looked at the effects of fluctuations in the price of crude oil and the exchange rate in the Nigerian stock market. Therefore, direct policy-making depends on the fact that a nation's economy was foreign-inspired and monopoly more dependent on crude oil. The methodology employ in the study is EGARCH to find if either the crude oil price volatility or the volatility in exchange rate, or both has an influence on the stock market volatility in Nigeria. The finding of the study show that share price volatility is prompted by the both factors crude oil price and exchange rate volatility. So, policy makers must keep an eye on policies that have a tendency to calm the exchange rate system on the one hand, and to pledge the net position of oil exporting for the economy, that market experts must frame portfolio policies in such a way that volatility in both crude oil price and exchange rates is factored in time when investment decisions are being made (Lawal et al., 2016).

Considering three shapes of volatility i.e. implied volatility, realized and conditional volatilityis a work conducted by Degiannakis et al. (2014) examined the impact of shocks created in the crude oil market on the volatility of European equity market. The findings of the study reveal that supply side shocks and demand side shock do not influence the volatility of the considered markets. Another study by Janor, Abdul-Rahman, Housseinidoust, and Rahim (2013) by deploying the GARCH and EGARCH model check the impact of oil prices volatility of oil

prices on the firms performance by considering the emerging markets. The data for this study has been considered from 1986 to 2011. By using above mentioned techniques on the considered time span this study reveals that oil prices have significant impact on the volatility of the emerging market and the response is asymmetric.

Song and Li (2015) have also contributed in the existing body of knowledge by conducting a study. this study checks the nexus among the Chinese crude oil prices with the international crude oil prices by employing the VAR and VAR TARCH models. This study finds that both crude oil markets are integrated. This study reveals that effect of the external shocks is much stronger and the Chinese crude oil market rapidly respond to the shock created in the global crude oil prices. Moreover, prior forecasting of the shocks helps to transmit the volatility of the both markets. In addition of that both Chinese and international crude oil market have developed the persistent relationship.

A study including a sample of GCC countires is done by Alqattan and Alhayky (2016) examine the effect of the oil price driven shocks by utilizing the Auto Regressive Distributive Lag Model (ARDL) approach from November 2006 to February 2015. This study aims to check the long term and short-term effect of the crude oil prices on the GCC economies. It indicated that being the main producers of the oil and big exporter of crude oil these markets are also affected by the shocks created in the crude oil market. The study further reveals that except Oman none of the other GCC country is integrated with the crude oil prices. However short-term relationship exists in the case of all GCC countries with crude oil prices.

Choi and Hong (2020) conducted a study to check the interelationship among crude oil prices and equity marekts by using autoregressive distributed lag (ARDL) and BEKK-GARCH model and the Granger causality tests in Crude oil market, KOSPI 200 index and S and P500 index. The findings of the study suggests that in the periods which includes shale gas revolution VIX and OVX show bi-directional causality. Furthermore, in the past period OVX Granger causes the VKOSPI, but in later period there found no causality between them. Consequently, in both the

sub-periods they found a very strong unidirectional causality from the VIX to the VKOSPI.

Siddiqui and Muhammad (2014) have studied the influence of global oil prices variations on the performance of equity market of Pakistan for which as a sample KSE 100 index is selected. The oil prices and other macroeconomic variables i.e. foreign private portfolio investment and exchange rate are considered as a main variables of study. The study has been concluded that foreign private investment and oil price have positive connection with equity market performance. Further, the study analyzed thet political stability has a significant affect on the stock market performance.

Exploiting newly introduced implied volatility indexes to find the directional risk transfer from oil market to the agricultural commodity market, precious meal, Euro/Dollar exchange rates and US equity market. Awartani et al. (2016)Cherif, Aktham and Awrtani (2016) found significant volatility spillover from oil market to the equity market and for the agricultural commodities market there found a little transmission of volatility spillover.

The pair wise total directional connectedness to the equity market is around 20.4%, while it is found only 2.0%, 1.0% and 1.6%, to the soybeans, corn and wheat markets respectively. The risk spillover from oil market to precious metals and Euro/Dollar foreign exchange rates is found moderate. Instantaneously, uncertainly oil market spills around 8.9%, 11.10% and 11.0% to Euro/Dollar exchange rate, silver and gold respectively. Crossover volatility spillover from all markets are found tiny to the oil market, implying that with these markets oil market is the main driver of its association. In conclusion, the study found a stronge evidence of volatility spillover that since the collapse of oil prices in July2014 the volatility transmission from oil market to other markets has increased (Awartani et al., 2016).

Hamma et al. (2014) investegated in first portion collaboration and links in terms of volatility at the sector-level between the crude oil and stock markets of Tunisia and after this in the second portion to define the fine hedging strategy for the crude oil-stock portfolio in contradiction to the risk of negative variations in the stock

market prices. For Equity classes the sample data in this study covers seven sectors of Tunisia: banking, basic materials, automobiles and parts, utilities, industry, financial services and consumer services.

Weekly data are collected from the Tunisian Stock Exchange Market (BVMT), and two representative prices of crude oil for the oil market, Brent's data from the Energy Information Administration (EIA) database. Prices and WTI are measured. The data collected has two weekly frequency for the period from 2 April 2006 to 12 July 2012, recorded at the end of each business week (with a total of 339 observations). Each sector index contains a collection of Tunisian companies with the same activity segment. To test the effect of fluctuations in crude oil prices fluctuations on various sector indices, and to use hedging ratio and conditional variables to capture the hedging ratio and to describe an appropriate hedging strategy The method used for this variable is Bi Variate GARCH model. Therefore, the results show that large-scale correlations from crude oil market to the Tunisian stock market is uni-directional, and that the conditional variability of the stock sector's return is also affected by the oil market and the fluctuations of the stock market. The result confirms that GARCH BEKK -model is more suitable than others to reduce the risk of oil stock portfolio (Hamma et al., 2014).

The impact of crude oil (WTI) market shocks on the stock markets of oil-depended economies has a lot of implications for both foreign and domestic investors. Youssef and Mokni (2019) examined the role of crude oil market in stemming the dynamic connection between stock markets of oil-importing and oil-exporting countries. To find this relationship here used the DCC-GARCH model to capture the dynamic association between these markets for the period since 2000 to 2018. The results show that the oil stock markets and oil-importing and oil-exporting countries has time-varying correlation. Furthermore, the study captured that the response of the stock market returns to oil price variations in the oil-importing countries is higher than for oil-exporting countries in selected periods of turmoil. Next, oil-stocks dynamic correlation changes the origin of crude oil prices shocks stanching from the changes in the global business cycle or from the period of global turmoil. Third, the crude oil prices positive and significantly drive the connection between

oil-exporting and oil-importing countries stock markets in both low and high oil-stock correlation regimes.

Using sample period from 9th November 2010 to 31st December, 2015 (total observations 1,070) a study conducted by Thenmozhi and Maurya (2020) examined the relationship between crude oil (WTI) and wheat, soybean and corn. All commodity prices and futures prices are derived from Derivatives Exchange Limited (NCDEX) and National Commodity. In this study, the Multivariate BEK-G Arch model was applied to explain the fluctuations in the crude oil market from the wheat market in the short term. The future of crude oil (WTI) in the long-standing wheat, corn and soybean markets.

The results show that the relationship of the selected commodities markets is very weak as compared to the futures market, but in the long run the maize spot volatility transmits to the crude oil (WTI) spot market. and there is no spillover observed in the short period the food and crude oil markets. The hedging ratio shows that dynamic hedging strategy is important for portfolio weight and risk management in the futures market is more than the spot market. These results indicate that cross-market splurge is more prominent in futures markets, while its own past conditional fluctuations are more positive in the discovery of spot prices and risk-taking in foodstuff futures markets (Thenmozhi and Maurya, 2020).

Liu et al. (2019) investigated the dynamics and nature of the volatility spillover between the commodity markets i.e corn, wheat and soybean and crude oil (WTI) market for the period of financial crisis since 2008 to 2009. To examine the volatility spillover here used a flexible bivariate heterogeneous autoregressive model to investigate the short run, mid and long run spillover effect. The study found bidirectional spillovers of short-run volatility spillover between the selected commodity and crude oil (WTI) markets in this period. Additionally, in post-crisis period volatility as compared to mid and long-run volatility of corn transmitted to the crude oil (WTI). So, the results propose that the commodity markets and crude oil (WTI) market after the crisis of 2008-09 have become less integrated.

Employing Diebold and Ylmaz (2009, 2012) spillover framework for returns and EGARCH filtered volatilities Yahya et al. (2019) examined the spillover effects

between the crude oil (WTI) and major agricultural commodity markets i.e sugar, soybean oil, coffee, soybean meal and canola. This study the selected data period is divided in two subsamples: 1st pre-period is from July 1986 to December 2005 and the 2nd sample is post period from January 2006 to June 2016. The data is totally collected from Commodity Research Bureau (CRB).

The results suggest that there is tiny information transmission between the crude oil (WTI) and selected commodity markets over the pre-period sample, however, in the post-period sample the crude oil (WTI) becomes the net receiver of information. Additionally, the results found that bidirectional and asymmetric transmission of information between crude oil (WTI) and selected commodities market strengthens during period of economic and financial turmoil. Later, in the period of high decline in crude oil (WTI) prices the net volatility spillover rises, such as in 2008 and later in 2014. So, Overall, the findings suggests a high comprehensive insight into channels of association among the selected commodities markets, which may contribute in risk management decision, developing policy recommendation and portfolio designs (Yahya et al., 2019).

Using sample period from 2012 to 2017 Yip et al. (2020) analyzed a complete framework after the global financial crisis 2008-09 of their dynamic implied volatility spillover, while in view of transition between oil volatilitys regimes. The study employ a partially integrated VAR model for the investigation of dynamic samples of the Markov switching autocorrelation model to extract oil regimes, as well as the spool effects of fluctuations. They employ daily CBOE commodity volatility indices of crude oil (WTI), wheat (WIV), soybean (CIV) and corn (CIV) that are take out from Data Stream. The results show that new evidence suggests that net fluctuations on selected commodities from crude oil (WTI). The effects are less pronounced when crude oil (WTI) is in its low volatility regime. In contrast, this effect faces a growing trend when crude oil remains in its relatively high volatility regime.

Yip et al. (2017) employed five primary commodities indices (Beverages Index, Agricultural Raw Materials Index, Food Index and Energy Index Metals Index) and eight commodities currencies in the analysis. Six from Among these currencies

are strained from the findings of Cashin et al. (2004) and the remaining currencies are of two Latin American countries, which are designated on the basis of their positive and significant role in the commodities market as well as to enhance the existing literature. In this study monthly based time series data is used taken from International Monetary Fund (IMF) since January 1992 to April 2016, together with real effective exchange rate (REER) based on five primary commodities group prices and consumer prices indices and used fractionally integrated VAR (FIVAR) model.

According to results the volatility spillover analysis and static return show that among all the commodity prices indices food is the only net receiver. Second, the fluctuations in volatility and dynamic total returns led by the four regional groups during the QE1 launch. The index increased by about 15-25% over the period and then it remained in the first two rounds of QE in the United States. However, both volatility and total returns between QE3 declined as the US Federal Reserve (FR) signaled QE tipping due to the expected US economic recovery. Third, metals and energy components were the most pure transmitters of fluctuations and returns during the US QEs. Finally, almost all the selected sample currencies fluctuated. Worked as a net recipient of QE and assisted in transferring goods in goods currencies, returning to the entire US QE (Yip et al., 2017).

Using daily observations from 1984 to 2004 a study conducted by Guo et al. (2005) investigated that the oil shocks imply impact on the macroeconomic activity by several channels, some of them imply a symmetric effect, and some can be asymmetric too. Particularly, quick variations oil price , either growths or reduces, may decrease total output temporarily because by rising uncertainty they delay business investment or boost costly sectoral resource reallocation. The result shows a significant and negative effect on growth. In addition, to control the equilibrium effect, this effect turns into high-key after various variations in the price of crude oil.

Wang and McPhail (2014) explored the impact of price shocks of energy on the U.S commodity prices volatilitly and agricultural production development using a structural VAR model. Applying annual historical data of U.S GDP, gasoline

prices, agricultural exports, real agricultural commodity prices and agricultural total factor productivity (TFP), since 1948-2011 to estimate the model. These results show that growth for shorter period of time the energy prices negatively affect productivity. Shocks in energy prices and shocks to agricultural production are slightly greater than the contribution of shocks to productivity, with fluctuations in the price of about 10% of US commodities per account. However, in the medium term (3 years) the impact of energy prices far outweighs the contribution of agricultural production. With more stable effects, energy shocks mostly (about 15%) contribute to long-term fluctuations in commodity prices.

After the Price Spike in the period of 2007 to 2008, a fast price growth in agricultural commodities has gained attention. Ismail et al. (2017) examined that the same flow was seemed in the period of 2010 due which it rises concern about the volatility in the agricultural commodity prices. they examined the factors influencing volatility of the nominated agricultural and food prices. In this study monthly data is used for the period since April 1983 to April 2013. Using normal and student-t distribution GARCH (1, 1), GJR (1, 1) and EGARCH (1, 1models are evaluated for all of them.

Variable results show that interest rates and money The average and fluctuating effect of the exchange rate is transmitted to all designated agricultural commodities. Fluctuations in the price of fertilizer are transmitted only by fluctuations in sunflower oil. In last the analysis shows that the past market prices have a negative significant affect on the prices of today market except cotton, sunflower and soybean (Ismail et al., 2017).

Gozgor and Memis (2016) collaborated with price fluctuations between crude oil, corn, wheat, sugar and soybean markets from January 1, 2006 and November 29, 2013, including pre Crisis and post-crisis financial period. Yang Zhang estimate are used for historical fluctuations and it is known that there are fluctuations from crude oil to corn market. A two-way link was also found between the soybean and corn markets. Furthermore, the study found significant fluctuations from the corn and soybean market to the wheat market. The results are also valid in a different sub-period analysis.

2.1 Hypothesis for This Study

Following Hypothesis are developed regarding research gap of the study:

Hypothesis 1

There exists spillover from Crude oil to Agriculture market and Pakistan stock exchange.

Hypothesis 2

There exists spillover from Crude oil market to agriculture market and Pakistan stock exchange under the consideration of asymmetric.

Hypothesis 3

There exists time-varying correlation among the prices of Crude oil market, Agriculture market and Pakistan stock exchange.

Hypothesis 4

There exists asymmetric behavior of conditional correlation among Crude oil market, Agriculture market and Pakistan stock exchange.

Chapter 3

Research Methodology

In this research three methods are applied to check the spillover affect from Crude oil (WTI) to the selected agricultural commodities markets. The first one method used in this research is ARMA GARCH proposed by Liu and Pan (1997) to capture the interdependency between the Crude oil (WTI) and selected commodity markets. The second one methodology is T- GARCH model proposed by Glosten et al. (1993) and Rabemananjara and Zakoian (1993) to check the spillover effect from Crude oil (WTI) to the selected commodity markets under the concederation of asymmetric behavior. The last one methodology applied in this research is Dynamic Conditional Correlation (DCC) and Asymmetric-DCC (ADCC) GARCH models proposed by Engle (2002) and Cappiello et al. (2006), to capture the time varying correlationbetween the Crude oil (WTI) and selected commodity markets, and also to capture that whether correlation is effected by asymmetric behavior amang the markets.

3.1 Data Description

3.1.1 Population and Sample of Study

In this research considered daily closing prices of crude oil (WTI), Pakistan Stock Exchange and major ten agricultural commodity markets including cocoa, coffee,

corn, cotton, oats, rice, rubber, soybean, soybean meal and wheat. The time spam for the study ranges from january01, 2000 to August31, 2020. The data is collected from the Commodity Research Bureau (CRB) and some of investing.com. In this study these agricultural commodity markets are selected on the bases of their high consumption or liquidity and on their high trading volume globally. Generally, all the selected commodity markets represent a significant/large proportion of S&P (stock market index of U.S.) GSCI (Goldman Sachs Commodity Index) agricultural commodities index, which is generally accepted instrument for measuring investment performance in agricultural commodities markets and as an economic indicator.

3.2 Description of Variables

To calculate the returns of crude oil (WTI), selected agricultural commodities markets and Pakistan Stock Exchange in this study took natural log and divided today closing price of the market by the closing price of previous day of the same market, formula is as follow:

$$R_t = ln(\frac{P_t}{P_{t-1}}) \tag{3.1}$$

Where

Rt = Return of WTI and commodity market

ln = Natural log

P_t = Current day closing prices

P_{t-1} = Previous day closing prices

3.3 Econometric Model

3.3.1 Return and Volatility Spillover ARMA GARCH

3.3.1.1 From Crude oil to agricultural commodities

To explore the return and volatility transmission form crude oil (WTI) to the selected agricultural commodities markets and Pakistan Stock Exchange, two-stage GARCH-in-mean approach (GARCH-M) is used, proposed by Liu and Pan (1997) . In the 1st stage, the relevant agricultural commodities returnare modeled through an ARMA (1, 1)-GARCH (1, 1)-M econometric model.

$$r_{k,t} = \beta_0 + \beta_1 r_{k,t-1} + \beta_2 V_{k,t} + \beta_3 \varepsilon_{k,t-1} + \varepsilon_{k,t}\varepsilon_{k,t} \sim N(0, V_{k,t}) \tag{3.2}$$

$$V_{k,t} = \alpha_0 + \alpha_1 V_{k,t-1} + \alpha_2 \varepsilon^2_{k,t-1} \tag{3.3}$$

Where $r_{k,t}$ represents the daily return of Crude oil (WTI) at time t, and residual (or unexpected return) is represented by $\varepsilon_{k,t}$ is the residual (or unexpected return)which is normally distributed with time-conditional and mean zero variance $V_{k,t}$.The inclusion of ARMA (1,1) and/or MA (1) structureIn the model the inclusion of ARMA (1,1) and/or MA (1) structure is designed to adjust possible serial correlation in the data.

In the second stage, the effects of mean return and volatility spillover across the markets are estimated by obtaining the standardized residual and its square in the first stage and substituting them into the mean and volatility equations of other markets.

$$r_{j,t} = \beta_0 + \beta_{j,1} r_{j,t-1} + \beta_{j,2} V_{j,t} + \beta_{j,3} \varepsilon_{j,t-1} + \Omega_j \varepsilon_{k,t} + \varepsilon_{j,t}, \varepsilon_{j,t} \sim V(0, V_{j,t}) \tag{3.4}$$

$$V_{j,t} = \alpha_{j,0} + \alpha_{j,1} V_{j,t-1} + \alpha_{j,2} \varepsilon^2_{j,t-1} + \phi_j \varepsilon^2_{k,t} \tag{3.5}$$

where $\varepsilon_{k,t}$ is the standardized residual series for the Crude oil, and captures the mean return spillover effects from these sources. To observe the volatility spillover, the exogenous variable $\varepsilon^2_{k,t}$ the square of the standardized residual series is included in the conditional volatility equation and is well-defined as $\varepsilon_{k,t} = \varepsilon_{k,t}\sqrt{V_{k,t}}$.The subscript j in each of the equations (3) and (4) refers to the one of the agricultural commodity.

3.3.2 GJR-GARCH Model

The GJR-GARCH or threshold GARCH model was proposed by the works of Rabemananjara and Zakoian (1993) and Glosten et al. (1993). The main target of this model is to capture asymmetries in terms of negative (or bad news) and positive shocks (or good news).

$$r_{k,t} = \eta_0 + \eta_1 r_{k,t-1} + \eta_2 V_{k,t} + \eta_3 \varepsilon_{k,t-1} + \varepsilon_{k,t}\varepsilon_{k,t} \sim N(0, V_{k,t}) \tag{3.6}$$

$$V_{k,t} = \rho_0 + \rho_1 V_{k,t-1} + \rho_2 \varepsilon^2_{k,t-1} + \gamma \mu^2_{k,t-1} d_{t-1} \tag{3.7}$$

$$r_{j,t} = \eta_0 + \eta_{j,1} r_{j,t-1} + \eta_{j,2} V_{j,t} + \eta_{j,3} \varepsilon_{j,t-1} + \lambda_j \varepsilon_{k,t} + \varepsilon_{j,t}, \varepsilon_{j,t} \sim V(0, V_{j,t}) \tag{3.8}$$

$$V_{j,t} = \rho_{j,0} + \rho_{j,1} V_{j,t-1} + \rho_{j,2} \varepsilon^2_{j,t-1} + \sigma_j \varepsilon^2_{k,t} + \gamma \mu^2_{j,t-1} d_{t-1} \tag{3.9}$$

3.3.3 Time-Varying Conditional Correlation - DCC and ADCC

The **DCC model** will capture the interdependency between Crude oil and Agricultural commodities.

$$Q_t = \bar{R} + \sum_{i=1}^{m} \pi i (\varepsilon_{t-i}\varepsilon_{\acute{t}-1} - \bar{R}) + \sum_{i=1}^{i} \varepsilon i (Q_{t-1} - \bar{R}) \tag{3.10}$$

The **ADCC model** will capture the asymmetric effect on the correlation among the markets.

$$\sigma_t = min(\epsilon_t, 0), \bar{N} = \frac{1}{T}\sum_{t=1}^{T} \sigma_t \acute{\sigma_t} \tag{3.11}$$

Chapter 4

Data Analysis and Discussion

This chapter includes the result of various test, applied to explore the spillover from WTI to the selected Commodity markets and Pakistan Stock Exchange.

4.1 Graphical Representation

4.1.1 Stationarity of Data

First of all, the basic essential steps in analysis is to check the stationarity of data that whether the data of all variables is stationary or not. Stationarity of data means statistical properties of the series is constant and do not change over time. To check the stationarity and heteroscedasticity of data, the basic method that widely uses is to plot the data and to see the behaviour of data by visualization that whether it shows some known characteristics of stationery and heteroscedasticity. In this study all the data is checked for the crude oil and agricultural commodities and PSX, which is stationary for all markets. All graphs are attached in the Appendix-A.

4.1.2 Descriptive Statistics

The second step is to define the characteristics of data set through descriptive statistics of WTI, selected agricultural commodities market and PSX. Descriptive

statistics find central tendency (mean), variability, skewness and kurtosis of the data, which are show in the table 4.1.

Mean return measures the performance of the selected commodity market and PSX. The descriptive statistics result shows mostly commodity markets like cocoa, coffee, corn, cotton, rice, soybean, soybean meal, wheat and Pakistan Stock Exchange have a positive return on daily bases, while oats and rubber markets have negative return of (0.002%) per day. The highest mean return is gained by and Pakistan Stock Exchange about (0.006%) per day. Furthermore, per day lowest and highest return of the commodity markets are given by the maximum and minimum values i.e. The per day highest gain of cocoa market is (0.93%) and the minimum loss per day earned is (1%), while for coffee per day highest gain is (1.7%) and the minimum loss is (1.3%) and so on. The per day highest gain from all the commodity markets is done by the corn market which is about (25%) and the highest loss per day is done by the rubber market which is about (30%)

The standard deviation of oats market is showing highest value of (2.40%) among all the commodity markets indicating that the market is highly volatile as compared to the other commodity markets, also we can say that this market is highly risky than of other markets. PSX market shows lowest standard deviation (0.01%) among all the markets, which indicate that this market is less volatile and bears less risk.

Asymmetric behaviour of the data is measured through Skewness around its mean. For all the commodity markets except coffee, cotton and wheat, the skewness coefficient show that the distribution of return is negatively skewed and for coffee, cotton and wheat is skewed positively. The peak ness or flatness of the data is measured by Kurtosis. As the kurtosis value is greater than 3 for all the commodity markets, indicating that the distribution is peaked or all series is leptokurtic.

Crude oil (WTI) indicates positive mean return of (0.001%) per day, while showing positive standard deviation of (0.34%). Maximum and minimum statistic shows (7.2%) return gain per day and (13.2%) loss per day. Furthermore, coefficient of skewness shows that the distribution of return of WTI is skewed positively.

TABLE 4.1: Descriptive Statistics

Commodity	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
WTI	0.00010	0.72254	-1.32422	3.36700	-9.75658	508.29120
COCOA	0.00023	0.09291	-0.10006	1.94070	-0.17293	4.94185
COFFEE	0.00002	0.16631	-0.12847	2.13190	0.22296	6.03846
CORN	0.00011	0.25029	-0.26862	1.84570	-0.46782	25.26932
COTTON	0.00005	0.13622	-0.15555	1.87260	0.01272	7.05524
OATS	-0.00015	0.15430	-0.21058	2.47100	-0.45875	10.52446
RICE	0.00005	0.09802	-0.29970	1.71250	-1.71425	33.65497
RUBBER	-0.00017	0.15492	-0.30959	2.17200	-1.16918	22.15778
SOYBEAN	0.00014	0.20321	-0.23411	1.59570	-0.84920	21.53945
SOYBEAN MEAL	0.00014	0.10316	-0.20521	1.84670	-1.23391	14.80219
WHEAT	0.00015	0.11607	-0.11715	1.96580	0.19280	5.49272
PSX	0.00068	0.08507	-0.09738	0.013576	-0.38494	7.47126

This table exhibits the descriptive statistics for the series of Crude oil, selected Agricultural Commodities and Pakistan Stock Exchange.

The peakness or flatness of the data is measured by Kurtosis. As the kurtosis value is greater than 3 for all the commodity markets, indicating that the distribution is peaked or all series is leptokurtic.

4.2 Mean and Volatility Spillover from Crude oil (WTI) to the Selected Agricultural Commodity Markets and PSX

The first step of this research is to find mean and volatility spillover from crude oil (WTI) to the selected agricultural commodity markets and Pakistan Stock Exchange through econometric models.

Table 4.2 describes the measure of spillover from crude oil (WTI) to selected agricultural commodity markets including cocoa, coffee, corn, cotton and oats using an ARMA GARCH (p, q) model. Coefficient of ARCH GARCH model are stated with their p-value (in parenthesis). The coefficient of GARCH in mean, β_1 1 is found insignificant for all variables, which means that past prices behaviour has no effect on today return of the market or in simple we can say that there is no relationship occurs between the returns past and present markets. The coefficient of β_2 is also found insignificant for all variables, which also indicate that past price shocks cannot affect todays return of the market. This means that there is no relation between the past and presents markets of these variables.

The coefficient of standardized residual error term, β_3 is found insignificant lag effect for all variables, which indicates that past economic movements has no effect on today return. It describes that there is no relationship between these markets. The coefficient of α_1 for all commodity markets is significant and positive which indicates that past volatility positively affects a todays commodity market return and by using past price movement today volatility can be predicted. The coefficient of α_2 is also positively significant for all commodities, which indicates that past persistence of volatility exist and past volatility can affect positively todays volatility.

Table 4.2: Mean & Volatility Spillovers from WTI to the Selected Commodity Market - ARMA GARCH Model

	WTI	**COCOA**	**COFFEE**	**CORN**	**COTTON**	**OATS**
β_0	0.000169	-0.002169	0.000267	-0.002206	0.00121	0.00137
	(0.6178)	(0.395)	(0.7615)	(0.4896)	(0.0358)	(0.2412)
β_1	0.261057	4.692896	-0.503598	6.75547	-2.718594	-2.836656
	(0.5862)	(0.3806)	(0.8226)	(0.0629)	(0.131)	(0.1608)
β_2	0.530917	5.429465	0.655303	1.286367	-0.409095	-0.506094
	(0.2563)	(0.2513)	(0.2701)	(0.4598)	(0.2093)	(0.3616)
β_3	-0.563099	-5.43046	-0.68412	-1.289651	0.454526	0.542454
	(0.2285)	(0.2512)	(0.2507)	(0.4581)	(0.1643)	(0.3291)
Ω	-	2.28E-03	0.003224	0.003037	2.60E-03	0.002891
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
α_0	1.01E-05	1.21E-06	6.12E-06	3.03E-04	3.78E-06	0.00018
	(0.0000)	(0.0316)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
α_1	0.112384	0.020947	0.035952	0.15	0.042391	0.180234
	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
α_2	0.877165	0.977174	0.950477	0.6	0.945635	0.524048
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ϕ	-	-1.58E-10	-7.81E-12	-5.97E-09	1.52E-10	7.59E-10
		(0.2515)	(0.9798)	(0.0000)	(0.4825)	(0.4123)

Where WTI = West Texas Intermediate,values in the parenthesis denotes the P- Value. Ω denotes the parameter of mean spillover and ϕ denotes the parameter of Volatility spillover.

The coefficient of Ω is showing significant positive mean spillover to all the markets i.e. cocoa, coffee, corn, cotton and oats from WTI. The positive sign indicates that change in WTI positively affect return of these commodity persistent. The coefficient of ϕ is totally positive and significant for the commodity markets which indicates that volatility spillover from WTI to the selected commodity markets positively transmits. Also, we can say that past market volatility affects today market.

Table 4.3 Table 4.3 also describes the measure of spillover between crude oil (WTI) and remaining selected agricultural commodity markets including cocoa, coffee, corn, cotton and oats as well as Pakistan stock exchange using an ARMA GARCH (p, q) model. Coefficient of ARCH GARCH model are stated with their p-value (in parenthesis).

The coefficient of β_1 results significant and positive for soybean and soybean meal, which indicates that the past price behaviour has an impact on today return of the market or also we can say that through past price behaviour current market return can be predicted. The results for rest of the markets is found to be insignificant, which means that past prices behaviour has no effect on today return of the market or in simple we can say that there is no relationship occurs between the past and present markets. The coefficient of β_2 is only found significant for soybean, which shows that past price shocks can affect today return of the market, it means that there exists relationship between the current and past markets of soybean, while for rest of the variable like rubber, rice, soybean meal, wheat and PSX, the result is found to be insignificant, which indicates that past price shocks cannot affect todays return of the market. It means that there is no relation between the past and presents markets of these variables.

The coefficient of error term β_3 is positive and significant only for soybean, which indicates that the past economic movements affect today return of the market, also we can say that there exist relationship between past and current markets of the soybean, while for rest of the variables like rice, rubber, soybean meal, wheat and PSX the result is found to be insignificant lag effect, which indicates that past economic movements has no effect on today return of the market of commodity.

TABLE 4.3: Mean & Volatility Spillovers from WTI to the Selected Commodity Market and PSX - ARMA GARCH Model

	WTI	**RICE**	**RUBBER**	**SOYBEAN**	**SOYABEEN MEAL**	**Wheat**	**PSX**
β_0	0.000169	-0.000554	-0.000289	0.002811	0.002851	0.000143	0.000652
	(0.6178)	(0.8653)	(0.6829)	(0.0006)	(0.0443)	(0.8924)	(0.0120)
β_1	0.261057	2.080555	1.230422	-11.16058	-12.2053	-0.230186	1.739809
	(0.5862)	(0.6122)	(0.4693)	(0.0009)	(0.0458)	(0.9408)	(0.2637)
β_2	0.530917	0.915249	0.164373	-3.131175	-3.020472	0.740252	0.236211
	(0.2563)	(0.4912)	(0.2644)	(0.0121)	(0.1308)	(0.6068)	(0.0544)
β_3	-0.563099	-0.837077	-0.035694	3.115475	3.012654	-0.751924	-0.114239
	(0.2285)	(0.5294)	(0.8116)	(0.0126)	(0.1323)	(0.6014)	(0.3605)
Ω	-	0.001715	0.001936	0.001832	0.001542	0.001889	0.000112
		(0.0034)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.3985)
α_0	1.01E-05	2.80E-04	2.45E-05	1.09E-06	1.84E-06	2.41E-06	5.50E-06
	(0.0000)	(0.0000)	(0.0000)	(0.0058)	(0.0006)	(0.0068)	(0.0000)
α_1	0.112384	0.15	0.151531	0.062495	0.052548	0.042175	0.164602
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
α_2	0.877165	0.6	0.79467	0.929903	0.940944	0.94863	0.792087
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ϕ	-	-5.27E-09	1.53E-09	4.25E-10	3.89E-10	4.48E-10	1.08E-09
		(0.0000)	(0.0454)	(0.0002)	(0.0108)	(0.0352)	(0.0000)

Where WTI = West Texas Intermediate, PSX = Pakistan Stock Exchange, values in the parenthesis denotes the P- Value. Ω denotes the parameter of mean spillover and ϕ denotes the parameter of Volatility spillover.

It describes that there exist is no relationship between these markets.

The coefficient of α_1 for all commodity markets is significant and positive which indicates that past volatility positively affects todays commodity markets and by using past price movement todays return can be predicted. The coefficient of α_2 is also positive and significant for all markets, which indicates that past persistence of volatility exist and past volatility can affect positively todays volatility.

The coefficient of mean spillover Ω is insignificant for PSX, while for rest of the markets it is showing significant positive mean spillover from WTI to all the markets like rice, rubber, soybean, soybean meal and wheat. The positive sign indicates that change in WTI positively affect todays return of these commodity market.

The coefficient of ϕ is also found positive and significant for the markets such as rice, rubber, soybean meal, soybean, wheat and PSX. Which indicates that volatility spillover from WTI to the selected agricultural markets and PSX positively transmits. Also, we can say that past volatility market affect today market.

4.3 T- GARCH -Estimation of Asymmetric Behavior from Crude oil (WTI) to Selected Agricultural Commodity Markets and PSX

As the standard ARCH and GARCH model captures good and bad news symmetrically and their impact on asset volatility is same. It does not capture the asymmetric behaviour as events, incidents and news, has a great and very powerful influence on decision-making of financial investor. So, in this study T-GARCH approach used to capture the Asymmetries in term of negative and positive shocks.

Table 4.4 captures the spillover from crude oil (WTI) to the selected agricultural commodity market cocoa, copy, corn, cotton and oats under the consideration

TABLE 4.4: Spillover from from WTI to the Selected Commodity Market under the Consideration of Asymmetric Behavior

	COCOA	COFFEE	CORN	COTTON	OATS
η_0	-0.00117	0.000332	0.000383	0.000951	0.001702
	(0.2676)	(0.7033)	(0.3086)	(0.0880)	(0.1501)
η_1	2.943925	-0.65079	-1.351485	-2.607409	-3.193596
	(0.2603)	(0.7556)	(0.3102)	(0.1460)	(0.1285)
η_2	1.957025	0.432752	-1.070464	-0.37547	-0.340306
	(0.2321)	(0.3940)	(0.0746)	(0.2305)	(0.5341)
η_3	-1.95931	-0.465787	1.093083	0.422286	0.377581
	(0.2314)	(0.3604)	(0.0684)	(0.1784)	(0.4912)
λ	0.002457	0.003105	0.001969	0.002594	0.002947
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ρ_0	9.64E-05	9.87E-06	3.82E-06	3.85E-06	0.000179
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ρ_1	0.15	0.056081	0.059791	0.029267	0.210606
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ρ_2	0.6	0.942872	0.898	0.94436	0.521661
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
σ	-2.15E-09	-2.07E-10	1.35E-09	1.76E-10	1.63E-09
	(0.0000)	(0.5418)	(0.0000)	(0.4349)	(0.1183)
γ	0.05	-0.041555	0.047807	0.029077	-0.061814
	(0.0235)	(0.0000)	(0.0000)	(0.0000)	(0.0302)

Where WTI = West Texas Intermediate, values in the parenthesis denotes the P- Value. λ denotes the parameter of mean spillover and σ denotes the parameter of Volatility spillover. γ denotes the parameter asymmetric behavior.

of asymmetric behaviour.The GARCH in mean coefficient η_1 gives insignificant results for all the variables which indicates that todays return cannot be predicted by past return of markets.

The coefficient of η_2 is found insignificant lag effect for all the markets of the selected variables which indicates that todays return cannot be predicted through past behaviour of markets. Also, in simple we can say that there is no relationship between the past and current markets. The coefficient of standardized residual error term, η_3 results insignificant for all markets, which indicates that the past abnormal movements could not transfer to current market, in simple there is no relationship between the current and past markets.

The coefficient of ρ_1 results positively significant for all commodity markets which shows that past market behaviour effects positively today commodity market or in simple we can say that through past price movement todays volatility can be predicted. For the coefficient of ρ_2 all the results are found positive and significant for all commodity markets which describes that present persistence of volatility effects by past volatility. It means the relationship exist between these markets.

The mean spillover parameter, λ results positive significant for all the commodity markets. It indicates that there exists positive mean spillover from crude oil (WTI) to the commodity markets of cocoa, coffee, corn, cotton and oats. The sign of positive relationship shows that any variation or change in WTI reflects the same to the selected commodity markets cocoa, coffee, corn, cotton and oats. The coefficient of volatility spillover, σ is results positive and significant for all the selected commodities market of cocoa, coffee, corn, cotton and oats, which indicates that there exists volatility spillover from WTI to the selected commodity markets. The positive sign of coefficient indicates that any variation in WTI will reflect the same to these commodity markets. Simply we can say that the commodity market positively exposed to all changes in the WTI.

The asymmetric parameter γ is found to be significant and positive only for cocoa and corn, which indicate that there exists asymmetric behaviour between the markets. Asymmetric behaviour indicates us that all commodity markets respond

randomly to the arrival of good and bad news from WTI. While for rest of the variable like coffee, cotton and oats, the results are found to be insignificant, which shows that there is no influence exists in term of good and news, also significant result gives us the evidence of existence of leverage affect in the selected commodity markets. Furthermore, positive sign of coefficient indicates us that negative return shocks make more volatility than of positive return shocks in the commodity markets, or simply we can say the volatility of bad news is much higher in comparison of the volatility created by good news.

Table 4.5 also capture the spillover from WTI to the selected agricultural commodity markets of rice, rubber, soybean, soybean meal, wheat and PSX under the consideration of the asymmetric behaviour.

The coefficient η_1 results only significant for soybean, which shows that through past return of the market soybean today return of the market can be predicted. For rest of the commodities like rice, rubber, soybean meal, wheat and PSX, the result is found to be insignificant, which indicates that todays return cannot be predicted by past return of markets. The coefficient of η_2 gives significant lag effect for the markets of rice, soybean and PSX, which indicates today return can be predicted through past behaviour of these commodities markets. While for rest of the variables like rubber, soybean meal and wheat, the result is found to be insignificant lag effect, which indicates that todays return cannot be predicted through past behaviour of these commodity markets. Also, simply we can say that there is no relationship between the past and current markets.

The parameter of error term η_3 results significant for rice and soybean only, which indicates that past abnormal movements could transfer to today market or also we can say that there exists relationship between past and current market of these commodity markets. The rest of the variables like rubber, soybean meal, wheat and PSX results insignificant, which indicates that the past abnormal variation does not translate in to these markets, in simple we can say there is no relationship between the current and past markets return.

The Coefficient of ρ_1 show positive significant result for all commodity markets which shows that past market behaviour positively effects the today,s commodity

TABLE 4.5: Spillover from from WTI to the Selected Commodity Market and PSX under the Consideration of Asymmetric Behavior

	RICE	RUBBER	SOYBEAN	SOYABEEN MEAL	Wheat	PSX
η_0	7.51E-05	-0.000303	0.003554	0.000794	-2.49E-05	4.60E-04
	(0.3762)	(0.6715)	(0.0007)	(0.5234)	(0.9844)	(0.0767)
η_1	-0.801724	1.352226	-12.3118	-2.407592	0.180411	0.156612
	(0.8125)	(0.4305)	(0.0009)	(0.5234)	(0.9566)	(0.9194)
η_2	0.748784	0.163188	-3.932579	0.26672	0.915971	0.370434
	(0.0000)	(0.2787)	(0.0091)	(0.8243)	(0.5362)	(0.0006)
η_3	-0.704847	-0.036743	3.921583	-0.261469	-0.928183	-0.232698
	(0.0000)	(0.8102)	(0.0093)	(0.8283)	(0.5313)	(0.0332)
λ	0.016069	0.001979	0.001858	0.001648	0.001885	0.000158
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.2160)
ρ_0	-2.28E-07	2.38E-05	1.00E-06	2.31E-06	2.60E-06	6.18E-06
	(0.0000)	(0.0000)	(0.0169)	(0.0001)	(0.0032)	(0.0000)
ρ_1	0.150000	0.158116	0.076638	0.094906	0.049114	0.083078
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
ρ_2	0.600000	0.797403	0.931511	0.930377	0.949659	0.794788
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0000)
σ	1.08E-09	1.69E-09	4.27E-10	6.23E-10	4.78E-10	8.21E-10
	(0.0000)	(0.0283)	(0.0002)	(0.0003)	(0.0259)	(0.0000)
γ	0.050000	-0.017872	-0.030064	-0.068245	-0.019085	0.155161
	(0.0695)	(0.2199)	(0.0000)	(0.0000)	(0.0007)	(0.0000)

Where WTI = West Texas Intermediate, PSX = Pakistan Stock Exchange, values in the parenthesis denotes the P- Value. λ denotes the parameter of mean spillover and σ denotes the parameter of Volatility spillover. γ denotes the parameter asymmetric behavior.

market or in simple we can say that through past price movement todays volatility can be predicted. For ρ_2 the result is found positive and significant for all commodity markets which describes that present persistence of volatility effects by past volatility. It means the relationship exists between these markets.

The parameter of mean spillover λ results only insignificant for PSX, while all other markets shows positive and significant linkage, which indicates that there exists positive mean spillover from WTI to the commodities markets of rice, rubber, soybean, soybean meal and wheat. The sign of positive relationship shows that any variation or change in WTI reflects the same to the selected commodity markets rice, rubber, soybean, soybean meal and wheat.

The coefficient of volatility spillover σ is found insignificant only for rice and rubber, which indicates that there exists no volatility spillover from WTI to these commodity markets. While for rest of the variables like soybean, soybean meal, wheat and PSX, the result is found significant, which indicates that there exists volatility spillover from WTI to the selected commodity markets. The positive sign of coefficient indicates that any variation in WTI will reflect the same to these commodity markets. Simply we can say that the commodity market positively exposed to all changes in the Crude Oil market.

The coefficient of asymmetric term γ is found to be significant and positive for all commodity markets like rice, rubber, soybean, soybean meal, wheat and PSX, which indicate that there exists asymmetric behaviour between the markets. Asymmetric behaviour indicates us that all commodity markets respond randomly to the arrival of good and bad news from WTI. Also, significant result gives us the evidence of existence of leverage affect in the selected commodity markets. Furthermore, positive sign of coefficient indicates us that negative return shocks make more volatility than of positive return shocks in the commodity markets, or simply we can say the volatility of bad news is much higher in comparison of the volatility created by good news.

4.4 Time-Varying Conditional Correlation DCC & ADCC

The above working including ARMA GARCH which captures mean and volatility spillover from WTI to the selected commodity markets and Pakistan Stock Exchange and T- GARCH which measures the asymmetric behaviour of the markets in term of good and bad news. As ARMA GARCH connects day to day impact but correlation can vary over time, so in this study Dynamic Conditional Correlation is used to measure the co-movement among the markets, and also to check that whether the time varying correlation exists between markets or not. To check the asymmetric affect among the markets extended version of DCC model and asymmetric dynamic conditional Correlation ADCC is used.

4.4.1 DCC MV GARCH Models - Estimates between WTI and Selected Commodity Markets and PSX

Table 4.6 and 4.7 display the most suitable univariate DCC model and estimates from WTI to the selected commodity markets and Pakistan Stock Exchange.

Table 4.7 shows the results of DCC GARCH model between the WTI and selected commodity markets and PSX. The most fitted model is selected on the basis of lowest Akaike Information Criteria (AIC). This table reports the two parameters θ_1 and θ_2. The θ_1 parameter measures the impact of past residual shocks on conditional correlation while θ_2 measure the effect of lagged dynamic conditional correlation respectively with their P- values. . To evaluate the DCC GARCH model the first basic condition is to check the stability condition that ($\theta_1 + \theta_2 < 1$) it means that both the thetas values must be less than 1 individually. All the selected commodity markets successfully met the stability condition.

The coefficient of θ_1 is found to be significant and positive for coffee, corn, cotton, soybean, soybean meal and wheat, which shows that there exists high correlation and past residual shocks effects positively the conditional correlation, while it is found to be insignificant for rice, cocoa and PSX., which indicates that there is no

TABLE 4.6: DCC MV- GARCH Models Estimate between WTI, selected Commodity Markets and Pakistan Stock exchange

Sr. No.	Commodities	Selected Model
1	**Cotton**	EGARCH
2	**Wheat**	EGARCH
3	**RICE**	GJR GARCH
4	**COCOA**	EGARCH
5	**COFFEE**	EGARCH
6	**SOYABEEN**	EGARCH
7	**SOYABEEN MEAL**	EGARCH
8	**CORN**	EGARCH
9	**OATS**	NA
10	**RUBBER**	NA
11	**PSX**	GJR GARCH

This table shows the optimal uni-variate DCC GARCH model with respect to each Commodity Market and Pakistan Stock exchange and then the appropriate model is chosen on the basis of lowest possible Akaike Information Criteria (AIC).

TABLE 4.7: DCC MV- GARCH Models Estimate between WTI, Selected Commodity Markets and Pakistan Stock Exchange

Sr.No	**COMMODITIES**	**WTI**	
		θ_1	θ_2
1	**WHEAT**	0.00752	0.98871
		(0.0019)	(0.0000)
2	**RICE**	0.01806	0.71945
		(0.1578)	(0.0161)
3	**COFFEE**	0.00712	0.99176
		(0.0000)	(0.0000)
4	**RUBBER**	NA	NA
5	**SOYABEEN**	0.00545	0.99347
		(0.0000)	(0.0000)
6	**SOYABEEN MEAL**	0.00617	0.98961
		(0.0127)	(0.0000)
7	**CORN**	0.00552	0.99257
		(0.0003)	(0.0000)
8	**OATS**	NA	NA
9	**COCOA**	0.00585	0.99213
		(0.0149)	(0.0000)
10	**COTTON**	0.00336	0.99545
		(0.0036)	(0.0000)
11	**PSX**	0.00250	0.97359
		(0.2903)	(0.0000)

This table summarizes the estimated coefficients from the DCC-MV-GARCH model in a bivariate framework for WTI, selected Commodity Market and Pakistan Stock exchange. Values in parenthesis are the p-values. Theta (1) and Theta (2) are reported above the p-values.The Akaike Information Criteria (AIC) is used for the selection of a suitable uni-variate GARCH model.

relationship exists between the past residual shocks and today market.The parameter of θ_2 is found to be highly significant for the markets like cocoa, coffee, corn, cotton, oats, rice, rubber, soybean, soybean meal, wheat and PSX. Which gives the evidence for the existence of lagged dynamic conditional correlation among these markets. The NA terms for rubber and oats, show that the stability conditions for the specified commodity like oats and rubber, is not met, so this model cannot be applied for these commodity markets. Also, we can say that conditional correlation does not exists in these markets.

4.4.2 ADCC MV GARCH Models - Estimates between WTI and Selected Commodity Markets and PSX

Table 4.8 and 4.9 display the most suitable univariate DCC model and estimates from WTI to the selected commodity markets and PSX. The most fitted model is selected on the basis of lowest Akaike Information Criteria (AIC).

Table 4.9 also show the parameter θ_1 and θ_2 which is same as previously used in DCC GARCH model i.e. The effect of past residual shocks on conditional correlation (θ_1) and effect of lagged dynamic correlation (θ_2). The third parameter used in this model is (θ_3) to captures the effect of asymmetric behavior (good or bad news) on dynamic conditional correlation. Here also in ADCC the first condition is to check the stability condition whether it met or not ($(\theta_1 + \theta_2 < 1)$. So, stability condition met for all Commodity markets and model can be used to examine the linkage among the markets.

The parameter of θ_1 is found to be significant and positive for coffee, corn, cotton, soybean, soybean meal, wheat and PSX., which shows that there exists high correlation and past residual shocks effects positively the conditional correlation.

Furthermore, the θ_1 is only found to be insignificant for rice, which indicates that there is no relationship exists between the past residual shocks and today market. The parameter of θ_2 is found to be highly significant for the markets like cocoa, coffee, corn, cotton, rice, soybean, soybean meal, wheat and PSX. Which gives the evidence for the existence of lagged dynamic conditional correlation among these

TABLE 4.8: ADCC MV- GARCH Models Estimate between WTI and Commodity Markets and Pakistan Stock Exchange

Sr. No.	commodities	Selected Model
1	**Wheat**	GJR/TARCH
2	**RICE**	GJR/TARCH
3	**COCOA**	EGARCH
4	**COFFEE**	EGARCH
5	**SOYABEEN**	EGARCH
6	**SOYABEEN MEAL**	EGARCH
7	**CORN**	EGARCH
8	**OATS**	NA
9	**RUBBER**	NA
10	**COTTON**	GJR/TARCH
11	**PSX**	EGARCH

This table shows the optimal uni-variate ADCC GARCH model with respect to each Commodity Market as well as Pakistan Stock Exchange and then the appropriate model is chosen on the basis of lowest possible Akaike Information Criteria (AIC).

TABLE 4.9: ADCC MV- GARCH Models Estimate between WTI, Commodity Markets and Pakistan Stock Exchange

SR.NO	**COMMODITIES**	**WTI**		
		θ_1	θ_2	θ_3
1	**WHEAT**	0.00744	0.98763	0.00126
		(0.0034)	(0.0000)	(0.3344)
2	**RICE**	0.01680	0.72062	0.00426
		(0.2087)	(0.0150)	(0.8125)
3	**COCOA**	0.03149	0.98549	0.00335
		(0.0000)	(0.0000)	(0.0000)
4	**COFFEE**	0.00689	0.99176	0.00056
		(0.0000)	(0.0000)	(0.4653)
5	**SOYABEEN**	0.00550	0.99346	-0.00008
		(0.0001)	(0.0000)	(0.8881)
6	**SOYABEEN MEAL**	0.00633	0.98975	-0.00046
		(0.0124)	(0.0000)	(0.6280)
7	**CORN**	0.00550	0.99256	0.00003
		(0.0003)	(0.0000)	(0.9677)
8	**OATS**	NA	NA	NA
9	**COTTON**	0.00854	1.01250	0.00023
		(0.0000)	(0.0000)	(0.0000)
10	**RUBBEE**	NA	NA	NA
11	**PSX**	-0.00910	0.78646	-0.00287
		(0.0000)	(0.0000)	(0.0000)

This table summarizes the estimated coefficients from the ADCC-MV-GARCH model in a bi-variate framework for WTI and selected Commodity Markets as well as Pakistan Stock Excahnge. Values in parenthesis are the p-values. Theta (1), Theta (2) and Theta (3) are reported above the p-values. The Akaike Information Criteria (AIC) is used for the selection of a suitable uni-variate GARCH model.

markets. The NA terms for rubber and oats, show that the stability condition for the specified commodity like oats and rubber, is not met, so this model cannot be applied for these commodities market. Also, we can say that conditional correlation does not exists in these markets.

The parameter of asymmetric effect θ_3 is only found to be positive and significant for cocoa, cotton and PSX. markets, which indicates that the correlation has been increased with the arrival of bad news. Further, the markets of coffee, corn, rice, soybean, soybean meal and wheat, is found to be insignificant which indicates asymmetric effect does not translate into the conditional correlation or simply we can say arrival of good or bad news has no impact on the correlation. The NA terms for rubber and oats, show that the stability condition for the specified commodity like oats and rubber, is not met, so this model cannot be applied for these commodities market. Also, we can say that conditional correlation does not exists in these markets.

Chapter 5

Conclusion and Recommendations

5.1 Conclusion

The purpose of this research is to examine the spillover from crude oil (WTI) to the Pakistan Stock Exchange and selected agricultural commodity markets such as cocoa, coffee, corn, cotton, oats, rice, rubber, soybean, soybean meal and wheats.

In this research is used three methodologies (1) ARMA GARCH model to investigate the mean and volatility spillover between crude oil (WTI) and selected agricultural commodities markets and Pakistan Stock Exchange. (2) T-GARCH model to examine the spillover from crude oil (WTI) to the selected agricultural commodity markets and Pakistan Stock Exchange under the consideration of asymmetric behaviour; (3) DCC GARCH and ADCC GARCH model to analyse time varying conditional correlation and asymmetric effect on these correlations among crude oil (WTI) and selected agricultural commodity markets and Pakistan Stock Exchange. The time period of the study is from 1 January 2000 to 31 August 2020, but time frame of three commodities is from 2010 to 2020, the trading days of crude oil (WTI) and selected commodity markets is matched to explore the connection among these markets.

There observed positive and significant mean spillover from crude oil WTI to all the commodity markets. The positive sign shows that any variation in WTI brings the same changes in these markets, its mean that WTI has a positive impact on the return of these commodity markets. While for PSX it shows insignificant results. Insignificant result means that there is no relationship between the WTI and these commodity markets. The results also show positive and significant volatility spillover from WTI to PSX and all the commodity markets i.e cocoa, coffee, corn, cotton, rice, rubber, soybean, soybean meal and wheat market. The positive sign shows that any variation in WTI brings the same changes in these markets, its mean that WTI has a positive impact on the return of these commodity markets.

The second approach we used in this study is T GARCH model to find the spillover effect from crude oil WTI to PSX and to the commodity markets of cocoa, coffee, corn, cotton, oats, rice, rubber, soybean, soybean meal and wheat, under the consideration of asymmetric behaviour. The findings show that there is insignificant connection between the crude oil, soybean and PSX only, while for rest of the variables there exists positive and significant relationship. Asymmetric behaviour indicates that the commodity markets differently respond to the arrival of good and bad news from crude oil (WTI). Additionally, the positive sign of coefficient indicates that the negative return shocks create more volatility than positive return shocks in the commodity markets. Simply, we can say that the volatility of bad news is higher compare to the volatility good news. Furthermore, there found no leverage effect for the soybean market, because asymmetric parameter is found to be insignificant or can say that there is no influence of good or bad news.

The 3rd methodology used in this research is DCC GARCH and ADCC to explore the time varying correlation among the markets and also to investigate the asymmetric effect on the correlations. The stability condition ($(\theta_1 + \theta_2 < 1)$ is not met only for rubber and oats for both DCC and ADCC GARCH, while for rest of the variables its met. The DCC and ADCC must be used to capture the connection among these markets. So, using DCC GARCH model the results show that there exist positive impact of the past residual shocks on conditional

correlation on the markets of cocoa, coffee, corn, cotton, rice, soybean, soybean meal and wheat, while for rice, cocoa and PSX, there found insignificant result in θ_1, while in θ_2 there is positive and significant impact on all the markets except oats and rubber for which this model is not applicable.

The ADCC model results positive asymmetric affect on the correlation only for cocoa, cotton and PSX markets which indicates that with the arrival of bad news the correlation has been increased. While for rest of all the commodity markets it is showing insignificant result which indicates asymmetric effect does not translate in to the conditional correlation or simply, we can say arrival of good or bad news has no impact on the correlation.

5.2 Recommendations

The key purpose of this research is to find out the spillover effect from Crude oil (WTI) to the selected commodity markets and Pakistan Stock Exchange. So, the linkage among selected markets plays a very significant and affective role for the investors to make portfolio investment, with portfolio investment risk minimizes and the benefit of divergence arises with the addition of shocks that increase in one market and reflects comparatively low level of correlation in another market. So, the overall results of this research strongly recommend to the markets players including traders, investors, portfolio managers as well as research analysts to have a strongest hold on the fluctuation of Crude oil (WTI) as it is positively linked with the commodity market return and Pakistan Stock Exchange. From this study the managers can make decisions for future to respond the market and can take initiative steps for risk management.

5.3 Limitations and Future Directions

This research mostly covers the information transmission from Crude oil (WTI) market to the selected agricultural commodity markets in a very comprehensive manner but there remains some space and in future on that further

research can be done to fill this gap. As in this study sample size of the commodity market is eleven including crude oil market, so in future there may include further some commodities to explore their relationship. Furthermore, this research includes daily based time series data and implied the ARMA and T GARCH models with extension of DCC and ADCC GARCH models, so in further studies there may include other GARCH models to find the relationship among these markets.

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Appendix A

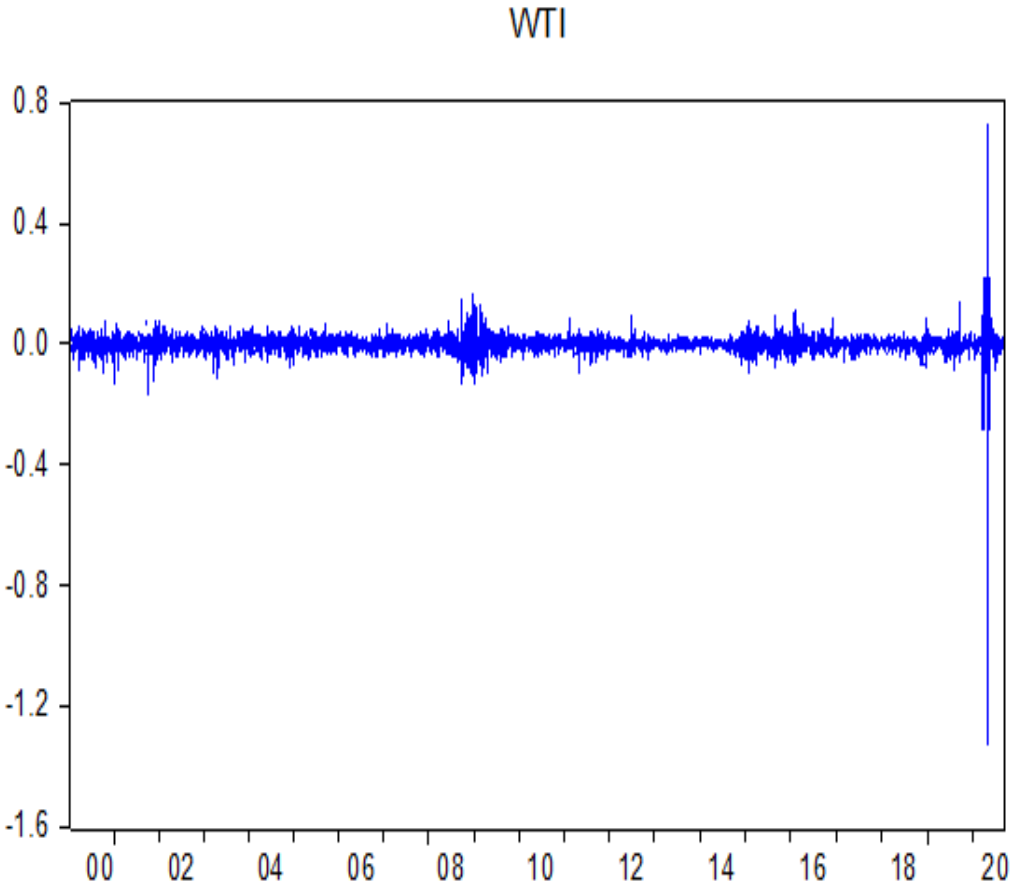

FIGURE 1: Return of Crude Oil (WTI)

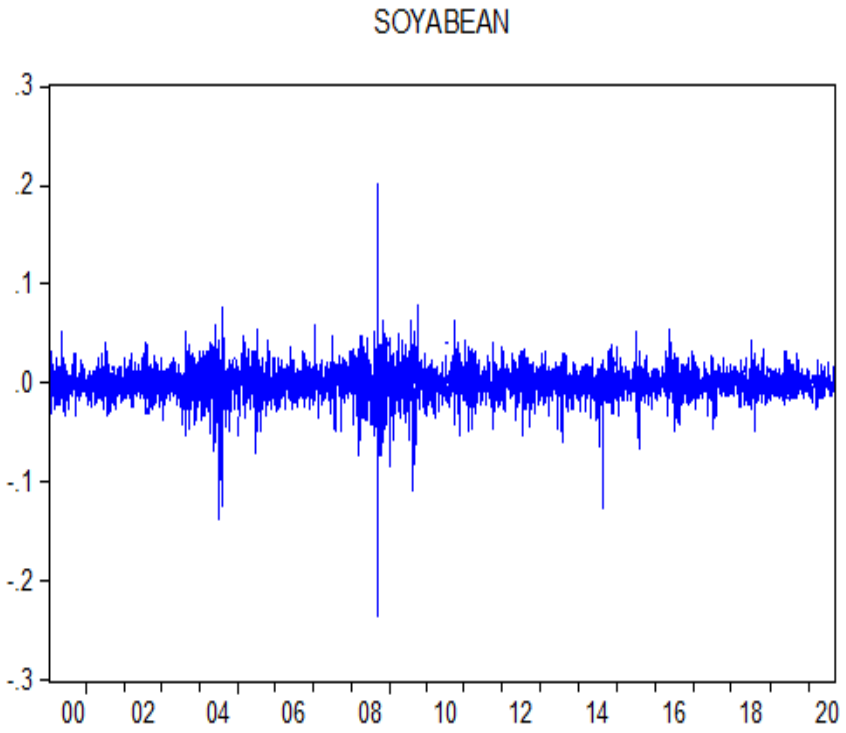

FIGURE 2: Return of Soyabean

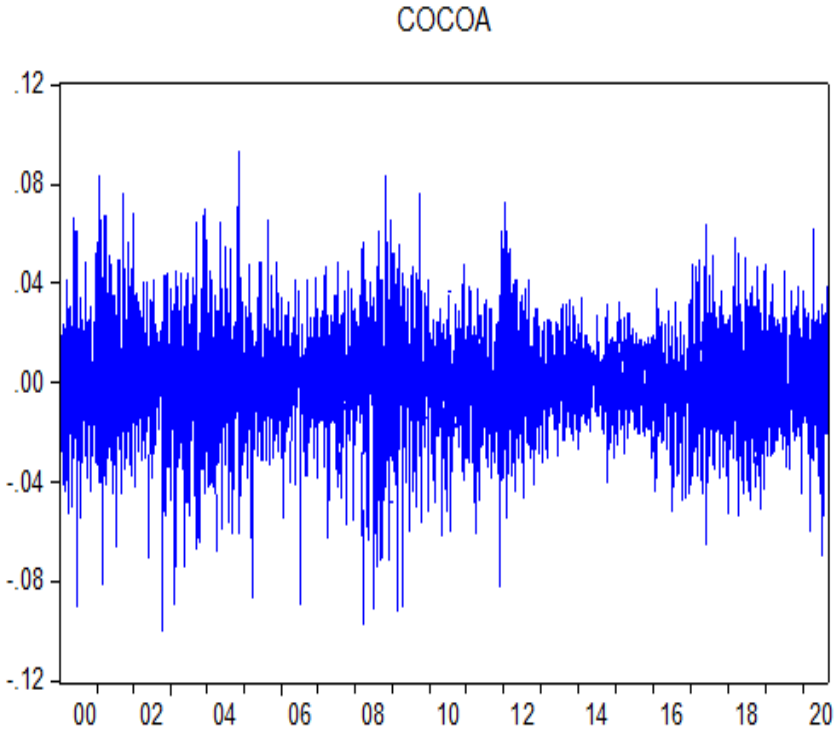

FIGURE 3: Return of Cocoa

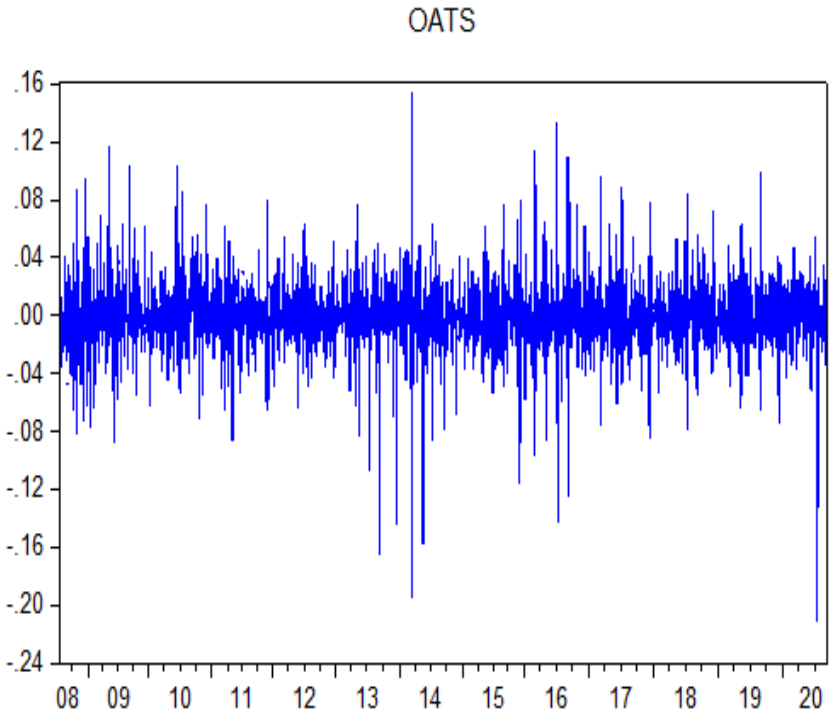

FIGURE 4: Return of Oats

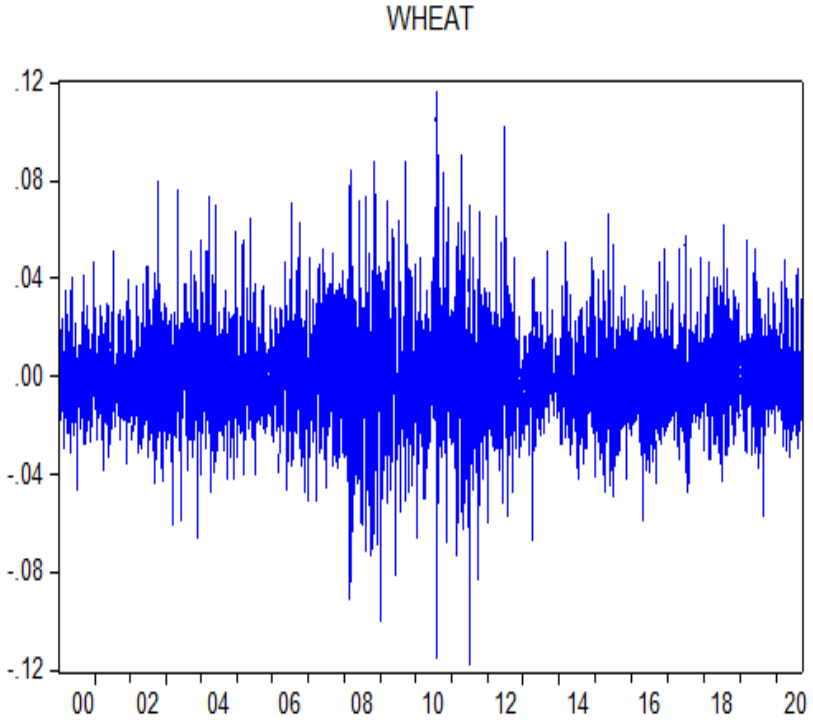

FIGURE 5: Return of Wheat

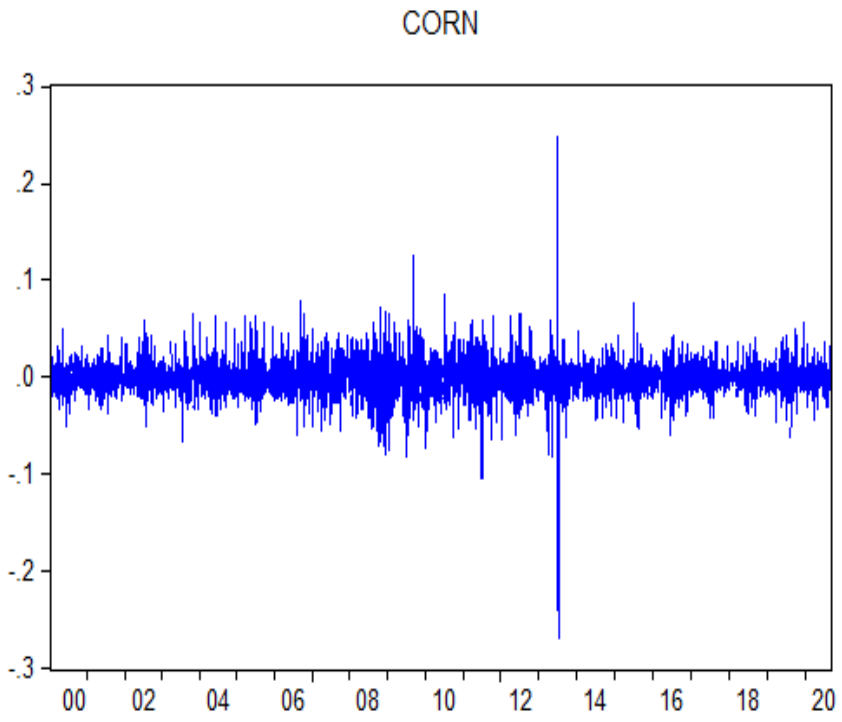

FIGURE 6: Return of Corn

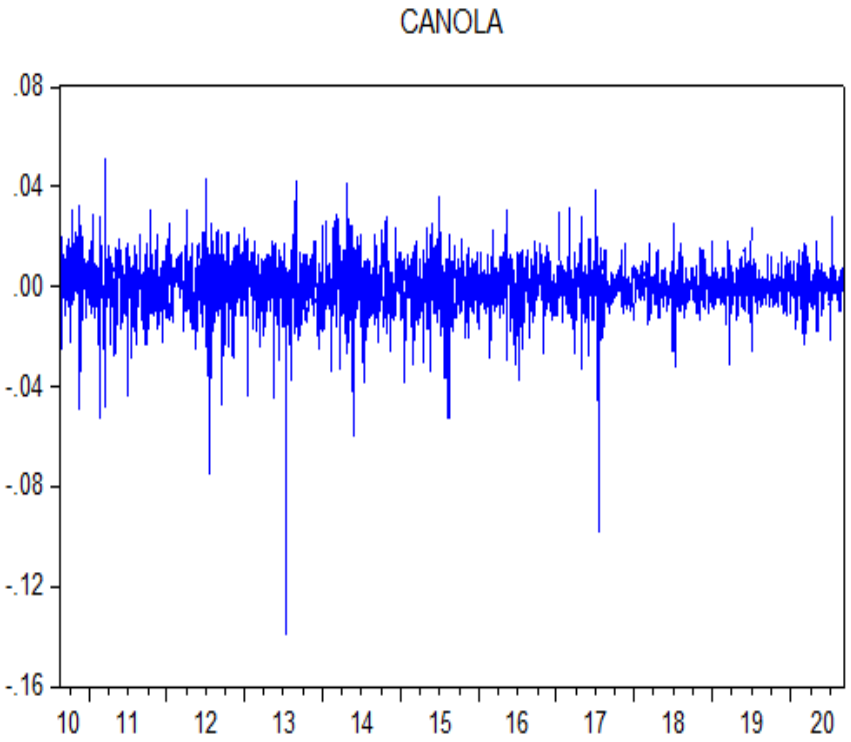

FIGURE 7: Return of Canola

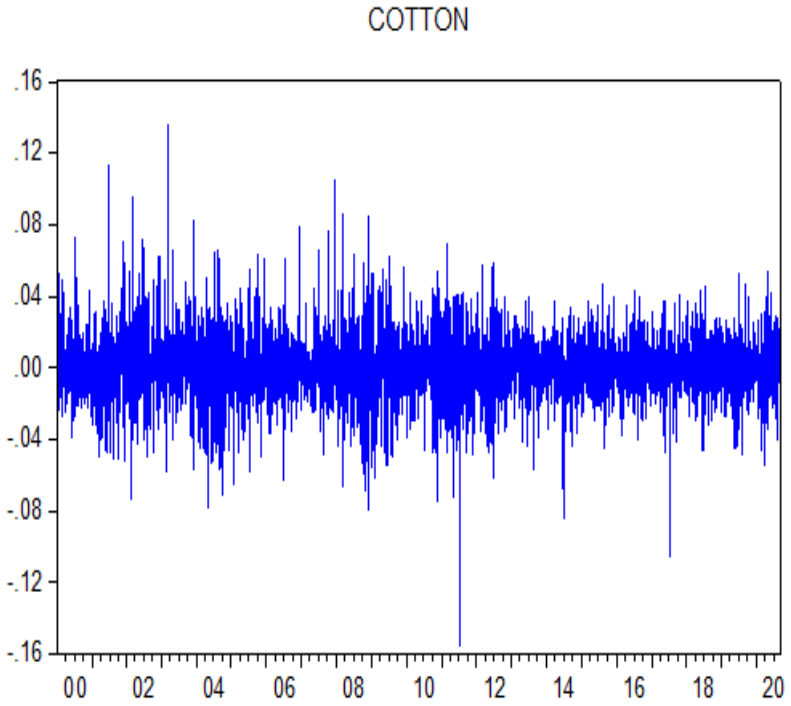

FIGURE 8: Return of Cotton

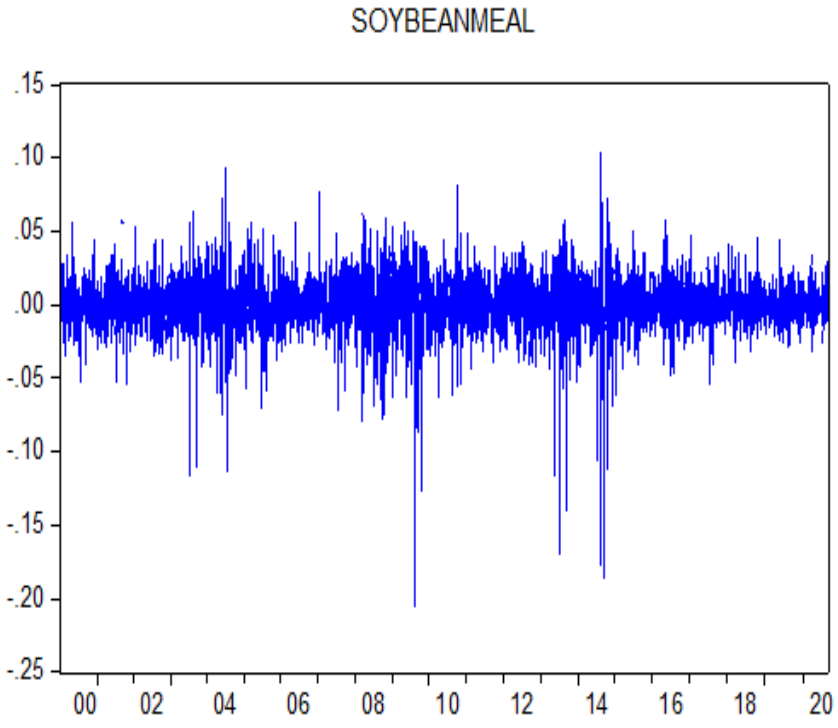

FIGURE 9: Return of Soyabean Meal

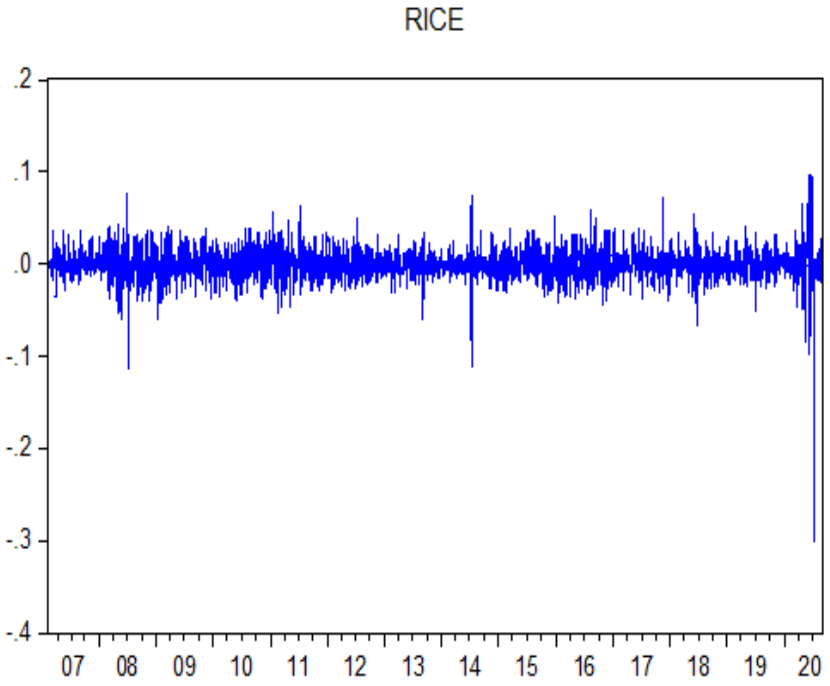

FIGURE 10: Return of Rice

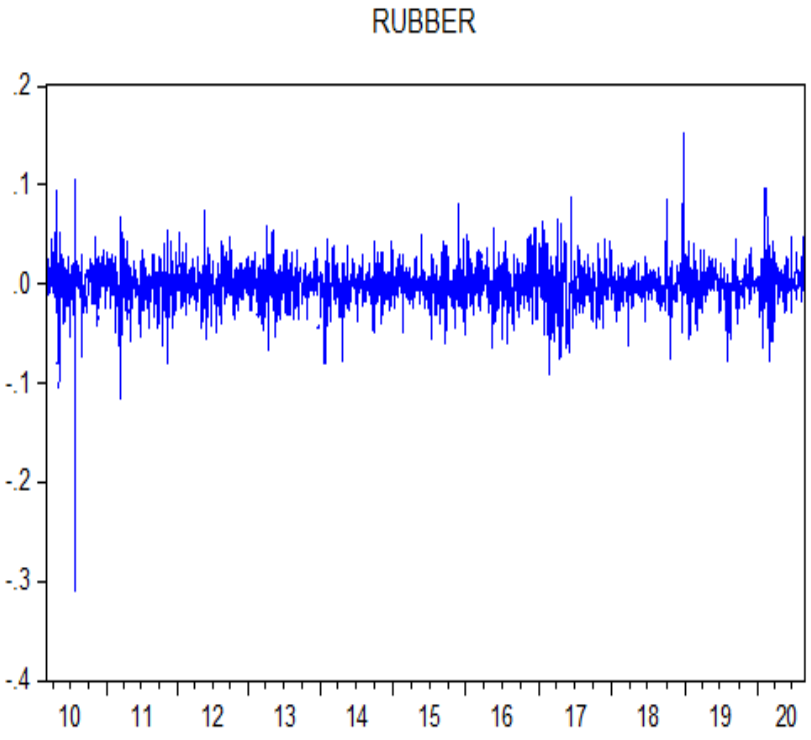

FIGURE 11: Return of Rubber

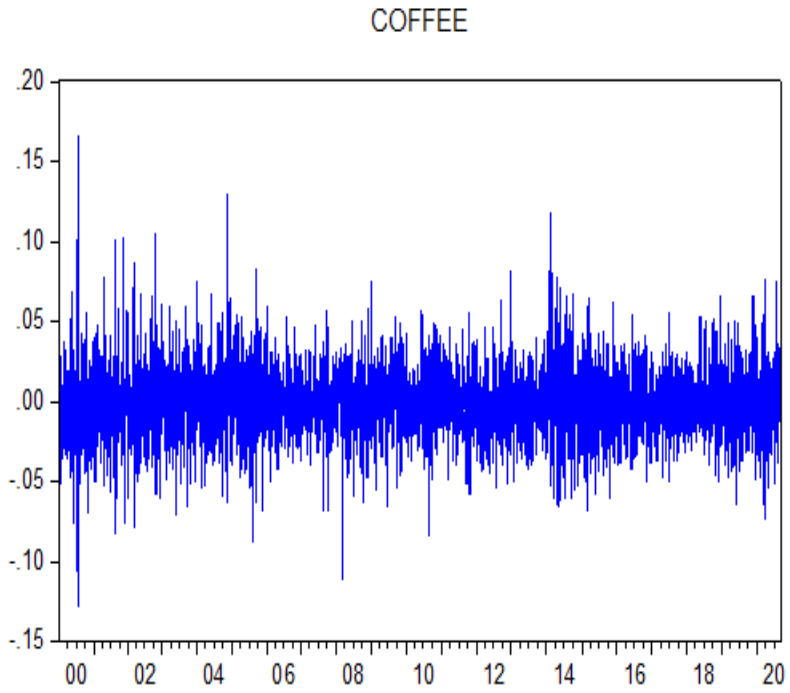

FIGURE 12: Return of Coffee

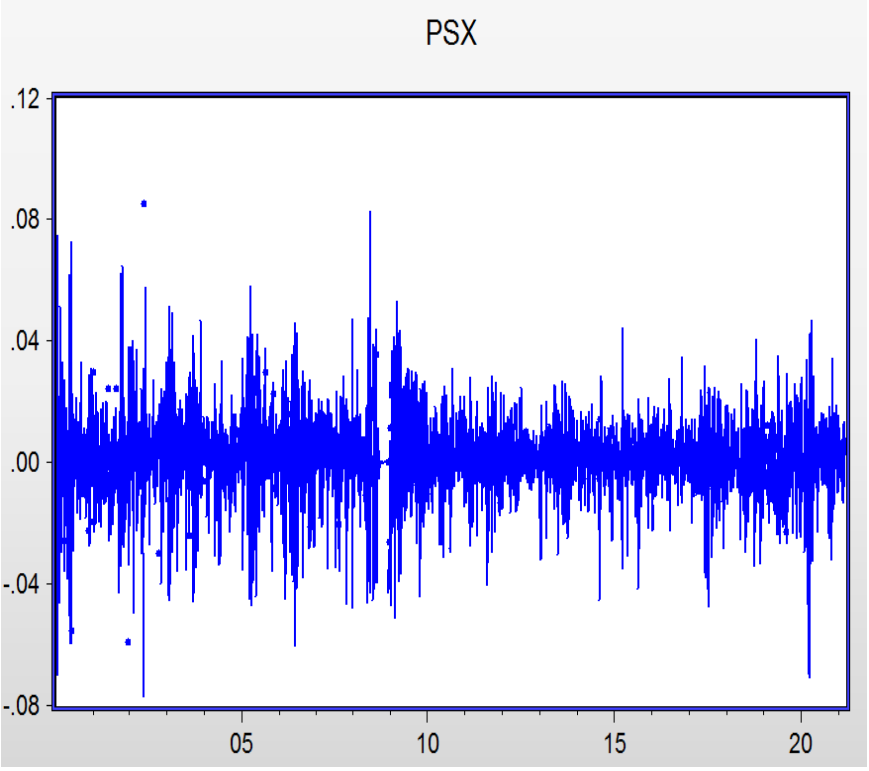

FIGURE 13: Return of Pakistan Stock Exchange