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A STUDY ON THE IMPACT OF CRUDE OIL PRICES ON STOCK MARKET, COMMODITY MARKET AND SELECT MACROECONOMIC VARIABLES

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Abstract
This study has been undertaken to understand how crude oil prices tend to impact the Indian Stock market (NIFTY 50 index), Commodity market (COMDEX) as well as India's macroeconomic variables namely Inflation (Wholesale Price Index) and Gross Domestic Product (GDP). The study is undertaken for a period ranging from 2007-2016. An effort has also been made to study the volatility of NIFTY 50 and COMDEX which are indexes of the National Stock Exchange of India Limited and Multi Commodity Exchange of India Limited respectively. The existence of relationship and Volatility was measured through various statistical and econometric tools like Unit Root test, Granger Causality Test, Correlation analysis, Ordinary Least Square (OLS) and Generalized Auto Regressive Conditional Hetroscedasticity (GARCH) Model. The study concluded that crude prices have a significant impact on the NSE, MCX, Inflation (Wholesale Price Index), and GDP. The study on crude oil price volatility provides a useful insight to consumers, policy makers, investors and even in academics.

Keywords: Crudeoil prices, Macroeconomic variables, Stock market (NIFTY 50 index), Commodity market (COMDEX), Ordinary least Square (OLS), Causality, GARCH Model.

Introduction

Economic growth is a result of an economy that is built on a strong industrial sector that necessarily requires energy. Energy is therefore essential to sustain the modern economy. Hence it is important that energy supplies are efficiently priced. Crude oil forms one of the most vital energy sources. Crude oil is not evenly distributed around the world; while some countries are not at all endowed with the resource some are highly endowed, hence there is a need to find alternate sources of energy.

India imports most of its energy requirements. Rapidly increasing energy demand and economic growth has resulted in India being the fourth largest crude oil consumer in the world. Since India imports its oil requirements any slight price fluctuations can have an influence on its economy.

Global energy consumption constitutes oil which contributed to about 27.3% in the year 2015. The world demand for oil stood at 1.8 million barrels per day in 2015, with India being the major non-OECD country having high oil demand growth. Consumption of petroleum has grown globally and India is one of the largest contributors to this phenomenon. India increased it consumption of fuel by 10.7% to 196.48 million metric tones in 2016.

In India one of the important factors that impact inflation are crude oil prices. As India is an importer of crude oil, a fall in its prices can reduce its current account deficit and result in fall in the overall prices of essential commodities. This can also have a positive effect on the growth rate. Investment in the Indian stock market includes foreign inflows in the form of Foreign Direct Index and Foreign Institutional Investors. If crude oil prices fall it will have an adverse effect on oil exporting economies like Russia. India shares good trade ties with Russia. Hence it is essential to understand the relationship between the crude oil prices and India Stock market performance. Commodity trading is gaining momentum in India which is evident from the numbers announced by exchanges like Multi Commodity Exchange (MCX) signaling growth in the volume of trade day by day. Investors need to understand the effect that crude oil inventories have on the prices of crude oil which in turn is likely to affect the commodity market as a whole.

Literature Review

Saif Siddique and Neha Seth (2015) examined how the stock market returns in India were affected by changes in crude oil prices at the global level. The study was conducted for a period ranging from January 2010 to December 2014 and daily closing prices of CNX Nifty. The Granger Causality test was used to test the presence causality among index prices. The Correlation test was conducted to find correlation between index returns, while Johansen Co-integration test was used to test co-integration among index prices. The Vector Auto Regression (VAR) model was also used to check the relation between the variables. The study concluded that there was a very weak correlation between oil prices and stock index series. Also it was seen that there was no long term integration between the variables nor did they cause each other in the short run.

A. Aparna (2013) investigated the impact on the Indian economy due to changes in crude oil prices. The variables considered for the study included Gross Domestic Product (GDP), Wholesale Price Index (WPI) and Index of Industrial Production (IIP). The study covered the period from 1995 to 2008. Since Granger Causality Test showed no presence of

direct casual relation between the variables Vector Auto Regression (VAR) model was used. The study concluded that there was a significant relationship between crude oil prices, GDP growth, WPI and IIP. A positive change in crude oil prices affected WPI positively while GDP and IIP were affected negatively.

Dr. P. Srithar, N. Bairavi and G. Mariselvam (2015) studied the impact that oil price volatility had on the economic indicators of India. The variables considered for the study were Gross Domestic Product (GDP), Stock market (NSE) and Inflation. The study was conducted for the period ranging from 2003 to 2013 and simple regression models were run in SPSS software to analyze the impact that crude oil prices had on GDP, NSE and Inflation in India. Each regression model was individually run to find out the impact. The findings of the study indicated the presence of positive relationship between crude oil and inflation i.e. when crude oil prices go up inflation also goes up. Gross Domestic Product (GDP), Stock market (NSE) was also seen to be impacted by volatility in crude oil prices and showed the presence of significant positive relationship.

Dr. Kapil Jain (2013) analysedthe relationship between macroeconomic variables namely Stock market (NSE), Inflation and Crude oil. The period of the study ranged from 2007 to 2013 and monthly data for Inflation as well as monthly closing data for NSE and crude oil were obtained. The relationship between crude oil and the dependent variables was tested with the help of simple regression model using SPSS software. The findings of the study indicated the presence of moderate relationship between crude oil and inflation i.e. there was a direct positive relationship between them. The study also showed that crude oil and NSE had a significant positive relationship.

Krishna Reddy Chittedi (2012) examined the long term relationship between crude oil prices and stock prices in India. The study covers the period from April 2000 to June 2011 and monthly data had been collected for each of the variables namely Crude oil, NSE (Nifty) and BSE (Sensex).The Auto Regressive Distributed Lag (ARDL) Model has been employed as it takes long run relationships into consideration. The study indicates that the volatility of crude oil prices to some extent are impacted by the volatility of stock prices in India. However stock prices are not affected by the change in crude oil prices.

Farhad Taghizadeh-Hesary and Naoyuki Yoshino (2015) studied how Gross Domestic Product (GDP) and Consumer Price Index (CPI) inflation rate were affected by changes in crude oil prices in emerging and developed economies. The study mainly examined the impact on emerging economy of China and developed economies of Japan and The United States. The focus was to find out whether these economies still react to volatility in Crude oil prices. In order to measure the relationship between the macroeconomic variables and crude oil Structural Auto Regression (SVAR) Model was used. The study concluded that the GDP growth of Japan and The United States was affected mildly by changes in oil prices as compared to the GDP growth rate of China. However changes in oil prices affected inflation rate in Japan and The United States to a greater extent than China.

Priyanshi Gupta and Anurag Goyal (2015) analysed the impact of oil price changes on the Indian economy. The variables considered for the study included Wholesale Price Index (WPI), Index of Industrial Production (IIP), Interest Rates, Money Supply, Net Exports, Exchange Rate, Foreign Exchange Reserves, Gold and Stock Index. The study was conducted for the period ranging from April 1991 to January 2013. The Vector Auto Regression (VAR) model was used to capture the linear interdependencies among the different variables under study. Cyclical correlation results showed that oil was counter-cyclical to exchange rate, money supply and net exports, while oil was pro-cyclical to interest rates, gold, foreign exchange reserves, and stock market, output and prices levels. The study concluded that oil prices impacted net exports and price levels (inflation) the most.

Prof. Vishal Sood, Dr. Ira Bapna, Dr. N. K. Totala and Prof. H.S. Saluja (2014) examined the impact that S&P CNX Nifty and S&P CNX Nifty companies' futures had had on the fluctuations of crude oil prices. Correlation test was used to test the existence of significant relationship between S&P CNX Nifty, S&P CNX Nifty companies' futures and crude oil. Similarly GARCH (1, 1) model, Jarque-Bera, Serial correlation and ARCH Lm test were used to study the volatility caused by the variables under study on the volatility in the price of crude oil. The study concluded that stock exchanges and crude oil have a significant relationship and it is financial products and not only consumption of oil that determine its prices.

Varsha Ingalhalli, Poornima B.G and Y.V. Reddy (2016) examined the casual relationship between the stock market, gold, oil and the forex market. The study was conducted for the period commencing from January 2005 to July 2015. The study uses econometric techniques of Granger causality and Correlation matrix to test the presence of relationships among the variables under study. The study concluded that unidirectional causality existed among the variables. It was observed that Sensex granger caused oil price fluctuations while oil prices granger caused both gold prices and exchange rate. It was seen that stock price index and gold were highly and positively correlated, which meant that if the stock market does not perform well gold prices would fall and vice versa.

Objectives of the Study

- To study the significant impact and volatility of Crude oil prices on the Stock market (NIFTY 50).
- To study the significant impact and volatility of Crude oil prices on the Commodity market (COMDEX).
- To study the significant impact of Crude oil prices on Macroeconomic Variables.
    a) To study the significant impact of Crude oil prices on Inflation (Wholesale Price Index).
    b) To study the significant impact of Crude oil prices on Gross Domestic Product.

Hypotheses

The following Null hypotheses were formulated for the purpose of the study.

- H0: There is no significant impact and volatility of Crude oil prices on the Stock market (NIFTY 50)
- H0: There is no significant impact and volatility of Crude oil prices on the Commodity market (COMDEX)
- H0: There is no significant impact of Crude oil prices on Macroeconomic Variables
    1) There is no significant impact of Crude oil prices on Inflation (Wholesale Price Index)
    2) There is no significant impact of Crude oil prices on Gross Domestic Product

Research Methodology of the Study

Source and Collection of Data

This study is completely based on secondary data. The frequency of data used to analyze each objective differs. The daily spot data has been used for objective 1 and objective 2 whereas quarterly data has been used for objective 3.

Variables	Sources	Type/ Frequency
Crude Oil Closing Price	Multi Commodity Exchange of India Limited (MCX)	Daily Spot Prices/Quarterly
NIFTY 50 Closing Price	National Stock Exchange of India Limited (NSE)	Daily Spot Prices
MCX COMDEX Closing Price	Multi Commodity Exchange of India Limited (MCX)	Daily Spot Prices
Wholesale Price Index	Bloomberg	Quarterly
Gross Domestic Product	Reserve Bank Of India	Quarterly

Period of the Study

The study is conducted for a period of 10 years and time series data from 1st January 2007 to 31st December 2016 is used.

Variables of the Study

The variables for the study include Crude oil considered as an independent variable while NIFTY 50 index of the National Stock Exchange of India Limited, COMDEX of the Multi Commodity Exchange of India Limited, Wholesale Price Index (WPI) and Gross Domestic Product (GDP) are considered as the dependent variables.

Statistical Techniques

Daily returns have been calculated for the variables by taking the logarithm of the daily closing prices of NIFTY 50, MCX COMDEX and Crude oil. Log normal returns of Quarterly last prices of Wholesale Price Index (WPI) and Gross Domestic Product (GDP) have also been used. The statistical techniques like Unit root test, Descriptive statistics, Correlation, OLS Model, Granger Causality test and Generalized Auto Regressive Conditional Hetroscedasticity (GARCH) Model were used for the purpose of analysis using MS Excel and E views software.

Empirical Analyses and Interpretation of Data

For the purpose of Analyzing and Interpreting the data objective wise, the following statistical tools and techniques are used.
Objective 1: To study the significant impact and volatility of Crude oil prices on the Stock Market (NIFTY 50).

1. Descriptive Statistics

Descriptive statistics have been used in the study to describe the features of the time series data that has been considered for the study. Descriptive statistics like mean, standard deviation, kurtosis, skewness and Jarque-Bera Test have been used for variables Crude oil and NIFTY 50.

Particulars	Crude oil	NIFTY 50
Mean	4081.715	5777.530
Standard deviation	1197.115	1533.671
Skewness	0.347117	0.348917
Kurtosis	2.200560	2.485799
Jarque-Bera	135.2750	90.66587
Probability	0.0000	0.0000
Source: Compilation by Author		

The mean values indicate that NIFTY 50 has the high average returns. Standard deviation as a measure of volatility/fluctuation indicates that NIFTY 50 returns have high volatility than that of Crude oil. The values of skewness indicate that both Crude oil and NIFTY 50 are positively skewed and therefore the series is asymmetric. The kurtosis and skewness figures for the above variables suggest that both the variables are not normally distributed which is also seen from the Jarque-Bera statistic as the null hypothesis of the Jarque-Bera Test is rejectedat 5 % level of significance.

2. Unit Root Test

Unit root test is used to test stationary of time series data. The Augmented Dickey-Fuller Test is used in this regard. In order to conduct Granger causality test and other tests, variables i.e. Crude oil and NIFTY 50 need to be stationary otherwise it could lead to spurious regression model. If the Augmented Dickey-Fuller (ADF) statistics is less than its critical value and p-value is less than 0.05 then the null hypothesis is rejected and the series is said to be stationary.

The hypothesis for testing stationary of the series using ADF test is:
H_0: There is presence of unit root in the series.

Critical Values for Crude oil and NIFTY 50			
Significance level	**1% level**	**5% level**	**10% level**
Critical values	-3.432419	-2.862340	-2.567240
Result of stationary at level for Crude oil and NIFTY 50			
Variables		**ADF statistic**	**Probability.***
Crude oil		-58.87577	0.0001*
NIFTY 50 index		-53.49844	0.0001*
Source: Compilation by Author			

The probability value from the above tables indicates that Crude oil and NIFTY 50 index at 5% level of significance are stationary at level. This leads to rejection of null hypothesis, thereby proving variables are stationary at level.

3. Correlation Test

Correlation simply means relationship between two variables. When the variables increase or decrease together in the same direction it implies a positive correlation and viceversa. Correlation coefficient ranges between -1 to +1 indicating perfectly negatively and positive correlation respectively and if it is zero it indicates that the variables are random and there is no relation between them.

The hypothesis for testing the Correlation between the variables is as follows:
H_0: There is no significant relationship between Spot prices of Crude oil and NIFTY 50 index.

Variables	Crude oil	NIFTY 50
Crude oil	1.000000	_____
NIFTY 50	0.103602 (0.0000)*	1.000000
Note:*denotes rejection of null hypothesis at 5% level of significance		
Source: Compilation by Author		

The above analyses display the results of Correlation analysis for Crude oil and NIFTY 50 index. As seen in the above table the p-value is 0.0000 for Crude oil and NIFTY 50 index which reveals that there is a significant relationship among the two

variables at 5% level of significance. Hence the null hypothesis is rejected and it is concluded that there is a significant relationship between Spot prices of Crude oil and NIFTY 50 index.

4. Ordinary Least Square (OLS) Model

Ordinary least square (OLS) regression or linear least square is a statistical method of analysis that estimates the impact of Crude oil (independent variable) on NIFTY 50 index (dependent variable). The hypothesis for testing the impact of Spot prices of Crude oil on NIFTY 50 index using OLS model is:

H_0: There is no significant impact of Spot prices of Crude oil on NIFTY 50 index.

Variables	Coefficient	t-statistic	Probability	Adjusted R-squared	D W Stat.
Crude oil	0.063799	5.602540	0.0000*	0.010391	2.007998
Note:*denotes rejection of null hypothesis at 5% level of significance					
Source: Compilation by Author					

The above Table displays the result of OLS model. It can be seen that that coefficient of the independent variable i.e. Spot prices of Crude oil is significant i.e. the null hypothesis is rejected at 5% level of significance. The result shows that if Spot prices of Crude oil change by 1% then NIFTY 50 index will change by 0.063799%. The Adjusted R- squared is 0.010391 which indicates that only 1% variations in NIFTY 50 index can be explained by Spot prices of Crude oil. The Durbin-Watson statistic value indicates that the model is good as there is no autocorrelation problem.

5. Granger Causality Test

Granger causality test is performed to investigate the presence of short-run causal relationships between Crude oil prices and NIFTY 50 index.

Null hypothesis	F- statistics	Probability	Remark
LN_ CRUDE_OIL does not Granger Cause LN_NIFTY50	0.20720	0.8129	Unidirectional Causality
LN_ NIFTY50 does not Granger Cause LN_CRUDE_OIL	10.5993	0.0000*	
Note:*denotes rejection of null hypothesis at 5% level of significance			
Source: Compilation by Author			

The result shows that Crude oil does not granger causes NIFTY 50 index at 5% level of significance. Hence the null hypothesis stating that Crude oil does not Granger Cause NIFTY 50 index cannot be rejected. Granger causality runs one-way therefore it is concluded that there exists Unidirectional Causality between Crude oil and NIFTY 50 index.

6. Generalized Auto Regressive Conditional Hetroscedasticity (GARCH) Model

The volatility of NIFTY 50 is estimated through Generalized Auto Regressive Conditional Hetroscedasticity (GARCH) model. The model explains current period volatility by long run average variance, past values of shocks and past history of volatility.). It enables the understanding of the relationship between information and volatility. The estimated GARCH (1, 1) model has been used, where Crude oil is used as the independent variable.

Variable	Coefficient	Std. Error	z-Statistic	Probability
	Variance Equation			
C	1.39E-06	2.34E-07	5.933710	0.0000*
RESID(-1)^2	0.062938	0.005482	11.48025	0.0000*
GARCH(-1)	0.931215	0.005765	161.5204	0.0000*
LN_CRUDE_OIL	0.036876	0.009518	3.874354	0.0001*
Note:*denotes rejection of null hypothesis at 5% level of significance				
Source: Compilation by Author				

The GARCH term is significant at 5% level indicating that current volatility is influenced by past volatility of NIFTY 50 index prices. Crude oil prices are also significant at 5% level indicating that they too influence the volatility of NIFTY 50 index prices. The result of the Arch is significant which indicates that volatility of NIFTY 50 is influenced by information about volatility in previous periods. Thus it is concluded that Crude oil does have an influence on stock market (NSE) volatility.

Objective 2: To study the significant impact and volatility of Crude oil prices on the Commodity Market (COMDEX).

1. Descriptive Statistics

Descriptive statistics Test have been used for variables Crude oil and COMDEX.

	Crude oil	**COMDEX**
Mean	4099.624	3074.151
Standard deviation	1206.137	651.4401
Skewness	0.334273	-0.071546
Kurtosis	2.166072	1.885093
Jarque-Bera	139.5619	154.3567
Probability	0.0000	0.0000
Source: Compilation by Author		

The results revealed that average returns of Crude oil are greater and Crude oil is highly volatile than COMDEX. The values of skewness indicate that Crude oil is positively skewed while COMDEX is negatively skewed and therefore the series is asymmetric. The kurtosis figures depict that both Crude oil and COMDEX have a flatter peak and follow a platykurtic distribution as both their values are less than 3. The null hypothesis of the Jarque-Bera Test is rejected at 5% level of significance and it is concluded that the both Crude oil and COMDEX are not normally distributed.

2. Unit Root Test

Critical Values for Crude oil and COMDEX			
Significance level	**1% level**	**5% level**	**10% level**
Critical values	-3.432391	-2.862328	-2.567234
Result of stationary at level for Crude oil and COMDEX			
Variables		**ADF statistic**	**Probability.***
Crude oil		-59.18096	0.0001*
COMDEX		-53.27640	0.0001*
Source: Compilation by Author			

The probability value of the above Table indicates that Crude oil and COMDEX at 5% level of significance are stationary at level. This leads to rejection of null hypothesis, thereby proving variables are stationary at level.

3. Correlation Test

The hypothesis for testing the Correlation between the variables is as follows:

H_0: There is no significant relationship between Spot prices of Crude oil and COMDEX.

Variables	**Crude oil**	**COMDEX**
Crude oil	1.000000	_____
COMDEX	0.199453 (0.0000)*	1.000000
Note:*denotes rejection of null hypothesis at 5% level of significance		
Source: Compilation by Author		

The above table displays the results of Correlation analysis for Crude oil and COMDEX. As seen in the above table the p-value is 0.0000 for Crude oil and COMDEX which reveals that there is a significant relationship among the two variables at 5% level of significance. Hence the null hypothesis is rejected and it is concluded that there is a significant relationship between Spot prices of Crude Oil and COMDEX. The strength of the relationship is +0.199453 i.e.19% indicating a very low degree of positive correlation between Crude oil and COMDEX.

4. Ordinary Least Square (OLS) Model

Ordinary least square (OLS) regression or linear least square is a statistical method of analysis that estimates the impact of Crude oil (independent variable) on COMDEX (dependent variable).It is used to determine the significance of coefficient of independent variables. If the coefficient of independent variable i.e. Spot prices of Crude oil is significant then it can be said that there is impact of Spot prices of Crude oil on COMDEX.

The hypothesis for testing the impact of Crude oil Prices on COMDEX using OLS model is:

H_0: There is no significant impact of Spot prices of Crude oil on COMDEX.

Variables	Coefficient	t-statistic	Probability	Adjusted R-squared	D W Stat.
Crude Oil	0.085165	11.01581	0.0000*	0.039454	2.215285
Note:*denotes rejection of null hypothesis at 5% level of significance					
Source: Compilation by Author					

The results display that the coefficient of the independent variable i.e. Spot prices of Crude oil is significant i.e. the null hypothesis is rejected at 5% level of significance. This indicates that there is a significant impact of spot prices of Crude oil on COMDEX. The result shows that if Spot prices of Crude Oil change by 1% then COMDEX will change by 0.085165%. The Adjusted R- squared is 0.039454 which indicates that only 3% variations in COMDEX can be explained by Spot prices of Crude Oil.

5. Granger Causality Test

Granger causality test is performed to investigate the presence of significant short-run causal relationships between Crude oil prices and COMDEX.

Null hypothesis	F- statistics	Probability	Remark
LN_ CRUDE_OIL does not Granger Cause LN_COMDEX	0.55449	0.5744	Unidirectional Causality
LN_ COMDEX does not Granger Cause LN_CRUDE_OIL	769.184	0.0000*	
Note:*denotes rejection of null hypothesis at 5% level of significance			
Source: Compilation by Author			

The result of the Granger Causality test indicates that the null hypothesis is rejected when p-value is less than 0.05. The result shows that Crude oil does not granger causes COMDEX at 5% level of significance. Hence the hypothesis stating that Crude oil does not Granger Cause COMDEX cannot be rejected. However at 5 % level of significance the null hypothesis stating that COMDEX does not Granger Cause Crude oil is rejected and it is concluded that COMDEX granger causes Crude oil. Therefore we conclude that there exists Unidirectional Causality between Crude oil and COMDEX.

6. Generalized Auto Regressive Conditional Hetroscedasticity (GARCH) model

In order to analyze and forecast volatility the GARCH model is of utmost important. GARCH captures volatility clustering of time series data. The estimated GARCH (1, 1) model has been used, where Crude oil is used as the independent variable.

Variable	Coefficient	Std. Error	z-Statistic	Probability
	Variance Equation			
C	1.39E-06	2.02E-07	6.903428	0.0000*
RESID(-1)^2	0.065134	0.005152	12.64259	0.0000*
GARCH(-1)	0.919347	0.006620	138.8807	0.0000*
LN_CRUDE_OIL	0.062390	0.007211	8.652010	0.0000*
Note:*denotes rejection of null hypothesis at 5% level of significance				
Source: Compilation by Author				

The GARCH term is significant at 5% level indicating that current volatility is influenced by past volatility of COMDEX prices. Crude oil prices are also significant at 5% level indicating that they too influence the volatility of COMDEX prices. The result of the Arch term is significant which indicates that volatility of COMDEX is influenced by information about volatility in previous periods. Thus it is concluded that Crude oil does have an influence on commodity market volatility.

Objective 3(a): To study the significant impact of Crude oil prices on Inflation (Wholesale Price Index).

1. Descriptive Statistics

	Crude oil	**WPI**
Mean	0.006608	0.012379
Standard deviation	0.181874	0.018604
Skewness	-1.055578	-0.509326
Kurtosis	4.777099	3.198102
Jarque-Bera	12.37447	1.749958
Probability	0.002056	0.416871
Source: Compilation by Author		

The results revealed that WPI has a high mean value whereas Crude oil has a lower mean value and Crude oil is highly volatile as compared to WPI. The values of skewness indicate that both Crude oil and WPI are negatively skewed and therefore the series is asymmetric. The kurtosis figures depict that both Crude oil and WPI have a sharper peak and follow a leptokurtic distribution as both their values are more than 3. The Jarque-Bera statistic value concludes that WPI is normally distributed while Crude oil is not normally distributed.

2. Unit Root Test

Critical Values for Crude oil and Wholesale Price Index			
Significance level	**1% level**	**5% level**	**10% level**
Critical values	-3.615588	-2.941145	-2.609066
Result of stationary at level for Crude oil and Wholesale Price Index			
Variables		**ADF statistic**	**Probability.***
Crude oil		-5.308707	0.0001*
COMDEX		-4.668602	0.0006*
Source: Compilation by Author			

The Unit Root Test was performed to determine whether Crude oil prices and WPI were stationary or not. Stationary becomes a necessary condition if tests like Granger Causality Test are to be applied. The results revealed that variables are stationary at level.

3. Correlation Test

Variables	**Crude oil**	**WPI**
Crude oil	1.000000	_____
WPI	0.802573 (0.0000)*	1.000000
Note:*denotes rejection of null hypothesis at 5% level of significance		
Source: Compilation by Author		

The above table displays the result of Correlation analysis for Crude oil and WPI. As seen in the above table the p-value is 0.0000 for Crude oil and WPI which reveals that there is a significant relationship among the two variables at 5% level of significance. The strength of the relationship is +0.802573 i.e. 80 % indicating a high degree of positive correlation between Crude oil and WPI. Crude oil forms an important part of Indian imports. Thus, any oil shock is bound to have an impact on India's trade balance. Also oil is an important input across all industries and transportation thus impacting price levels. Therefore, an increase in oil price leads to a hike in input costs which in turn results in higher price level.

4. Ordinary Least Square (OLS) Model

Ordinary least square (OLS) regression or linear least square is a statistical method of analysis that estimates the impact of Crude oil (independent variable) on WPI (dependent variable).

Variables	Coefficient	t-statistic	Probability	Adjusted R-squared	D W Stat.
Crude oil	0.082095	8.183447	0.0000	0.644124	1.831379
Note:*denotes rejection of null hypothesis at 5% level of significance					
Source: Compilation by Author					

The above table displays the result of OLS model with the Crude oil as independent variable and WPI as dependent variable. The Crude oil is significant i.e. the null hypothesis is rejected at 5% level of significance. This indicates that there is a significant impact of Crude Oil on WPI. The result shows that if Crude Oil changes by 1% then WPI will change by 0.082095% and 64% variations in WPI can be explained by Crude oil. The Durbin-Watson statistic is 1.831379 which indicates that the model is good as there is no autocorrelation problem.

5. Granger Causality Test

Null hypothesis	F- statistics	Probability	Remark
LN_CRUDE_OIL does not Granger Cause LN_WPI	0.89705	0.4178	No Causality
LN_WPI does not Granger Cause LN_CRUDE_OIL	1.82495	0.1776	
Note:*denotes rejection of null hypothesis at 5% level of significance			
Source: Compilation by Author			

The above result shows that neither Crude Oil granger causes WPI nor WPI granger causes Crude oil at 5% level of significance. Since the p-value is more than 0.05 the null hypothesis cannot be rejected. Therefore it appears that there is no Granger Causality among Crude oil and WPI, i.e. there is no short run relationship between the two variables when tested quarterly.

Objective 3(b): To study the significant impact of Crude oil prices on the Gross Domestic Product (GDP).

1. Descriptive Statistics

	Crude oil	GDP
Mean	0.006608	0.027163
Standard deviation	0.181874	0.097754
Skewness	-1.055578	3.627824
Kurtosis	4.777099	19.90284
Jarque-Bera	12.37447	549.8193
Probability	0.002056	0.0000
Source: Compilation by Author		

It is known from Table that GDP has a high mean value and lower volatility as compared to Crude oil. Crude oil negatively skewed while GDP is positively skewed and therefore the series is asymmetric. The kurtosis figures depict that both Crude oil and GDP have a sharper peak and follow a leptokurtic distribution as both their values are more than 3.The Jarque-Bera Test is concludes that both Crude oil and GDP are not normally distributed.

2. Unit Root Test

Unit root test is used to test stationary of time series data.

Critical Values for Crude oil and GDP			
Significance level	**1% level**	**5% level**	**10% level**
Critical values	-3.615588	-2.941145	-2.609066
Result of stationary at level for Crude oil and GDP			
Variables		**ADF statistic**	**Probability.***
Crude oil		-5.308707	0.0001*
COMDEX		-6.309417	0.0000*
Source: Compilation by Author			

The Unit Root Test was performed to determine whether Crude oil prices and GDP were stationary or not. The probability value of the above indicates that Crude oil and GDP at 5% level of significance are stationary at level. This leads to rejection of null hypothesis, thereby proving variables are stationary at level.

3. Correlation Test

Variables	Crude oil	GDP
Crude Oil	1.000000	
GDP	-0.284220 (0.0795)	1.000000
Note:*denotes rejection of null hypothesis at 10% level of significance		
Source: Compilation by Author		

The above table displays the results of Correlation analysis for Crude oil and GDP. The strength of the relationship is -0.284220 i.e. 28 % indicating a low degree of negative correlation between Crude oil and WPI. If Crude oil prices rise GDP will decline i.e. there exists an inverse relationship between them.

4. Ordinary Least Square (OLS) Model

Ordinary least square (OLS) regression or linear least square is a statistical method of analysis that estimates the impact of Crude oil (independent variable) on GDP (dependent variable).

Variables	Coefficient	t-statistic	Probability	Adjusted R-squared	D W Stat.
Crude oil	-0.152763	-1.803211	0.0795	0.055937	2.256259
Note:*denotes rejection of null hypothesis at 10% level of significance					
Source: Compilation by Author					

It can be seen that that coefficient of the independent variable i.e. Crude oil is significant at 10% level of significance i.e. the null hypothesis is rejected at 10% level of significance. This indicates that at 10% level of significance there is an impact of Crude oil on GDP. The result shows that if Crude oil changes by 1% then GDP will change by -0.152763%.

5. Granger Causality Test

The lead and lag relationship between the Crude oil prices and Gross Domestic Product (GDP) is examined here. The result of this test indicates whether Granger Causality exists and if it exists, then in which direction such causality exists between the variables.

Null hypothesis	F- statistics	Probability	Remark
LN_CRUDE OIL does not Granger Cause LN_GDP	0.66283	0.5223	Unidirectional Causality
LN_GDP does not Granger Cause LN_CRUDE OIL	3.35148	0.0477*	
Note:*denotes rejection of null hypothesis at 5% level of significance			
Source: Compilation by Author			

The result of the Granger Causality test for Crude oil and GDP is summarized in above table. The result shows that Crude Oil does not granger causes GDP at 5% level of significance. Hence the null hypothesis stating that Crude oil does not Granger Cause GDP cannot be rejected, but the null hypothesis stating that GDP does not Granger Cause Crude oil is accepted. Therefore it appears that Granger causality runs one-way from GDP to Crude oil and not the other way.

Conclusion

It is evident from the study that Crude oil prices have a significant impact on the National Stock Exchange of India. However they share a very low degree of positive correlation .It is seen that NIFTY 50 index prices predict Crude oil prices as there is unidirectional causality between them. Finally it is seen that the crude oil prices influence the volatility of the NSE.

Crude oil also has a significant impact on the commodity market of India represented by COMDEX. Like NIFTY 50, COMDEX too has a very low degree of positive correlation with oil. There is unidirectional causality between COMDEX and Crude oil. The volatility of the MCX is influenced by crude oil prices. Crude oil inventories have an effect on the prices of crude oil which is likely to affect the commodity market as a whole as well as its index.

Crude Oil forms an important part of Indian imports. Thus, any oil prices fluctuations are bound to have an impact on India's trade balance. It is seen that there is a significant impact of crude oil prices on inflation and in the short run crude oil prices granger cause inflation. They share a high degree of positive correlation. In 2014 when oil prices fell, India got the benefit in the form of lower crude oil prices. This was evident from the decline in WPI in 2015 which was influenced by low fuel prices.

Lastly the study reveals that there is a significant impact of crude oil prices on GDP and both crude oil prices and gross domestic product share a low degree of negative correlation. This indicates that an inverse relationship exists between them. Any fall in the Crude oil prices can have positive outcomes in the form of an increase in GDP growth rate. The recent fall in crude oil prices led to decrease in India's Current Account Deficit to 1.1% of GDP and GDP crossed $ 2 trillion in 2015.

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