ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

RELATIONSHIP BETWEEN INTERNATIONAL CRUDE OIL PRICE AND THE INFLATION RATE (CPI) IN INDIA FROM 2011 TO 2014

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Manuscript Info

Manuscript History:

Received: 15 March 2015
Final Accepted: 22 April 2015
Published Online: May 2015

Key words:

Crude oil price CPI inflation rate Petroleum Pricing Policy Augmented Dickey-Fuller Test (ADF) Granger Causality test

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Abstract

India meets 70% of its energy needs by crude oil imports. The Price of Petroleum (per barrel of Crude oil of 159 liters) at the international market influences the prices of domestic petrol and diesel (domestic prices linked to International energy derivative market). Any fluctuations in the international crude oil price influence all other macro economic variables and Inflation too. CPI (consumer price Index) is said to be a perfect measure of inflation by the economist. So, for the accurate prediction of the relationship between petroleum price and inflation, the CPI inflation is considered for the analysis. The study proposes to use Augmented Dickey-Fuller Test (ADF) unit root test and Granger Causality test. Crude oil price and CPI Inflation monthly data from 2011 to 2014were used to find the exact relationship. Apart from that the paper focuses on the petroleum pricing policy of India in brief. The study confirms with the empirical analysis that the consumer price Inflation is not influenced by the hike in crude oil price.

INTRODUCTION

India is a crude oil importing country which meets its 70% of her energy needs through imports from Middle East and other countries having meager percentage of gas and petroleum reserves. The price of a barrel of oil is highly dependent on both its grade, determined by factors such as its specific gravity or API (American Petroleum Institute) its sulphur content, and its location. Other important benchmarks include Dubai, Tapis, and the OPEC basket. The Energy Information Administration uses the imported refiner acquisition cost, the weighted average cost of all oil imported into the US, as its "world oil price". The price of oil underwent a significant decrease after the record peak of US$145 it reached in July 2008. On December 23, 2008, WTI crude oil spot price fell to US$30.28 a barrel, the lowest since the financial crisis of 2007–2010 began, and traded at between US$35 a barrel and US$82 a barrel in 2009.On 31 January 2011, the Brent price hit $100 a barrel for the first time since October 2008, on concerns about the political unrest in Egypt. Recently the price of crude oil dips to the lowest at $49 a barrel since 2009 it's the lowest. Any fluctuation in the price affects the growth, inflation, forex reserves and widens the CAD (Current Account Deficit) of crude importing countries. Few countries china and Malaysia are able to maintain the fixed price for crude oil and India's inability to maintain the fixed pricing policy for petroleum costs the petroleum products users severely. Petrol and diesel are the major fuels for transportation, Industrial and other purposes. Fluctuations in the price of petrol and diesel have a cascading effect on Indian economy. The study throws a light on the relationship between Crude oil price and the Inflation rate only. The paper further divided in to four sections. The second section dedicated to Pricing of petroleum in India. The third section gives the literature review on impact of

crude oil price on CPI Inflation. The fourth section dedicated to methodology and empirical analysis. Finally the fifth section offers concluding comments.

2. Pricing of Petroleum in India

Crude oil, both indigenous and imported are refined in to various petroleum products viz., petrol (motor spirit), naphtha, light diesel, aviation fuel, kerosene, high speed diesel, furnace oil, bitumen, waxes etc. The pricing of refined petroleum products have gone through various phases beginning from value stock accounting system and import parity pricing and then to retention pricing under Administrated price mechanism (APM) and presently trade parity pricing. Till 1939, there was no control on the pricing of petroleum products. Between, 1939 to 1948 the oil companies themselves used to pool accounts for major products without intervention of the government. However, since independence the pricing of petroleum products witnessed several structural changes in policies. In 1948, an attempt was made to regulate prices through valued stock account procedure. This was a cost plus formula based on import parity to which additions like ocean freight up to Indian ports, insurance, ocean loss, remuneration, import duty and other levies and changes. The realization of oil companies under this procedure was restricted to import parity price of finished goods plus excise duties/local taxes/dealer margins and agreed marketing margins of each of the refineries. Any realization in excess of normal was surrendered to the government.

The petroleum industry has been deregulated with the intention of shifting to market determined pricing mechanism. However in practice the deregulation process has been only implemented partially due to restriction on prices imposed by the Government to shield the Indian consumer from oil price volatility especially since 2004.

The process of deregulation of petroleum product prices begun in 1998, five sensitive products namely petrol, diesel, domestic LPG, PDS kerosene, ATF (Aviation Turbine Fuel) continued as controlled commodities. In the post-APM era beginning from 1-4-2002, oil marketing companies were allowed to sell their products at market determined prices. It is based on the notion of import parity from April 2002 to May 2006 and from June 2006 on wards on the basis of trade parity for petrol and diesel (except PDS Kerosene and LPG subsidy continued) after consultation with the ministry of petroleum and natural gas (MoPNG).In 2004 the prices started rising in the international market. Although the oil marketing companies were granted freedom to fix retail selling price fortnightly basis, price used to be revised after informal clearance from MoPNG and there was no price revision of petrol and diesel during the period of mid 2004 ruling price international market were abnormally high during this period.

In August 2004 Government worked out new methodology allowing OMC's limited freedom to revise the prices of Petrol/diesel within a price band. The concept of price band on the principle of rolling average price of these products in the International market accordingly, oil companies were permitted to carryout autonomous adjustments in prices within a band of +/- 10% of the mean of rolling average CIF price of preceding 12 months and preceding quarter i.e. three months. In case of breach of this band, the OMC's had to approach the Ministry of Finance (MoF) through ministry of Petroleum and Natural gas (MoPNG) to modulate the excise duty rates so that the spiraling process prevailing in the international markets do not cause undue hardship to the consumer. However consequent to the further rise in oil prices, price band approach had to be given up.

Oil refining and marketing companies become all the more worse due to high volatility of oil prices and they have made huge losses. The oil companies reported financial distress in terms of "Under recoveries", with respect to import parity price formula that has been in use since the end of the APM regime. A separate section has been devoted in the post-APM era between 2003-2008 on account of asymmetric price adjustments between international crude oil prices, domestic prices of sensitive petroleum products i.e. High powered committee on financial position of oil companies. Presently trade parity pricing has been in practice for petroleum products for refinery gate as well as retail pricing (recommended by Rangarajan committee) and proposed to review and update the trade parity price every year depending on the relative weights of exports and imports.

Based on the recommendations of the Kirit Parikh Committee, the Government of India (GOI) on 25 June, 2010 announced the full deregulation of the prices of two crucial petroleum products: petrol and diesel. Henceforth, prices of these two products will be determined by the unfettered play of market forces and government "subsidies" on these products, which worsen the fiscal situation, will be completely removed. Government control over the determination of the prices of these key commodities was willingly ceded to the magic of the market, presumably to "rationalize" prices and to wipe away losses of state-run Oil Market Companies (OMCs) to the tune of Rs. 22,000 crore.

The markets were ecstatic about the full liberalization of petrol and diesel prices and these sentiments were almost immediately reflected in rising oil stock prices. There were strident complaints that this policy change was not enough: prices of kerosene and liquefied petroleum gas (LPG) were still minimally under government control and therefore even after the deregulation move, the losses of the OMCs on account of these two petroleum products would stand at Rs. 53,000 crore for fiscal 2011.The first crucial victory of this struggle came in 2002 when the

government dismantled the administrative pricing mechanism (APM). This move reduced the "subsidies" on petrol and diesel but the government decided to continue to "subsidize" kerosene and LPG. In 2005, the GOI constituted the Rangarajan Committee to study pricing and taxation of petroleum products. This committee recommended a half-way house: a ceiling on the refinery gate price (computed according to the so-called trade parity formula) along with the freedom for OMCs to set retail prices. Of course, this was not enough. Accordingly, in 2009 the next committee was constituted to examine the same set of issues, i.e., the Kirit Parikh Committee. In its report submitted in February 2010, the Kirit Parikh Committee finally recommended what the capitalist sector had been telling GOI all these years. It recommended full liberalization of petrol and diesel prices. The new government in 2014 has deregulated the price of diesel too as according to the energy policy.

3. Literature review

Food sector prices are influenced by high speed diesel oil prices as diesel is fuel for trucks to carry the agricultural output from one part of the country to other. Syed Atif Ali et.al (2012) examined the effects of high speed diesel oil prices on food sector prices in Pakistan using multiple linear regression. The food includes rice, Maize, wheat, chicken and cooking oil which are dependent variables in the study. The independent variables are high speed diesel. It is hypothesized that there is a significant relationship and positive effect of oil prices on food inflation. The study concludes with a support of hypothesis that there is a highly significant effect of oil prices on food inflation. (High speed diesel price found to be have highly significant effect on food inflation in Pakistan)

Oil price shocks have a sudden transmission in the economies through inflation. Benjamin Wong (2012) found the impact of different oil shocks on US inflation and inflation expectations since 1970's. The findings confirm oil supply shocks have never been a major factor, demand side shocks in the oil market generally been more important in explaining inflation dynamics and movements, inflation expectations. The authors said that exogenous political events induce oil shocks that are more inflationary. The author concludes that demand shocks in the oil market have a much larger role for inflation and inflation expectations. The response to oil supply shocks that raise real oil prices by the same magnitude doesn't appear to exhibit time variation invoking a hypothetical thought experiment where demand side shocks in the oil market raise the real oil price by a fixed magnitude (say 10%) shows a large drop off in the response of inflation and inflation expectations. (Exogenous political factors induce oil shocks that are more inflationary and demand shocks in the oil market have a much larger role for inflation and inflation expectations than supply shocks).

Consumer price Index (CPI) is a best indicator of inflation than Whole sale price index (WPI). Surjit Bhalla (2011) studied that across most countries emerging and developed, the best indicator of overall inflation (as measured by GDP deflator) is the consumer price index (CPI). Policy makers in India, including the RBI have been erroneously using the whole sale price index (WPI) as a surrogate for underlying inflation even when its ability to accurately forecast overall inflation is close to zero, especially in the presence of information on CPI inflation. Since Feb. 20th 2011, a new national CPI index has been released with urban and rural all India components. Indian inflation for the last thirty years is strongly correlated to international inflation which in turn is correlated to commodity prices over which domestic monetary policy has little control, each $10 rise in oil price increases inflation by about 0.5% for emerging markets, including India. For developed economies, the effects are muted- each $10 in the price of oil raises the inflation rate by only 0.03 percent. (Crude oil price rise highly correlates with CPI index and confirms domestic monetary policy has a little control).

With the above literature background the study analyses the relationship between the Crude oil price and Consumer Price Index (Inflation) from January 2011 to September 2014.

Material and Methods

The data on oil prices were downloaded from eia.gov. Data relating to consumer price index is downloaded from labour bureau of India. The study employs an empirical analysis and only focuses on the two chosen variables. The variables that we use are the world crude oil prices in US Dollars, Consumer price inflation rate. Time series data from January 2011 to September 2014 are used for the variables.

Statement of Hypothesis

The hypothesis for this study has been stated below

Null Hypothesis:

H0: There is no significant relationship between crude oil price and inflation rate (CPI)
H1: There is a significant relationship between crude oil price and inflation rate (CPI)

Descriptive statistics technique

Descriptive statistics is the discipline of quantitatively describing the patterns and general trends of a dataset and summarize it in single value. It enables a reader to quickly understand and interpret the set of data that has been collected. In this study, descriptive statistics provide a useful quantitative summary of the variables. Here, descriptive statistics provide a historical account of variables behavior and convey some future aspects of the distribution of dataset. The study used measures of central tendency (mean) and measures of Variability (standard deviation, minimum and maximum) to explain the dataset.

Inferential statistics technique
Inferential statistics is defined as the branch of statistics that is used to make inferences/ valid judgments about the characteristics of a population based on sample data. These statistics are ways of analyzing data that allow the researcher to make conclusions about whether a hypothesis was supported by the results.

A ***hypothesis*** is an educated guess about a trend, group difference or association believed to exist. A null hypothesis states that the results will be due to chance whereas an alternate hypothesis tells that the results are due to the manipulation of the independent variable. Here in our study, ***null hypothesis (H0)*** There is a significant relationship between crude oil price and inflation rate (CPI), while ***alternate hypothesis (Ha)*** is there is a significant relationship between crude oil price and inflation rate (CPI).

There are different ways to inference the results. Here, we used correlation matrix analysis and linear regression analysis (t-ratio, f-sign, p- value, r-square) which allows us to make a conclusion related to our hypothesis. We have used 5% of level of significance and two tailed test so as to accept or reject our null hypothesis according. Regression analyses are typically done using statistics software and here we used Eviews8.

Econometric Regression Model
The term ***regression*** was introduced by Francis Galton. Linear regression analysis is an inferential statistical technique that is used to learn more about the relationship between a independent variable (referred to as X) and dependent variable (referred to as Y) When there is only one independent variable, the prediction method is called simple regression. So, the regression equation $\boldsymbol{Yi = \beta 0 + \beta 1\ Xi + ui}$ where *Yi* is the dependent variable, *X*i is the independent variable, $\beta 0$ is the constant (or intercept), $\beta 1$ is the slope of the regression line which represent the strength and direction of the relationship between the independent and dependent variables and *ui* is random error term. Here, in the study carried out this method to see and interpret the effect of crude oil price on inflation rate (CPI).
Statistic test

R-square: also known as the coefficient of determination is commonly used to evaluate the model fit of a regression equation. That is, how good are all of your independent variables at predicting your dependent variable? The value of R-square ranges from 0.0 to 1.0 and can be multiplied by 100 to obtain a percentage of variance explained.
Sign-F: whether the model as a whole is significant. It tests whether R- square is significantly different from zero.
T-ratios: the reliability of our estimate of the individual beta. For that we can look at p- values.

Unit root test (Augmented Dickey –Fuller test)

The stationarity of a data series is a prerequisite for drawing meaningful inferences in a time series analysis and to enhance the accuracy and reliability of the models constructed. If the variable is not stationary estimation can obtain a very high R^2, although there is no meaningful relationship between the variables. This situation reflects the problem of spurious regression between totally unrelated variables generated by a non-stationary process. Generally a data series is called a stationary series if its mean and variance are constant over a given period of time and the covariance between the two extreme time periods does not depend on the actual time at which it is computed but it depends only on lag amidst the two extreme time periods.

One of the common method is to find whether a time series is stationary or not is the unit root test. There are numerous unit root tests. One of the most popular among them is the Augmented Dickey-Fuller (ADF) test. Augmented Dickey -Fuller (ADF) is an extension of Dickey -Fuller test. Following equation of ADF test checks the stationarity of time series data:

$$\Delta Y_t = \alpha + \beta T + \rho Y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta Y_{t-i} + e_t$$

where Y_t is the variable in period t, T denotes a time trend, Δ is the difference operator, e_t is an error term disturbance with mean zero and variance σ^2 , and k represents the number of lags of the differences in the ADF equation. The ADF is restricted by its number of lags. It decreases the power of the test to reject the null of a unit root, because the increased number of lags necessitates the estimation of additional parameters and a loss of degree of freedom. The test for a unit root is conducted on the coefficient of y_{t-1} in the regression. If the coefficient is significantly different from zero (less than zero) then the hypothesis that y contains a unit root is rejected. Rejection of the null hypothesis denotes stationarity in the series.

Null and alternative hypothesis are as follows:

$H_0 : \rho=0$ [Variable is not stationary]

$H_a : \rho<0$ [Variable is stationary]

Our study also contains time series data. The time series variables considered in this paper are the stock market indices and seven macroeconomic variables. This necessitates the inclusion of ADF test in the present study. Also our study includes Granger causality test which assumes that the variables involved are stationary. Thus prior to testing and implementing the Granger Causality test, econometric methodology needs to examine the stationarity for each individual time series. If the variables are not stationary the standard assumptions for asymptotic analysis in the Granger test will not be valid.
Null hypothesis in this case would be that particular CPI Inflation rate and Crude oil price is not stationary & alternative being that they are stationary.
Note: We have considered p- value for testing at 5% significance level. If the p-value is smaller than 0.05 then Null hypothesis will be rejected & variables would be stationary & vice versa.

ADF test is used to find the stationarity or non-stationarity of the variables in the data series. Inferential statistics techniques are used to inference about the results like multiple linear techniques after attaining stationarity of both the series using E-VIEWS8.0.

Granger causality test

Granger (1969) and Sim (1972) were the ones who first developed Granger causality test to examine the application of causality in economics. Granger causality test is a technique for determining whether one time series is significant in forecasting another. The standard Granger causality test seeks to determine whether past values of a variable helps to predict changes in another variable. Granger causality technique measures the information given by one variable in explaining the latest value of another variable. In addition, it also says that variable Y is Granger caused by variable X if variable X assists in predicting the value of variable Y. If this is the case, it means that the lagged values of variable X are statistically significant in explaining variable Y. The null hypothesis (H_0) that we test in this case is that the X variable does not Granger cause variable Y and variable Y does not Granger cause variable X. In summary, one variable (X_t) is said to granger cause another variable (Y_t) if the lagged values of X_t can predict Y_t and vice-versa. The test is based on the following regressions:

$$Y_t = \beta_0 + \sum_{k=1}^{M} \beta_k Y_{t-k} + \sum_{l=1}^{N} \alpha_l X_{t-l} + u_t$$

$$X_t = \gamma_0 + \sum_{k=1}^{M} \gamma_k X_{t-k} + \sum_{l=1}^{N} \delta_l Y_{t-l} + v_t$$

Where Y_t and X_t are the variables to be tested, and u_t and v_t are mutually uncorrelated errors, and t denotes the time period and 'k' and 'l' are the number of lags.

The null hypothesis is:

$H_0 : \alpha_t = \delta_t = 0$ for all i [X does not granger cause Y]

The alternative hypothesis is:

$H_a : \alpha_t \neq 0$ and $\delta_t \neq 0$ for at least some i [X granger cause Y]

If the coefficient α_t are statistically significant but δ_t are not, then X causes Y. In the reverse case, Y causes X. But if both α_t & δ_t are significant, then causality runs both ways. The null hypothesis is tested by using the standard F-test of joint significance. The F-test is applied, as follows:

$$F = \frac{(RSS_R - RSS_{UR})/m}{RSS_{UR}/(n-k)}$$

Here RSS_R & RSS_{UR} are the restricted and unrestricted residual sum of squares respectively. M is the number of lags, n is the number of observations and k is the parameters in the unrestricted equation. If the computed *F*-value exceeds the critical *F*-value at the chosen level of significance, the null hypothesis is rejected. This would imply that macroeconomic variable 'Granger cause' or improve the prediction in stock prices and vice versa.

Note: That it has been taken one period lag in the above equation. In practice, the choice of the lag is arbitrary.

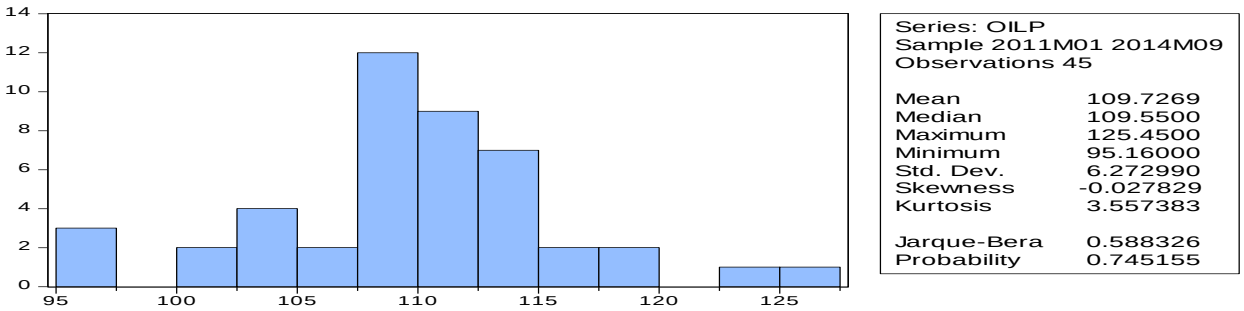
In the present study Granger Causality Model has been used to test the causality between Crude oil price and CPI inflation rate. Here the test signifies whether past information on macroeconomic variables predict stock prices in India, Null & Alternative hypothesis being:

H0: There is no significant relationship between crude oil price and inflation rate (CPI)
H1: There is a significant relationship between crude oil price and inflation rate (CPI)

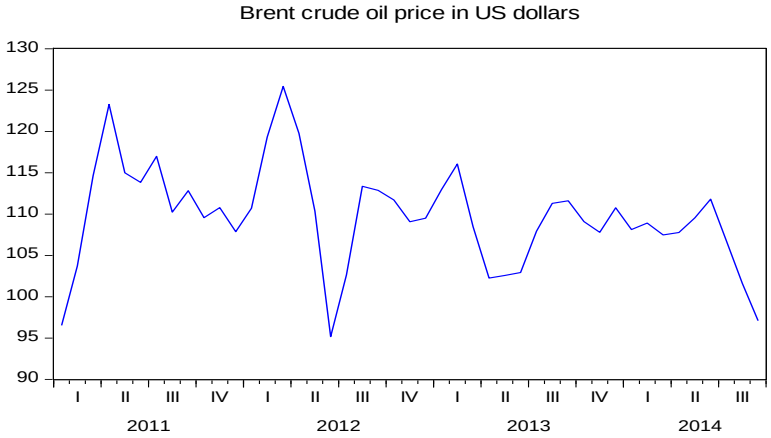
Note: A lag of five months has been considered.

Empirical analysis:

Crude oil is an indispensable input for production and therefore, the price of oil is included as a proxy for real economic activity. India is largely an importer of crude oil and consequently, oil price takes part an imperative role in Indian economy. It is apparent that any key movement in oil prices leads to uncertainties in the stock market which could persuade investors to suspend or delay their investments.
Moreover, increase in oil prices results in higher transportation, production and heating costs which have negative effect on corporate earnings. Rising fuel prices also raise alarm about inflation and diminish consumers' discretionary spending. Therefore, the financial risk of investments increases when there is wide fluctuation in oil prices. Therefore, for oil importing countries like India, an increase in oil price will lead to an increase in production costs and hence to decreased future cash flow, leading to a negative impact on the stock market. Therefore, an increase in the price of oil in the international market means lower real economic activity in all sectors which will cause stock price to fall.



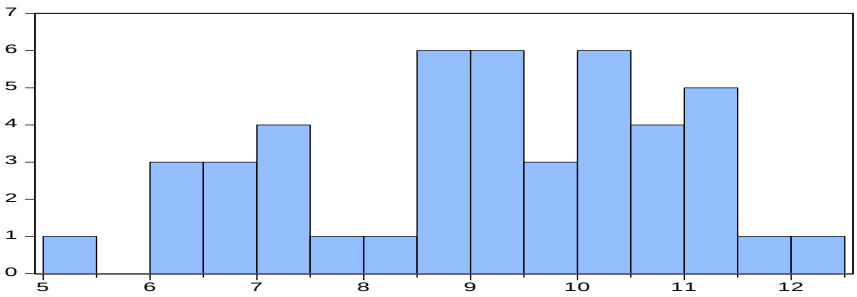
The mean of crude oil price is 109.72 and its maximum value is 125.45 and minimum value is 95.16, while standard deviation is 6.27. The crude oil price data found tobe stationary at the level itself the following graph confirms the stationarity of the data series. Apart from that ADF test applied to know the stationarity.



ADF test results shows that the p-value is 0.001 which is less than the critical value. Where oil price is series find tobe stationary at the level itself.

Consumer Price Index (CPI)

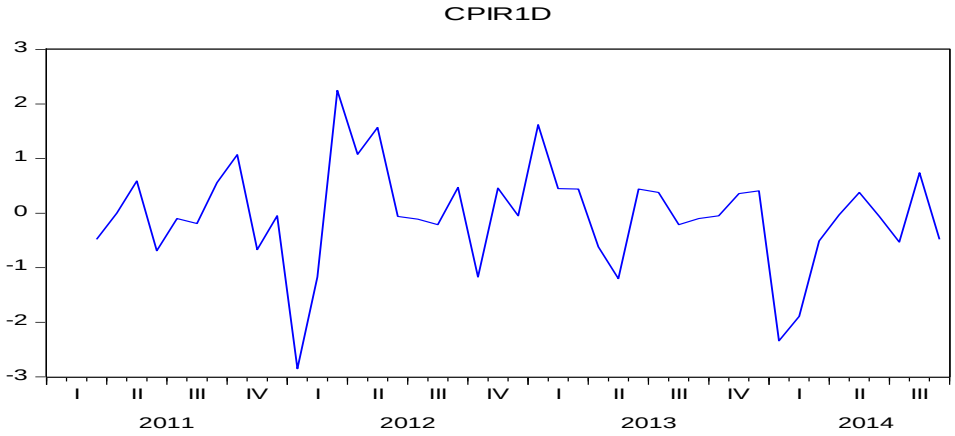
Inflation is measured by changes in the Consumer Price Index (CPI). High rate of inflation increase the cost of living and a shift of resources from investments to consumption. This leads to a fall in demand for market instruments which lead to reduction in the volume of stock traded.. High rate of inflation increase the cost of living and a shift of resources from investments to consumption. This leads to a fall in demand for market instruments which lead to reduction in the volume of stock traded. Also the monetary policy responds to the increase in the rate of inflation with economic tightening policies. Inflation is ultimately translated into nominal interest rate and an increase in nominal interest rates increase discount rate which results in reduction of present value of cash flows. High Inflation affects corporate profits, which in turn causes dividends to diminish thereby lower stock prices. When inflation begins to move upward, it likely leads to tight monetary policies which result in increase in the discount rate. It indicates that the cost of borrowing increases which in turn leads to investment reduction in the stock market. So, it is said that an increase in inflation is negatively related to equity prices.



Series: CPIR
Sample 2011M01 2014M09
Observations 45

Mean	9.123778
Median	9.340000
Maximum	12.06000
Minimum	5.320000
Std. Dev.	1.710835
Skewness	-0.353654
Kurtosis	2.145450
Jarque-Bera	2.307265
Probability	0.315489

The mean of the inflation rate is 9.12 and the maximum and minimum rate about 12.06 and 5.3 respectively. While std. deviation is 1.71. The ADF Unit root test states that the series is non-stationary with the p-value of 0.2416 which is higher than the critical value and the series find tobe stationary at the first difference.



The ADF test confirms the series stationary at the first difference with p-value of 0.001 which is less the critical value.

Granger causality test

Granger causality test is a technique for determining whether one time series is significant in forecasting another or not. Here Granger-causality test has been conducted to study the causal relationship between Crude oil price and CPI Inflation rate. The tables below reports granger causality test results with lag of 5 that is the appropriate selection of lags. The null hypothesis has been tested on the basis of the P-value. If the P-value is less than the critical P value at 5% than the null hypothesis is rejected and there will be a significant relation between the variables. First differencing of the variables has been used to apply granger causality test.

Granger Causality Tests for Crude oil Price and CPI Inflation Rate

Null Hypothesis	P-Value	Result	Relationship
Oil price does not granger cause CPI rate	0.9369	ACCEPT	NO RELATION
CPI rate does not granger cause oil price	0.2503	ACCEPT	

The above table shows granger causality test for Crude oil price and CPI inflation rate, the test confirms there in no relation between crude oil price and CPI inflation rate. The monthly data analysis of the two variables does not found the relationship.

Conclusion

The paper examined the effects of hike in crude oil price on the domestic inflation (CPI) rate using time series monthly data from January 2011 to September 2014. Augmented Dickey fuller unit root test (ADF) has been used to find the stationarity of the data series, where crude oil price found to be stationary at the level and CPI inflation rate was non stationary at the level and brought to stationary at the first difference. The correlation matrix and regression does not find the perfect relationship between the two variables and Granger causality test also confirms that there is no relation. So, the paper concludes that the hike in crude oil price does influence the domestic inflation rate as suggested by monthly data of two variables. Daily and weekly data of crude oil price and weekly inflation rate can be verified to know exact relationship.

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