Abstract
Crude oil prices play a very significant role on the economy of any country. India’s growth story hovers around the import of oil as India imports 70% of its crude requirements. In this paper, an attempt has been made to study the impact of crude oil price on the Indian economy by considering Gross Domestic Product (GDP), Index of Industrial Production (IIP) and Wholesale Price Index (WPI) as the relevant variables. Vector Auto Regression (VAR) has been used to analyse the objective since a direct causal relationship could not be established.

Keywords: Gross Domestic Product (GDP), Index of Industrial Production (IIP) and Wholesale Price Index (WPI), Vector Auto Regression (VAR).
Introduction

The recent rise in the prices of crude oil has drawn everyone’s attention towards the crucial role that oil plays in the economy of any nation. Crude oil is one of the most necessitated commodities in the world and India imports around 100 million tons of crude oil and other petroleum products. This in turn, results in spending huge amounts of foreign exchange. The increasing quantum of imports of petroleum products has a significant impact on the Indian economy, especially when crude oil prices are shooting up globally. Crude oil not only serves as a source of energy but also as a major raw material to various industries. With no major discoveries in the recent years, the increasing costs of production have pushed up crude oil prices globally. Also, the high volatility in the prices of oil breaching the $100/barrel mark and rising to a high of $147/barrel could be attributed to the fact that in the recent years, many index funds have taken positions in commodities considering oil to be an asset stock in their portfolios. It has been usually observed that in India, the pricing scheme is designed in such a way that it offers a system to moderate the soaring international oil prices and thereby study the impact on growth, inflation, etc.

In spite of the global economy being affected due to the European debt crisis, crude oil prices are soaring against a backdrop of increasing tensions around the situation in Iran. The price of Brent crude has gone beyond $120 per barrel. This spike in crude oil price significantly increases the energy costs of every country and becomes a major concern in the fragile global economy.

The impact of rising oil prices on the economy differs from country to country depending upon individual energy supply and demand structures. Countries that could be adversely affected by the increase in crude oil price are usually characterized by high net imports of oil per GDP. Traditionally, the non-oil producing developing countries fall under this category. Against this background, developed countries are more economical in their usage of oil and therefore, see an easing of this adverse effect of rise in crude oil prices. This phenomena has led to many European developed countries enjoying a significant inflow of oil money.

Today, we may find a negative impact of rise in crude oil prices. A steep fall in the current accounts leads to further worsening of the treasury budgets, which, in turn, will further worsen the balance between savings and investments. Also, reducing tax revenues and other extraneous factors will further deteriorate the treasury budgets. Due to the economic crisis in Europe, where the treasury budgets have shaken, there is a monumental imbalance between savings and investments. These imbalances continue worsening because of rising crude oil prices, which threaten to push the economy into much deeper crisis. When a country has a fixed nominal exchange rate and there is also an output gap, increases in oil prices leads to an increase in the general price levels. According to a RBI report (2005), for every unit dollar increase in crude oil price, WPI inflation rises by 30 basis points. Kaushik Bhattacharya et al. (2005) analysed the impact of increase in oil price on inflation. They studied the mechanism of increase in the prices of petroleum products on the prices of other commodities and the output in India. In February 1999, from an all time low of 11 U.S Dollars per barrel, it increased to a peak of 35 dollars in the first week of September 2000. Due to this, all oil importing countries faced the threat of oil shock; India, being a major oil importer, was particularly affected.
Historically, there have been four oil shocks in the past thirty years. In spite of this, low inflationary pressure has been assisting the developed countries in mitigating the risk associated with oil shocks. Contrary to this, developing countries are affected more because of the absence of advanced technology to conserve oil.

Literature reveals that most researchers agree with the fact that inflation has a recessionary effect on oil prices. According to Bruno (1982), oil price shocks lead to an increase in wages and prices, and decrease in real output. The same conclusion was substantiated by Hamilton (1983) using the Vector Auto regression (VAR) technique. Burbidge and Harrison (1984) found that the impact was different across different countries in spite of the fact that all were developed countries. Hooker (1996) on the other hand, found that the causal relationship between oil prices and macro-economic variables weakened post 1973 and were not able to capture the dynamics of business. Christini (1998) observed a very strong correlation between macroeconomic factors and oil prices.

In India, increase in petroleum prices often results in debates among the public. This indirectly results in delay in any kind of adjustment in prices and in the long run, creates a bigger shock. It also impacts the prices of all those commodities which use these products as inputs and can lead to a subsequent spike in the wage prices which is evident from the 1970 oil shock. Most of the earlier studies in the Indian context are based on estimating the cost push effect of a hike using input-output analysis. Rangarajan et al’ (1981) and Sastry (1982) used input-output analysis to estimate the cost-push effect of a hike. This method is not useful in estimating the shock over a long period of time given its static nature.

Strategically, oil plays a very significant role in the economy of any country. Keeping this in view, an attempt has been made in this paper to explore the relationship between volatility in oil prices and its impact on the Indian economy. This topic is pertinent to the current situation when India imports almost 90% of its oil requirements. The objective of this paper is to determine the relationship between increase in oil price and the change in GDP, IIP and WPI.

**Methodology:** Oil impacts the economy through various channels. This study restricts itself to analyzing the direct impact of oil prices on the WPI and IIP, and thereby on the GDP of the country. Quarterly data from 1995 till 2008 has been considered for the study which has been obtained from the CMIE database. The variables that have been considered for the study are as follows:

- GDPX: Log normal change in Indian GDP (in Rs.)
- IIPX: Log normal change in Index of Industrial Production (in Rs.)
- CPX: Log normal change in Crude oil price per barrel (in Rs.)
- WPIX: Log normal change in Inflation measured in terms of Wholesale Price Index (WPI)

Since the series is non-stationary and increasing, log normal values have been considered. Direct causal relationship (Granger’s Causality) using a series of t-tests and F tests could not be established between the variables. In this paper, VAR models are used to analyse multi-variate time series data, because they are extremely helpful in analysing the dynamic behaviour of economic and financial time series. Also, the...
superiority of VAR Models as compared to any other causal analysis is one of the reasons for it to be used in this paper. Lastly, since the paper brings in the aspect of policy analysis, VAR as a technique has been found to be appropriate. VAR is a multi-equation system where all the variables are treated as endogenous. The k-variable VAR model is given as:

\[ Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \cdots + \beta_k Y_{t-k} + \varepsilon_t \]

where

\[ \varepsilon_t \]

is the error term which is a nx1 matrix.

An explicit causal relationship cannot be established between the variables considered and hence VAR is preferred.

**Hypothesis:** The hypothesis proposed here is as below:

There is a significant relationship between change in manufacturing IIP, GDP growth, WPI change and crude oil price change.

**Results:**

The Vector Auto Regressive estimates, R-Squared and the Akaike Information Criterion and Schwarz criterion are shown in the following table:

<table>
<thead>
<tr>
<th>Vector Auto Regressive Estimates:</th>
<th>GDPX</th>
<th>IIPX</th>
<th>WPIX</th>
<th>CPX</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDPX(-1)</td>
<td>-0.371</td>
<td>0.105</td>
<td>-0.004</td>
<td>-1.511</td>
</tr>
<tr>
<td></td>
<td>(0.144)</td>
<td>(0.06889)</td>
<td>(0.04948)</td>
<td>(0.70194)</td>
</tr>
<tr>
<td></td>
<td>[-2.77823]</td>
<td>[1.45565]</td>
<td>[-0.11013]</td>
<td>[-2.15596]</td>
</tr>
<tr>
<td>GDPX(-2)</td>
<td>-0.544</td>
<td>-0.401</td>
<td>0.068</td>
<td>-1.689</td>
</tr>
<tr>
<td></td>
<td>(0.17675)</td>
<td>(0.10398)</td>
<td>(0.06888)</td>
<td>(0.98992)</td>
</tr>
<tr>
<td></td>
<td>[-3.00602]</td>
<td>[-3.75454]</td>
<td>[1.03603]</td>
<td>[-1.77857]</td>
</tr>
<tr>
<td>IIPX(-1)</td>
<td>0.398</td>
<td>-0.131</td>
<td>-0.060</td>
<td>3.596</td>
</tr>
<tr>
<td></td>
<td>(0.40395)</td>
<td>(0.23897)</td>
<td>(0.15413)</td>
<td>(2.19432)</td>
</tr>
<tr>
<td></td>
<td>[1.00634]</td>
<td>[-0.57665]</td>
<td>[-0.42981]</td>
<td>[1.74327]</td>
</tr>
<tr>
<td>IIPX(-2)</td>
<td>-1.121</td>
<td>0.095</td>
<td>-0.039</td>
<td>4.544</td>
</tr>
<tr>
<td></td>
<td>(0.32678)</td>
<td>(0.19253)</td>
<td>(0.12455)</td>
<td>(1.77658)</td>
</tr>
<tr>
<td></td>
<td>[1.00627]</td>
<td>[0.50354]</td>
<td>[-0.32189]</td>
<td>[2.52129]</td>
</tr>
<tr>
<td>WPIX(-1)</td>
<td>-0.581</td>
<td>-0.510</td>
<td>0.069</td>
<td>-5.110</td>
</tr>
<tr>
<td></td>
<td>(0.54433)</td>
<td>(0.32021)</td>
<td>(0.20801)</td>
<td>(2.89967)</td>
</tr>
<tr>
<td></td>
<td>[-1.04978]</td>
<td>[-1.60297]</td>
<td>[0.33943]</td>
<td>[-1.72341]</td>
</tr>
</tbody>
</table>


\[
\begin{align*}
\text{VAR model:} & \\
\text{Vector Auto Regression:} & \quad (\text{Standard Errors in } (\text{ )} \text{ and t-Statistic in } [\text{ ]}) \\
\text{Hypothesis:} & \\
\text{Impact of Oil Prices on the Indian Economy} & \\
\end{align*}
\]

\[
\begin{array}{|c|c|c|c|}
\hline
\text{WPIX(-2)} & 1.372 & 0.163 & 0.181 & 1.498 \\
\text{(0.54362)} & (0.31423) & (0.21452) & (2.88678) \\
\hline
\text{CPX(-1)} & -0.018 & -0.0259 & -0.030 & -0.090 \\
\text{(0.04423)} & (0.02654) & (0.01765) & (0.23798) \\
\hline
\text{CPX(-2)} & 0.039 & 0.030 & 0.003 & 0.242 \\
\text{(0.03464)} & (0.02019) & (0.01311) & (0.18698) \\
\hline
\text{C} & 0.049 & 0.0259 & 0.005 & 0.005 \\
\text{(0.01152)} & (0.00685) & (0.00424) & (0.06128) \\
\hline
\end{array}
\]

\[
\text{R- squared and The Akaike Information Criterion and Schwarz criterion Table :}
\]

<table>
<thead>
<tr>
<th>\text{GDP}</th>
<th>\text{IIP}</th>
<th>\text{WPI}</th>
<th>\text{CPX}</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.95627</td>
<td>0.94434</td>
<td>0.44563</td>
<td>0.44200</td>
</tr>
<tr>
<td>0.94317</td>
<td>0.93313</td>
<td>0.21762</td>
<td>0.22874</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\text{Sum of Square residuals} & = 0.01034 \\
\text{S.E. Equation} & = 0.02212 \\
\text{F Statistic} & = 76.65712 \\
\text{Log Likelihood} & = 77.88953 \\
\text{Akaike Information Criterion (AIC)} & = -4.522031 \\
\text{Schwarz Criterion (SC)} & = -4.11342 \\
\text{Mean Dependent} & = 0.02147 \\
\text{Standard deviation Dependent} & = 0.10192
\end{align*}
\]

The Akaike Information Criterion and Schwarz criterion are the least for a lag of two therefore indicating that a lag of two periods is the optimal. The high value of R-squared for GDP and IIP indicates a good fit between these variables against WPI and IIP. The F values also indicate a significant relationship at 10% level of significance. Hence, we may not reject the hypothesis. Therefore, we may say that there exists a significant relationship between the GDP growth, manufacturing IIP, WPI and crude oil price. The relationship between the variables is as under:

\[
\begin{align*}
\text{\( \hat{y} = 0.019 - 0.371y_{t-1} + 0.514y_{t-2} - 0.387p_{t-1} - 1.122p_{t-2} - 0.387w_{t-1} - 1.372w_{t-2} - 0.01p_{t-2} + 0.012 \)} \\
\end{align*}
\]

\[
\begin{align*}
\text{impact of Oil Prices on the Indian Economy} & \\
\text{ISSN: 0971-1023} & \text{ NMIMS Management Review} \\
\text{Double Issue: Volume XXIII October-November 2013} & \text{University Day Special Issue January 2014}
\end{align*}
\]
Any positive change in the crude oil price has an
immediate negative impact on the increment in the
GDP and IIP whereas it affects the WPI positively.
While GDP and IIP show signs of oscillating decay over
a period of time, WPI, after a positive increment,
returns to its original value within four months. A
shock or impulse when given to WPI affects GDP in the
same fashion considering the fact that WPI also
includes other terms apart from fuel which constitute
nearly 14.23% weight directly but also indirectly
influences other commodity baskets. It also affects the
IIP negatively and the effects last for a considerable
period of time showing signs of oscillating decay.

It can be seen that the analysis conforms with the
discussion that the system does have a long-term
memory and has an effect for more than 10 quarters in
case of GDP and IIP while for WPI, the system returns
to its original value immediately as compared to
others, thereby having a short-term memory. Any
sudden change in the price of oil has the ability to
impact the industrial growth adversely. It also causes a
very high spurt in the WPI. Altogether, change in oil
price, WPI increase and declining IIP affect the
economy negatively and even if the impulse or shock is
short term, it has a long-lasting impact on the
economy.

\[ w_{t+1} = 0.005 \times w_{t} - 0.003 \times p_{t} + \epsilon \]

\[ w_{t+1} = 0.004 \times w_{t} - 0.9 \times p_{t} + \epsilon \]

\[ w_{t+1} = 0.005 \times 1.51 \times w_{t} - 1.69 \times w_{t-2} - 3.59 \times w_{t-3} - 4.54 \times w_{t-4} + 5.11 \times w_{t-5} - 11.49 \times w_{t-6} + 0.09 \times w_{t-7} + 0.24 \times p_{t-1} + \epsilon \]
Any positive change in the crude oil price has an immediate negative impact on the increment in the GDP and IIP whereas it affects the WPI positively. While GDP and IIP show signs of oscillating decay over a period of time, WPI, after a positive increment, returns to its original value within four months. A shock or impulse when given to WPI affects GDP in the same fashion considering the fact that WPI also includes other terms apart from fuel which constitute nearly 14.23% weight directly but also indirectly influences other commodity baskets. It also affects the IIP negatively and the effects last for a considerable period of time showing signs of oscillating decay. It can be seen that the analysis conforms with the discussion that the system does have a long term memory and has an effect for more than 10 quarters in case of GDP and IIP while for WPI, the system returns to its original value immediately as compared to others, thereby having a short term memory. Any sudden change in the price of oil has the ability to impact the industrial growth adversely. It also causes a very high spurt in the WPI. Altogether, change in oil price, WPI increase and declining IIP affect the economy negatively and even if the impulse or shock is short term, it has a long lasting impact on the economy.


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