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BETA CLUSTERING OF IMPACT OF CRUDE-OIL PRICES ON THE INDIAN ECONOMY

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Introduction

Indian economy is the 10th largest economy in the world with a nominal GDP of \$2.05 trillion in 2014. It is the third largest in terms of GDP purchasing power parity. The largest contributor to the GDP in India came from the services sector (64.8%), followed by the industry sector (21.5%) and finally the agricultural sector (13.7%) in 2013.

Indian economy's dependence on crude-oil is well documented (Sivakumar, 2008). India is the 10th largest importer and 19th largest exporter of oil in the world. India ranks among the top 10 largest oil-consuming countries in the world. About 30% of India's total energy consumption is met by oil. Although India consumes around 2.2 million barrels of oil per day, the production is only about 0.8 million barrels per day. Therefore, 70% of its total oil consumption has to be imported (mcxindia.com, 2014). The importance of crude-oil to the Indian economy is represented in Figure 1 showing the relationship between crude-oil prices and GDP.

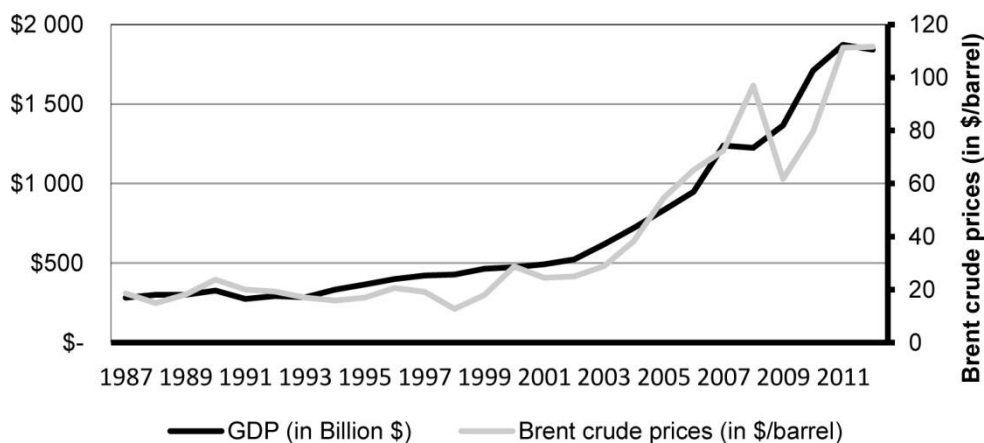


Figure 1. Importance of Crude-Oil to the Indian Economy

Crude-oil prices have always been volatile affecting the performance of the economy. In the recent months, the international crude-oil prices have been decreasing significantly. This study assumes significance because it tries to understand the extent of impact of crude-oil prices on the Indian economy. The objectives of the study are as follows:

- 1) To study the similarity in the extent of impact of change in crude-oil prices on key economic parameters in the Indian context.
- 2) To classify the extent of impact of change in crude-oil prices (as represented by regression betas) into meaningful clusters.

The paper is structured as follows: After a review of research on the impact of crude-oil prices on various economic parameters across the globe, the paper gives the methodology of the study. The results of the study are then presented. The clustering of the extent impact of crude-oil prices on the Indian economy is discussed finally.

Literature Review

In this section a review of research on the impact of crude-oil prices on economic variables is discussed.

Several research studies have been performed to understand the factors affecting changes in crude-oil prices. Kilian (2009) proposed that uncertainty plays the most important role in determining crude oil prices apart from demand and supply. Hamilton (2008) analysed the cause of 2008 crude-oil price rise and identified factors such as low price elasticity of demand for crude oil, increase in demand for the crude oil from China and other countries entering the industrialisation phase and global production of crude oil not matching the rising demand leading to the speculation in crude oil market contributing to the price rise. Chevillon and Riffart (2009) found factors that were not part of the historical physical market behaviour in determining oil prices which included cointegrating relations between OPEC's behaviour to control the prices by using its market power and the coverage rate of OECD's expected future demand using inventory behaviours. In the recent times (Mulla, 2014) has shown that the fall in oil prices can be attributed to increased supply, less dependence on OPEC and stabilising geo-political situations.

Research has been conducted to understand the impact of crude-oil prices on interest rates and inflation in the international context. Reicher and Utlaut (2010) studied the relationship between the international crude oil prices and the long run nominal interest rates and showed that there was a strong positive relationship between the oil price and the interest rates, in the US. Cologni and Manera (2008) examined the impact of oil shocks on the inflation and the interest rate of the G-7 countries and concluded that there was a considerable amount of impact on interest rates, which was caused due to the monetary policy decisions taken by the concerned authority to curtail the inflation. Yanagisawa (2012) showed that the importing country's purchasing power decreased significantly when oil prices rose, leading to a multiplier effect, which affected the consumers as well as the producers.

Studies have been done to study the impact of crude-oil prices on market returns. Maghyereh (2004) found that there was a very weak relationship between oil prices and returns from the stock market in several emerging economies due to inefficiency in capturing the information related to international crude oil prices. Ono (2011) showed a significant impact of oil price indicators on real stock returns in India, China and Russia. Casassus and Higuera (2013) studied the impact of oil prices on the industry portfolio returns using the Capital Asset Pricing Model (CAPM). Rise in oil price reduced the growth opportunities of industry and therefore negatively affected the price dividend ratio of the companies. Hedi Aroui and Khuong Nguyen (2010) examined the relationship between the international crude oil prices and the sector wise stock indices in Europe with both positive and negative relationships. Toraman et al. (2011) showed that the maximum impact of changes in Brent crude oil prices is on the industrial index in the Istanbul stock exchange.

There have been international studies on the impact of crude-oil prices on

economic variables. Cobo-Reyes and Perez Quiros (2005) used the Markov Switching Model to examine the impact of crude oil prices on industrial production and revealed that, in the long run changes in Brent crude oil prices have more impact on the industrial production than on stock returns in USA. Coudert et al. (2007) found the presence of long term relationship between oil prices and United State's effective exchange rate expressed in real terms. Ferraro et al. (2012) proved that Canadian\$ - US\$ exchange rate could be predicted by analysing the daily oil price movements. Novotný (2012) studied the relationship between International crude oil prices and US dollar showed that the changes in the exchange rate had a negative impact on the crude oil prices.

Crude-oil prices have impact on the world economy. Zaytsev (2010) examined the impact of changes in international oil prices on the GDP of Ukraine. The results showed a time lag between the moments of oil price rise and its impact on GDP. This is because of the time for the transmission of the change in oil price to economy through downward demand and cost. Allegret et al. (2013) analysed the impact of international crude oil prices on the current account balance of 27 oil exporting countries and showed that there was a positive impact of rising oil prices on the current account of the countries which were less financially developed like Turkmenistan, Congo, and Columbia. Abeyasinghe (2001) used the VARX model to examine the direct and indirect impact of oil price shocks on the economic growth of ASEAN countries. Countries like Malaysia and Indonesia had a positive impact on their GDP in the short run as they were oil exporting nations. Jiménez-Rodríguez and Sanchez (2005) examined the impact of international crude oil prices on the real GDP movement of the OECD nations and showed that increase in oil prices had an adverse effect on the GDP of oil importing countries. Akram and Mortazavi (2011) conducted a study to find out the impact of changes in crude oil prices on the economic growth in the Indian subcontinent. *The study concluded that a decrease in oil prices had a greater impact on the economic growth than an increase in crude oil prices.*

Many of the above studies have been replicated in the Indian context too. Bhunia (2012) and Chittedi (2012) examined the relationship between the movements of the international crude oil prices and the Indian stock market and concluded that there was a long term relationship between BSE 500, BSE 200 and BSE 100, NIFTY and international crude oil prices. Kumar (2009) studied the impact of crude oil price shocks on the industrial production growth in India and concluded that a 100% rise in the real oil price lead to reduction in growth of Industrial Production by 1%. Bhanumurthy et al. (2012) studied the impact of oil price on the various macroeconomic factors namely, GDP, inflation, current account deficit and fiscal deficit of India based on pass-through impact and showed that, if pass-through is increased GDP growth is negatively impacted while there is a positive impact on inflation.

The above studies explain the importance of understanding the impact of crude-oil prices on economic variables. However, a study on whether the extent of impact of crude-oil prices on economic variables is similar is yet to be done in the Indian context. Similarly there is no study on identifying meaningful clusters based on the impact of crude-oil price changes. The current paper attempts to fill this research gap.

The Methodology

The methodology used for this study is discussed in this section.

Hypothesis

Bhanumurthy et al. (2012) had found that there is a significant impact of crude-oil price changes on several economic variables in the Indian economy. The same phenomenon has been observed across the world (Abeysinghe, 2001; Rodríguez and Sanchez, 2005 and Zaytsev, 2010). However, these studies do not attempt to understand whether the extent of impact is similar. Based on this idea, the hypothesis of the study has been formulated as follows:

Null Hypothesis: The extent of impact of change in crude-oil prices on selected economic parameters is similar.

The economic parameters selected for the study are based on past studies (Bhanumurthy et al., 2012; Bhunia, 2012; Kumar, 2009) and are presented in Table 1.

Table 1. Data Collected for the Study

<i>Economic parameter</i>	<i>Proxy used</i>
BSE Sensex	BSE Sensex closing values
Trade deficit	BOP current account deficit
Exchange rate	USD-INR exchange rate
GDP	Gross Domestic Product
Gross profit margin	Gross profit margin of refining sector
Industrial production	Index of industrial production
Inflation rate	Wholesale price index
Interest rate	364 day T-bill implicit yield
Net profit margin	Net profit margin of refining sector
BSE Oil and Gas Index	BSE Oil and Gas Index closing values
Raw material cost	Raw material cost of the refining sector
Sales turnover	Sales turnover of the refining sector
Crude-oil price	Brent crude-oil spot price

Statistical Techniques

Regression: Regression equations were developed to study the impact of crude-oil prices on the selected economic parameters. The extent of impact is calculated by the betas in the following regression equations:

$$\text{BSEC} = \alpha_1 + \beta_1 \text{CDPC} + \varepsilon, \quad (1)$$

$$\text{DEFC} = \alpha_2 + \beta_2 \text{CDPC} + \varepsilon, \quad (2)$$

$$\text{EXCC} = \alpha_3 + \beta_3 \text{CDPC} + \varepsilon, \quad (3)$$

$$\text{GDPC} = \alpha_4 + \beta_4 \text{CDPC} + \varepsilon, \quad (4)$$

$$\text{GPMC} = \alpha_5 + \beta_5 \text{CDPC} + \varepsilon, \quad (5)$$

$$\text{IIPC} = \alpha_6 + \beta_6 \text{CDPC} + \varepsilon, \quad (6)$$

$$\text{INFC} = \alpha_7 + \beta_7 \text{CDPC} + \varepsilon, \quad (7)$$

$$\text{IRC} = \alpha_8 + \beta_8 \text{CDPC} + \varepsilon, \quad (8)$$

$$\text{NPMC} = \alpha_9 + \beta_9 \text{CDPC} + \varepsilon, \quad (9)$$

$$\text{OGIC} = \alpha_{10} + \beta_{10} \text{CDPC} + \varepsilon, \quad (10)$$

$$\text{RMCC} = \alpha_{11} + \beta_{11} \text{CDPC} + \varepsilon, \quad (11)$$

$$STC = \alpha_{12} + \beta_{12} CDPC + \varepsilon, \quad (12)$$

where, BSEC refers to change in the BSE SENSEX,

DEFC refers to change in Trade deficit,

EXCC refers to change in the Exchange rate,

GDPG refers to change in the GDP,

GPMP refers to change in Gross profit margin of Refining sector,

IIPC refers to change in Industrial production,

INFC refers to change in Inflation rate,

IRC refers to change in Interest rates,

NPMC refers to change in Net profit margin of Refining sector,

OGIC refers to change in BSE Oil and Gas Index,

RMCC refers to change in Raw material cost of Refining sector,

STC refers to change in Sales turnover of Refining sector,

CDPC refers to change in Crude-oil prices,

α , β refer to regression coefficients, and

ε represents error term.

t test: To understand whether the beta values of all regressions were equal, the mean beta was subjected to a t test along with calculating its confidence interval and other descriptive statistics.

Beta clustering: Beta clustering is a statistical technique of finding clusters of betas when variables are regressed against a common independent variable. Beta clustering is useful to understand the varying impact of the independent variable on several dependent variables (Lance and Williams, 1967). Beta clustering as an analysis technique has been adopted to study several phenomena including equity unit trust performance (Bertolis and Hayes, 2014), farm management practices (Raffrenato et al., 2003), optimum mix of duration and effort in the education sector (Oosterbeek, 1995) and shopping motivations (Kim, 2006). In this study, beta clustering technique has been used to study the similarity or differences in extent of impact of crude-oil prices on the Indian economy.

Data collection

Table 1 shows the economic parameters selected for the study along with the data collected for studying them.

The data has been collected and time-adjusted for the period 1987 to 2013 depending on data availability. To ensure stationarity of the data, the changes in the data have been used for analysis purposes.

Findings

Regression results: Table 2 gives the results of the various regressions conducted in the study.

Table 2. Betas of Regression Analysis

Economic parameter	β	p -value
BSE	0.0850	0.0000*
DEF	0.0445	0.9380
EXC	-0.0300	0.0295*
GDP	5.0135	0.0045*
GPM	-0.9459	0.1295
IIP	0.0224	0.5954
INF	0.0046	0.2238
IR	0.1339	0.0002*
NPM	-0.6853	0.2526
OGI	0.0942	0.0000*
RMC	0.4126	0.0054*
ST	0.3441	0.0204*

*Note: The shaded cells represent the values that are significant at 95% confidence level

Figure 2 presents the regression betas graphically.

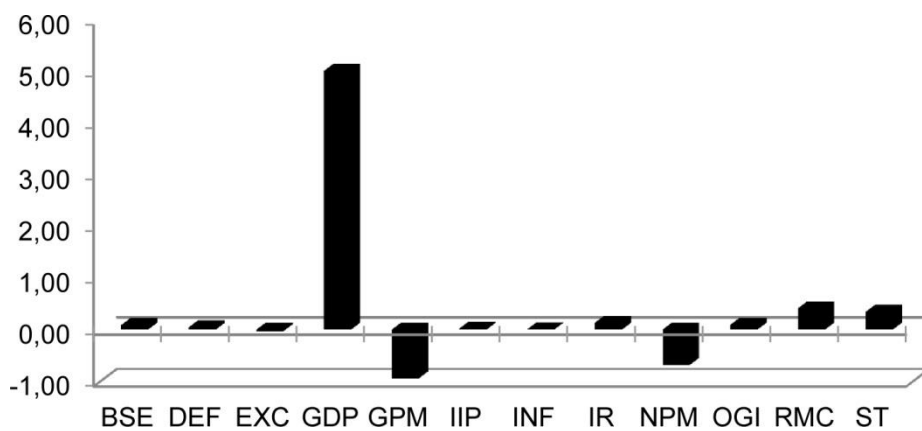


Figure 2. Betas of Regression Analysis

T-test Results

Table 3 provides the results of t tests and confidence interval test.

An analysis of Table 3 shows that the absolute range of the betas is very high. Even the range of the confidence interval of the mean betas is high.

Discussion

Tables 2 and 3 presented the results of the regression analysis and t test performed in this study. A study of these tables shows that the betas are not equal and have a high coefficient of variation of 408%. The absolute and 95% confidence interval ranges are also very high, being 5.96 and 1.91 respectively. This shows that the extent impact (as represented by the beta values) of crude-oil prices on selected economic parameters are not similar leading to the non-acceptance of the null hypothesis of the study.

Table 3. Results of T-tests

<i>Particulars</i>	<i>Value</i>	<i>p-value</i>
Mean β	0.37	-
Standard deviation	1.51	-
Coefficient of variation	408%	-
Hypothesised β	0	0.41
95% confidence level lower limit	-0.58	0.05
95% confidence level upper limit	1.33	0.05
Absolute range	5.96	-
Range of confidence interval	1.91	-
Kurtosis	10.07	-
Skewness	3.03	-

* Note: The shaded cells represent the values that are significant at 95% confidence level

Beta Clusters Analysis

Since the betas values of the regression analysis were shown as not equal, an attempt was made to find meaningful clusters in them. The beta values of the various regressions were clustered using k-means cluster analysis technique in SPSS. Tables 4 and 5 give the details of the cluster analysis of betas. Figure 3 presents the various beta clusters graphically.

Table 4. Cluster Analysis of the Betas

<i>Economic parameter</i>	<i>Cluster</i>	<i>Distance</i>
GDP	1	0
RMC	2	0.03
ST	2	0.03
NPM	3	0.13
GPM	3	0.13
INT	4	0.08
OGI	4	0.04
BSE	4	0.03
DEF	4	0.01
IIP	4	0.03
INF	4	0.05
EXC	4	0.08

Table 5. Distances between Final Clusters

<i>Cluster</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>
1	-	4.64	5.83	4.96
2	4.64	-	1.19	0.33
3	5.83	1.19	-	0.87
4	4.96	0.33	0.87	-

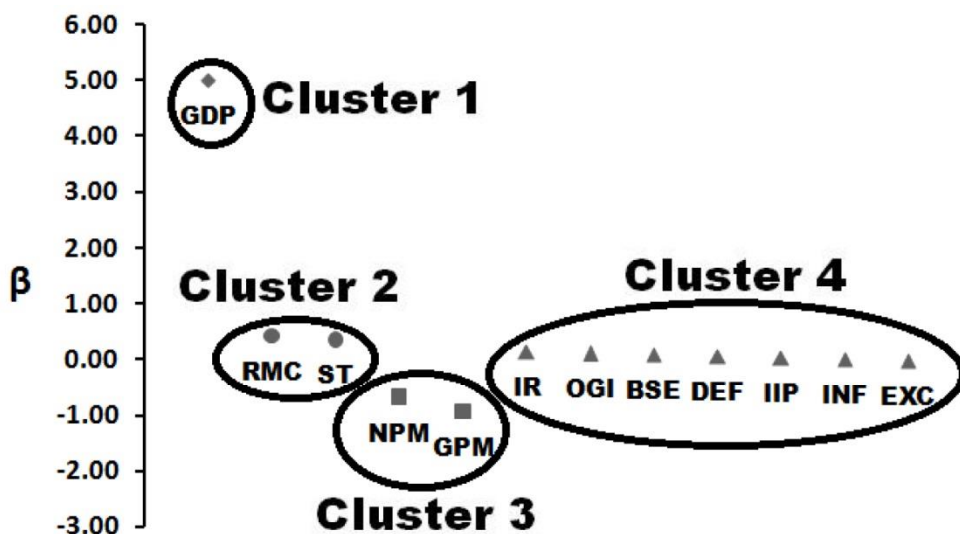


Figure 3. Beta Clusters

As Figure 3 shows there can be four different beta clusters of the impact of crude-oil prices on the Indian economy. These are

✓ *Cluster 1 – General Economy impact cluster:* At a primary level crude-oil prices have the biggest impact on the GDP of the nation. As India is a very large importer and exporter of crude-oil (mcx.com, 2014), any price change has a huge significant impact on the country's GDP.

✓ *Cluster 2 – Sectoral efficiency impact cluster:* At the secondary level crude-oil prices have the next highest impact on the raw material costs of the refining sector. Due to relatively inelastic demand nature of crude-oil, any price change in raw material cost is also passed on to the customer, which is seen in the impact of crude-oil prices on the sales turnover of the refining sector.

✓ *Cluster 3 – Sectoral profitability impact cluster:* At a tertiary level crude-oil prices negatively impact the profitability of the refining sector affecting both gross profit and net profit margins.

✓ *Cluster 4 – Economic policy impact cluster:* At the final level crude-oil prices impact various economic parameters which are central to policy making. These include inflation rate, interest rate, exchange rate, trade deficit, industrial production and market returns. Crude-oil price changes have a moderate impact on these policy parameters.

Conclusion

The objective of this paper was to understand the similarity in the extent of impact of crude-oil prices on the Indian economy. The paper has shown that the impact of crude-oil prices is not similar across various economic parameters. Further, the paper has also shown that betas can be clustered meaningfully to understand the varying levels of impact of crude-oil prices on the Indian economy. The results of the study not only show the significance of crude-oil for the Indian economy, but also provide pointers to policy makers for effective use of the beta clusters for better policy making.

Dedication

The authors humbly dedicate the paper to Bhagavan Sri Sathya Sai Baba, The Revered Founder Chancellor of Sri Sathya Sai Institute of Higher Learning, Prasanthinilayam, India.

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BETA CLUSTERING OF IMPACT OF CRUDE-OIL PRICES ON THE INDIAN ECONOMY

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Abstract

Indian economy depends on crude-oil to sustain its fast growth. There are several studies which have tried to understand the impact of crude-oil prices on Indian economic parameters. The current study is intended to understand whether the extent of impact of crude-oil prices on selected economic parameters is similar. The results of the study show that the extent of impact of crude-oil prices on the Indian economy is not similar. The study has also performed a cluster analysis using the regression betas to classify the extent of impact of crude-oil price changes and identified four meaningful clusters.

Keywords: beta clustering, crude-oil prices, Indian economy