

AN ANALYSIS ON CHANGES IN BEHAVIOURAL ASPECTS OF PRICE INDEX OF INDUSTRIAL PRODUCTION OF INDIA DUE TO CHANGES IN CRUDE OIL PRICE: A STUDY

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ABSTRACT

This paper investigates that how the behavioural aspects of price index of industrial production of India is impacted by the crude oil prices variations by utilising the data related to price index of different industry for the period 2012 to 2022. Using the econometric model along with different variables, the paper will finds that an rise in the crude oil prices, has an encouraging and extremely influence on Indian industrial production. This paper is based on the different crude oil prices i.e. imported, on shore, off shore and weighted average crude oil prices, which are independent variables. The price index of industrial production of India is divided among four sectors i.e. manufacturing industry, mining and quarrying industry, electricity industry and general industry. Furthermore, the magnitude of the rates of crude oil coefficient, directs the standing of rates of oil in shaping the price index of industrial production in India. With reference to the prices of crude oil, the study shows that the price index of industrial production of India are inclined to, to positive oil price variations mainly because they depend heavily on crude oil.

KEYWORDS: Price Index of Industrial Production, Durbin-Watson, Crude Oil Price, Anova.

Introduction

A necessary basic resource for industrial production is oil. The cost of petroleum products, energy bills, and other production expenses is directly impacted by the price of oil. The price of oil has seen numerous global shocks in recent decades, which have impeded the economic development of developing nations. In general, changes in the price of oil have a multiplicity of transmission pathways that impact economic growth. Shocks to the oil price raise production costs, which in turn reduces output on the supply side. Through the demand channel, rising oil prices raise the cost of commodities, which has an impact on the price index of industrial production. Consumers lose purchasing power as a result, which has an adverse effect on business and household decisions about investments and consumption. Stagflation brought on the oil price shocks significantly lowers output. Since emerging nations are more financially constrained than the global economy, oil price shocks are a serious problem. Because of their excessive reliance on oil imports and poor use of oil, developing economies that import oil are particularly vulnerable to these shocks.

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Energy, the main component of industrial production, is essential to the growth of an economy, particularly in oil-producing nations. The demand for investment and consumer items declines when oil prices rise. Oil-importing nations' foreign exchange reserves are depleted by the rising price of crude oil, widening their current account deficits. The degree to which a nation depends on oil and the proportion of its income that comes from oil expenditures determine how much of an impact oil price shocks have on that nation's economy. Industrial production is directly impacted by changes in the price of a necessary material, like petroleum. Furthermore, the actual economy is negatively impacted by increased oil prices.

Shifts in industrial production, political and geopolitical aspects, number of reserves available, financial speculating, weather, economic growth, exchange rate fluctuations, and other factors like the recent drop in oil prices due to excess supply or decreased global demand and the sub-prime crisis are some of the factors that have a substantial effect on the crude oil bazaar. Changes in foreign commerce, investment, and all other productive activities are directly impacted by these swings in the crude oil markets. They also have an effect on the overall economy and the global financial markets. India and other developing nations have two sources of crude oil. One comes from imports, while the other is domestic. There are two more splits in indigenous crude oil sources. One is located offshore, while the other on land. The term "on-shore oil field" describes the oil reserves found beneath the earth's layers, whereas "offshore oil field" refers to the seabed.

The pricing performance of the major industrial sectors of the Indian economy is shown by the pricing Index of Industrial Production (PIIP) of India. Every month, the Central Statistical Organization (CSO) computes and disseminates it. It is a combined measure of the overall price level of the economy's industrial activity. We have separated the industries into four categories in our study: manufacturing, mining and quarrying, electricity, and general industry.

This study looks at how variations in oil prices affect India's industrial output price index. The negative and substantial correlation between industrial production and oil price shocks implies that rising oil prices lower developing nations' industrial output. These shocks reduce industrial output through driving up the cost of production and imports, as well as by lowering demand for investment and consumption. In addition to causing market instability, oil prices also raise the cost of production. Consumption and cash flows to manufacturing firms both decline in this way. Consequently, businesses cut back on their investments.

Businesses can use this study to predict how pricing changes would effect their products. Nevertheless, financial speculators may take advantage of the correlation between the index of the production of India's many industries and the price of oil, even while economic planners may utilize these estimations to create policies for the public which would permit economic growth and expansion.

The following components of the study are organized as follows. Section 2 provides a brief overview of the literature, while Section 3 provides a detailed analysis of industrial production and oil prices. Section 4 presents the data and methodology, while Section 5 provides a detailed examination of the empirical results. Section 6 offers a conclusion and recommendations.

Literature Review

Overall economic growth and industrial production in developing nations are prone to oil price surprises. They are impacted by changes in oil prices mainly due to, they depend seriously on crude oil, which makes a key share of their import costs. Progresses in the terms of trade results to an upsurge in investment return, endorsing manufacturing production. (AL-Risheq 2016)

Industrial production is complexly effected by the oil prices. The production costs raise with a rise in oil prices, which lowers supply-side output. This decrease in investment leads to an even greater contraction in output. (Brown and Yücel 2002)

National economies are directly abrupt by the instabilities in the rate of crude oil, resulting in adjustments to foreign commerce, investments, and productive endeavors. For this reason, the market for crude oil is crucial to the growth of the economy. (Salles and Almeida 2017)

The demand for money rises in response to an increase in oil prices. Economic growth is hampered when monetary authorities, for whatever reason, are unable to keep up with the demand for money, which leads to an increase in interest rates. (Brown and Yücel 2002)

Research Gap

Studies have been conducted on the effects of oil prices on industry in both industrialized and emerging nations' industrial production. To the best of the researcher's knowledge, no studies have been done specifically for developing nations that look at the price index of India's industrial production between 2012 and 2022. Since oil provides the foundation for the price index of developing countries' industrial activity, it is therefore a prospective topic to investigate. The purpose of this research is to analyze how India's industrial output price index is affected by the oil prices. In addition, it offers policy recommendations and analyzes other important variables, such as the many forms of crude oil prices.

Research Methodology

This study examined the relationship between the Price Index of Industrial Production of India, displayed as PIIP and the Crude Oil Prices, indicated as COP, over the years 2012 to 2022. The study has implemented procedure based on analytical research, quantitative and descriptive. The data for the study were obtained from secondary sources available on Indian government website. The two types of COP are taken into consideration i.e Imported Crude Oil Price (ICOP) and Domestic Crude Oil Prices (DCOP). The analysis takes into account three different types of DCOP: weighted average domestic crude oil price (WADCOP), off-shore domestic crude oil price (OFSDCOP), and on-shore domestic crude oil prices (ONSDCOP). In order to analyze the correlation between the independent factors, such as COPs, and to determine the relationship between the independent and dependent variables, the researcher used the DURBIN WATSON test. Additionally, the researcher employed an economic model to identify patterns in the residual data.

Objective

- To know the trends of domestic crude oil price (onshore, offshore and weighted average) trend.
- To identify the trends imported crude oil price
- To ascertain the correlation between the crude oil price of domestic and imported.
- To know the trend of index of industry production of India.
- To examine the connection between the price of crude oil, both imported and domestic and the index of industrial production.

Hypothesis 1

H₀: The residuals (price of imported and domestic crude oil) do not correlate.

H₁: There is autocorrelation between the residuals (price of domestic and imported crude oil).

Hypothesis 2

H₀: The Index of Manufacturing Industry Production and the price of crude oil, both domestically and imported, do not significantly correlate.

H₁: The Index of Manufacturing Industry Production and the price of crude oil, both imported and domestic, are significantly correlated.

Hypothesis 3

H₀: The Index of Mining & Quarrying Industry Production and the price of crude oil, both domestically produced and imported, do not significantly correlate.

H₁: The price of crude oil, both imported and domestic, and the Index of Mining and Quarrying Industry Production are significantly correlated.

Hypothesis 4

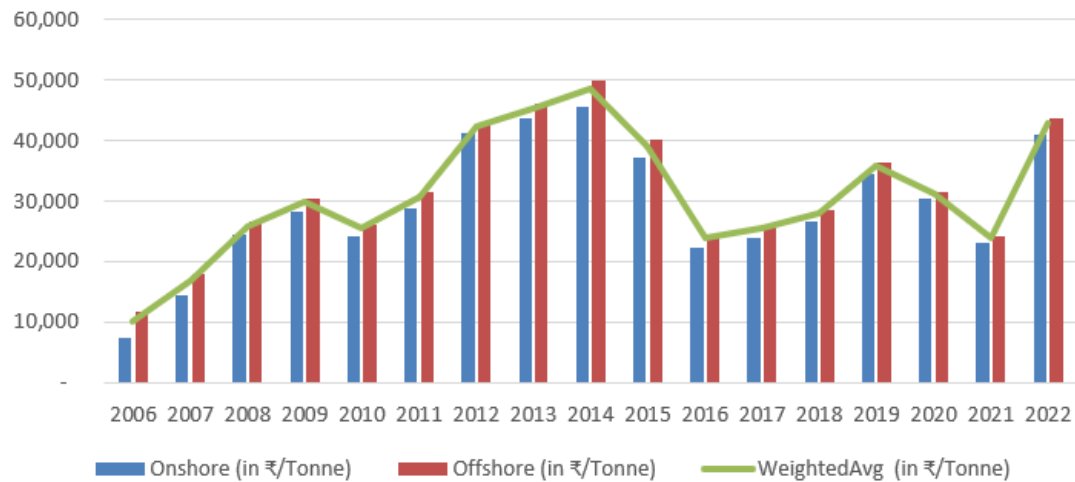
H₀: The Index of Electricity Industry Production and the price of crude oil, both imported and domestic, do not significantly correlate.

H₁: The Index of Electricity Industry Production and the price of crude oil, both imported and domestic, are significantly correlated.

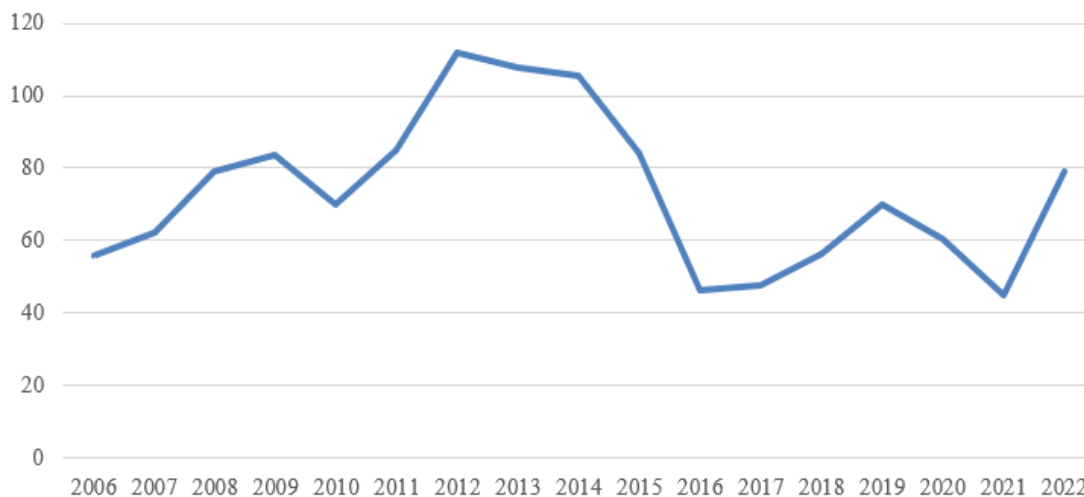
Hypothesis 5

H₀: The price of crude oil, both imported and domestic, has no discernible link to the Index of General Industry Production.

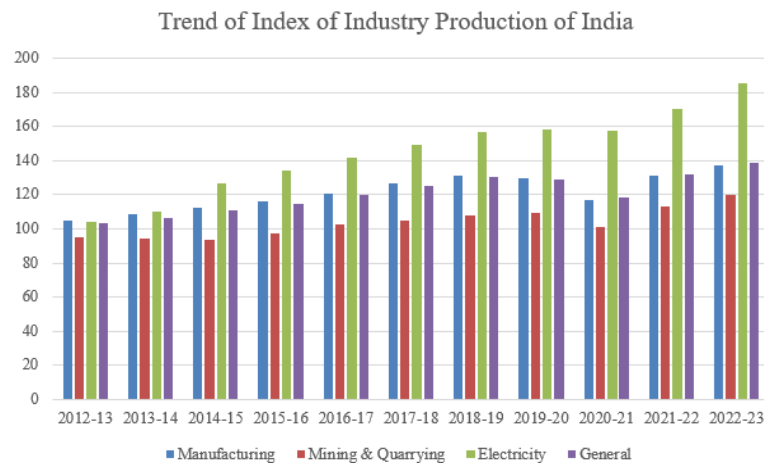
H₁: The Index of General Industry Production and the price of crude oil, both imported and domestic, are significantly correlated.

Data Analysis & Interpretation**Domestic Crude Oil Price Trend****Chart 1**

The above chart, specifically showing the trends for Domestic Crude Oil price for all the three category i.e Offshore, onshore and weighted average price. The chart shows that the price of crude in 2022 is drastically increase in comparison to 2021 and matched with the crude oil prevailed in 2015. This trend analysis shows that in 2014, the domestic crude oil price was at peak. This chart shows the fluctuating price trend of crude in domestic market in India.

Imported Crude Oil Price Trend**Chart 2**

This chart is showing the trend of imported crude oil price. This chart clearly shows the fluctuating trend. This chart and trend shown above chart i.e Chart No. 1, is more or less same. In 2012 to 2014, the crude oil price was at all-time high for the period covered under the study as same as in Chart No. 1 supra. The trend shows that in 2022, there is drastic upsurge in the imported crude oil price in comparison to 2021.

**Chart 3**

The above chart significantly showing that the as the economy of India is in developing stage and rapidly growing year to year, the price index of industrial production is also increasing. All the industries except electricity drastically dips in the year 2020-21 and the main reason behind the same is COVID-19 and lockdown situation and we can say that the COVID-19 effects the price index of industrial production but not having same impact on electricity industry. But we can see that in the next year only, after COVID-19 i.e 2020-21, the PIIP has drastically gone increase, when the lockdown open and impact of COVID-19 getting neutralized and in the year 2021-22, the PIIP was at the all time high which shows the growth in the economy as well.

The results of the DURBIN WATSON test show that it is 0.57076. The researcher consults the Durbin-Watson critical (table) values for $n = 17$ (No. of observations), $\alpha = 0.05$, $k = 4$ (No. of independent values) in the regression model to ascertain whether at a given alpha level, the Durbin-Watson test statistic is significantly significant or not. The DW table displays the lower critical values and upper critical values as 0.78 and 1.90, respectively. Given that our DW statistics value of 0.57076 doesn't falls in this range. Therefore, the Durbin-Watson test's null hypothesis can be rejected with adequate evidence. Put differently, there exists a correlation between the residuals.

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.910 ^a	.828	.742	4.8776	.828	9.612	3

Model Summary^b

Model	Change Statistics		
	df2	Sig. F Change	Durbin-Watson
1	6	.010	1.235

a. Predictors: (Constant), WeightedAvg (in ₹/Tonne), Imported Crude Oil Price, Onshore (in ₹/Tonne)

b. Dependent Variable: Manufacturing Index Price

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	686.041	3	228.680	9.612	.010 ^b
	Residual	142.748	6	23.791		
	Total	828.789	9			

a. Dependent Variable: Manufacturing Index Price

b. Predictors: (Constant), WeightedAvg (in ₹/Tonne), Imported Crude Oil Price, Onshore (in ₹/Tonne)

After applying ANOVA, we can observe that the R Square for this is 0.828, meaning that this model accounts for 82.80% of the variation in response. Thus, we can conclude that this model fit perfectly. The R Square change in this model, which is 82.80%, illustrates how effectively the researcher's model forecasts the reaction to fresh observations. Greater projected R² values indicate a higher level of predictive power for the models. As can be seen in the above table, the P Value is 0.010, or less than 0.05, or the significance threshold ($P\text{-value} \leq \alpha$). Consequently, our alternate hypothesis is approved, and researchers can settle that there is a considerable correlation among the index of manufacturing industry production and the price of crude oil, both domestically and internationally.

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.939 ^a	.882	.823	2.9258	.882	14.964	3

Model Summary^b

Model	Change Statistics		
	df2	Sig. F Change	Durbin-Watson
1	6	.003	1.829

a. Predictors: (Constant), WeightedAvg (in ₹/Tonne), Imported Crude Oil Price, Onshore (in ₹/Tonne)

b. Dependent Variable: Mining & Quarrying Index Price

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	384.306	3	128.102	14.964	.003 ^b
	Residual	51.363	6	8.561		
	Total	435.669	9			

a. Dependent Variable: Mining & Quarrying Index Price

b. Predictors: (Constant), WeightedAvg (in ₹/Tonne), Imported Crude Oil Price, Onshore (in ₹/Tonne)

After doing ANOVA, we can observe that the R Square in this case is 0.882, indicating that this model accounts for 88.20% of the variation in response. Thus, we can conclude that this model fit perfectly. The R Square change in this model, which is 88.20%, illustrates how effectively the researcher's model forecasts the reaction to fresh observations. Greater projected R² values indicate a higher level of predictive power for the models. The table above indicates that the P Value is 0.003, which is below the significance limit of 0.05 ($P\text{-value} \leq \alpha$). Thus, our alternate hypothesis is approved, and the researcher can accomplish that there is a substantial correlation among the index of mining and quarrying industry production and the price of crude oil, both domestically and internationally.

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.990 ^a	.979	.969	3.8600	.979	94.558	3

Model Summary^b

Model	Change Statistics		
	df2	Sig. F Change	Durbin-Watson
1	6	.000	2.501

a. Predictors: (Constant), WeightedAvg (in ₹/Tonne), Imported Crude Oil Price, Onshore (in ₹/Tonne)

b. Dependent Variable: Electricity Index Price

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4226.608	3	1408.869	94.558	.000 ^b
	Residual	89.397	6	14.899		
	Total	4316.005	9			

a. Dependent Variable: Electricity Index Price

b. Predictors: (Constant), WeightedAvg (in ₹/Tonne), Imported Crude Oil Price, Onshore (in ₹/Tonne)

After applying ANOVA, we can observe that the R Square in this case is 0.979, indicating that this model accounts for 97.90% of the variation in response. Thus, we can conclude that this model fit perfectly. The R Square change in this model, which is 97.90%, illustrates how effectively the researcher's model forecasts the reaction to fresh observations. Greater projected R² values indicate a higher level of predictive power for the models. As we can see from the above table, the P Value is 0.000, or less than 0.05, or the significance level ($P\text{-value} \leq \alpha$). Consequently, our alternate hypothesis is approved, and researchers can achieve that there is a considerable correlation among the index of electricity industry production and the price of crude oil, both domestically and internationally.

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.940 ^a	.883	.824	4.1998	.883	15.079	3

Model Summary^b

Model	Change Statistics		
	df2	Sig. F Change	Durbin-Watson
1	6	.003	1.282

a. Predictors: (Constant), WeightedAvg (in ₹/Tonne), Imported Crude Oil Price, Onshore (in ₹/Tonne)

b. Dependent Variable: General Index Price

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	797.905	3	265.968	15.079	.003 ^b
	Residual	105.831	6	17.639		
	Total	903.736	9			

a. Dependent Variable: General Index Price

b. Predictors: (Constant), WeightedAvg (in ₹/Tonne), Imported Crude Oil Price, Onshore (in ₹/Tonne)

We used an ANOVA in this analysis, and the results show that the R Square is 0.883, or 88.30% of the response variation explained by this model. So, it is safe to say that this model fit perfectly. The R Square change in this model, which explains how effectively the researcher's model forecasts the reaction for fresh observations, is 88.30%. Greater predictive power is exhibited by models with higher anticipated R² values. The P Value in the table above is 0.003, which is less than 0.05, or the

significance level ($P\text{-value} \leq \alpha$). Consequently, our alternate hypothesis is approved, and researchers can achieve that there is a considerable correlation among the index of general industry production and the price of crude oil, both domestically and internationally.

Conclusion

A nation's degree of industrialization serves as a barometer for its level of development. Nations aiming to boost their industrial output would rather have easy and inexpensive access to energy sources and resources. However, the industrial production of nations that rely on oil is impacted by rising oil costs. Moreover, rising production costs also raise general prices, which will undoubtedly have an effect on the industrial production index price. As result in this study shows that there is a strong and positive relation among the dependent and independent variable. As a result, the study comes to the conclusion that changes in the independent variable will cause changes in the dependent variables. Therefore, if the price of crude oil rises and vice versa, an increase in the indexed price of industrial production lowers the welfare level of consumers and subsequently lowers their demands, resulting in an economic recession.

Crude oil prices, however, have an impact on the relationship between the price index of industrial production and the ability to classify industries based on used base. As a result, it would be beneficial and worthwhile to investigate the inclusion of additional dependent variables in future research, such as the division of the price index of industrial production into six categories based on usage, namely the primary goods industry, capital goods industry, intermediate goods industry, infrastructure / capital goods industry, consumer durables goods industry, and consumer non-durable goods industry.

In addition to being an essential component of industrial production, crude oil serves as a major raw material for everyday consumer products like gasoline, diesel, and lubricating oil. As a result, there is a strong correlation between economic development and sudden changes in the price of crude oil. The research period for this study's annual data spans from 2012 to 2022. Future researchers can update the data and include more research factors to continue examining this topic if they are interested in it.

Recommendation & Scope for Further Research

The price index of industrial production may be less affected by oil shocks thanks to several significant policy implications of this study. The study's conclusions could lead one to suggest that India's economic management actors ought to keep a careful eye on oil prices. It is advised in this context to focus more on alternate energy sources in order to avoid industrial output becoming reliant on crude oil. Increased energy production and the allocation of finances and incentives for renewable energy sources, such as geothermal, solar, and wind energy, which have a great potential for energy capacity, are necessary to lessen the nation's reliance on foreign sources for crude oil. The production of industrial goods that operate on electricity rather than oil, including electric automobiles and high-speed trains, is also vital. In addition to the aforementioned, it is advised that low lending rates be maintained, particularly for industry, in order to increase investment for production objectives. Furthermore, in contrast to developed nations, developing economies lack a robust industrial foundation. The real currency rate should be maintained at a level that supports emerging nations' export and domestic output. Finally, as the economy of most emerging nations rely on oil imports, it is imperative that India enhance its oil reserve system to lessen its susceptibility to oil shocks.

References

1. AL-Risheq, Suhair M. 2016. "The Impact of Oil Prices on Industrial Production in Developing Countries."
2. Brown, Stephen P.A., and Mine K Yücel. 2002. "Energy Prices and Aggregate Economic Activity: An Interpretive Study." *Quarterly Review of Economics and Finance*.
3. Mahunta, Rajendra. 2011. "Relationship between International Crude Oil Price and Indian Stock Market (NSE)." *Interscience Management Review (IMR)* 4 (1). doi:10.47893/IMR.2011.1081.
4. Nazir, Shahid, and Dr. Shakeel ul Rehman. 2021. "Trends in Crude Oil Price and its Economic Impact." *South Asian Journal of Marketing & Management Research (SAJMMR)* 11 (5). doi:10.5958/2249-877X.2021.00038.2.
5. Negi, Pushpa. 2015. "Impact of Oil Price on Economic Growth: A Study of Bric Nations." *Indian Journal of Accounting XLVII* (1): 144-155.
6. Nirmala, Dr. M, and Siva Thivya.R. 2020. "Impact of Crude Oil Price on Select Macroeconomic Indicators of India." *Our Heritage* 68 (1): 9406-9413.

7. NITI Aayog. 2024. *India Climate & Energy Dashboard*, Niti Aayog. January 06. Accessed January 06, 2024. <https://iced.niti.gov.in/>.
8. Punati, Narendra, and Raghavender G Raju. 2017. "Determinants of Crude Oil Prices in India." *SSRG International Journal of Economics and Management Studies (SSRG-IJEMS)*.
9. Salles, Andre Assis de, and Pedro Henrique Acioli Almeida. 2017. "The Crude Oil Price Influence on the Brazilian Industrial Production." *Open Journal of Business and Management* (Scientific Research Publishing) 401-414. doi:10.4236/ojbm.2017.52034.

