

## OPEN ACCESS

Manuscript ID:  
ECO-2023-11025917

Volume: 11

Issue: 2

Month: March

Year: 2023

P-ISSN: 2319-961X

E-ISSN: 2582-0192

Received: 12.12.2022

Accepted: 15.02.2023

Published: 01.03.2023

## Citation:

Preetha M. and Joseph, Kaviya Nijaritha. "The Impact of Macro Economic Variables on Crude Oil Pricing in India from the Years 2000 to 2021." *Shanlax International Journal of Economics*, vol. 11, no. 2, 2023, pp. 38–49.

## DOI:

<https://doi.org/10.34293/economics.v11i2.5917>



This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License

# The Impact of Macro Economic Variables on Crude Oil Pricing in India from the Years 2000 to 2021

**M. Preetha**

*III B. A Economics*

*Stella Maris College (Autonomous), Chennai, Tamil Nadu, India*

**Kaviya Nijaritha Joseph**

*Assistant Professor*

*Stella Maris College (Autonomous), Chennai, Tamil Nadu, India*

 <https://orcid.org/0000-0001-7051-6510>

## Abstract

*Crude oil is a necessary commodity for all the economies across the Globe. Demand for it is rising and more so witnessed in developing countries like India. Demand for crude oil has a lot of influential and counter reactive consequences such as increase in oil import, dependence of oil, exchange rate, trade deficit etc. The study examines the current state of crude oil pricing and crude oil imports into India. Annual time series data for the years 2000 to 2021 were used in this study. A variety of data analysis tools have been used with an effort to identify the key factors that influence crude oil prices. The macroeconomic variables considered for the study are foreign exchange rate, inflation, production, imports, consumption, and carbon emissions of crude oil which has greater influence on Oil pricing in India.*

**Keywords:** Foreign Exchange Rate, Imports, Production, Inflation, Consumption, Carbon Emission, Demand, Supply and OPEC.

## Introduction

The most essential source of energy for economic activity is crude oil, which is also the most traded commodity in the world. Crude oil has always been a very volatile commodity on a worldwide scale. Due to the fact that a limited number of nations hold the main reservoirs, demand for these resources sometimes causes political unrest. The top three oil-producing countries worldwide are the United States, Saudi Arabia, and Russia. A group of 14 significant oil-producing nations known as OPEC generates nearly 40% of the world's crude oil collectively. About 60% of the petroleum traded worldwide is exported by the OPEC. There are two widely used benchmarks for crude: Brent Crude and West Texas Intermediate (WTI) Crude. Refined Brent crude oil is often used to make diesel and gasoline. It acts as one of the primary benchmarks for oil prices in the Middle East, Europe, and Africa. whereas WTI (West Texas Intermediate) oil is widely used in the, refinement of gasoline. It primarily acts as a benchmark for oil prices in the US oil market. Brent crude and WTI are distinct, in terms of where it is extracted, its composition, how geopolitics affects it, where it is sold, and how it is valued.

Coal and oil are international commodities that are imported all over the world. As a result, the pricing for various energy sources is determined by global market forces of supply and demand. The cost of domestic oil-based energy, such as gasoline and heating oil, can be impacted by global events. Because of the booming demand in the developing world, notably in Asia, oil prices are high right now. More oil shipments are going to these nations as demand rises in those regions. As a result, prices elsewhere must increase.

There is a concern that political instability might halt oil production in some oil-producing countries, which is another factor in the high price of oil. There are lot of global factors that affect oil and petroleum pricing, this was made evident in the happening of few major global uncertainties that happened in the recent years, such as the invasion of Ukraine by Russia has had widespread humanitarian and economic repercussions, notably for the oil sector. The energy sector, like all others, is currently working in an uncharted territory. Even before the battle really escalated, global oil prices were soaring. The price of crude oil, which was approximately \$76 per barrel in the beginning of January 2022, shot up to almost \$110 per barrel on March 4 as a result of Russia's war on Ukraine. Due to increased demand sparked by the world economies' recovery from the COVID-19 pandemic and poor investment in the oil and gas sector, the price of crude oil was already high even before the conflict. The gap between supply and demand was predicted to increase to 2% in 2022 as a result of the rebound in demand that came after the lifting of pandemic restrictions.

India is the third-largest crude oil importer in the world, behind China and the United States. Nearly 85 % of our overall oil imports and 94 percent of our gas imports come from OPEC nations. India is now entirely dependent on imported crude oil due to the country's rapidly rising crude oil demand. India's domestic oil output did not increase as the country's crude consumption did throughout time. As a result, imports became more prevalent. Due to the sharp increase in crude prices, India's import expenditure for crude oil grew to \$120.4 billion in FY22. The macroeconomic condition is harmed by a larger import bill since it worsens the trade imbalance. Even if the fundamental cost of crude oil is constantly lower, import taxes increase its cost to the average person. The cost of gasoline and other associated goods rise in parallel, increasing the average person's expense. (Zaidi, et al., 2018).

Domestic crude output in India has been steadily declining. It decreased to 28.4 MMT in FY22, the lowest level in more than 20 years. Despite being the third-largest oil consumer, 85% of the nation's requirements are imported. India's high reliance on imports has driven up the cost of its petroleum

imports and increased its trade imbalance. A significant portion of domestic oil production is produced by the state-owned ONGC, whose output has been progressively declining. India's ageing oil wells have been a significant roadblock in its efforts to lessen its dependency on imports. As output from mature wells has decreased and there have been no big new finds, production has been considerably hindered.

The Ministry of Petroleum and Natural Gas has taken a number of actions, including promoting the use of renewable and alternate fuels like ethanol, second generation ethanol, compressed bio gas and biodiesel, promotion of natural gas as clean fuel/feedstock in the country with a view to move towards a gas based economy, refinery process improvements, promoting energy efficiency and conservation, efforts for increasing production of oil and natural gas through various policies under Production Sharing Contract (PSC) regime, Discovered Small Field Policy, Hydrocarbon Exploration and Licensing Policy, Setting up of National Data Repository, etc. By streamlining approval procedures, including the use of an electronic single window approach, the government has also given National Oil Companies functional flexibility and increased private sector engagement. In an effort to lessen the reliance on oil imports, the Ministry of Petroleum and Natural Gas is also collaborating with other Central Government Ministries and other stakeholders. Ministry of Petroleum & Natural Gas (2021) Reducing dependence of oil imports; Accessed (November 2022)

There are several factors that affect the crude oil pricing, and the economic variables that influence the pricing of crude oil have been extensively studied in the literature. Among other variables the market forces such as the demand and supply affect the crude oil pricing the most. The production, need and use of the any commodity is usually governed by the law of demand and supply. It is the same for energy consumption also.

The demand for both gasoline and diesel has been rising in parallel with the steady increase in the number of two wheelers and four-wheelers on Indian roadways. The supply cannot always be met since crude oil must be purchased from the international market by Indian oil refinery businesses in order to

be converted into gasoline and diesel. Economic law dictates that when supply is constrained and demand is high, fuel prices must rise.

With different degrees of success throughout the years, the Organization of Petroleum Exporting Countries (OPEC) has attempted to affect the price of oil by reducing the supply of petroleum. The growth of shale supplies in the continental U.S. has recently weakened OPEC's ability to control prices, but its cooperation with Russia and other exporters under the OPEC+ umbrella has strengthened it. The decisions made by OPEC+ continue to be closely watched by governments, oil firms, and investors.

The value of the Indian Rupee relative to the US Dollar is a significant factor affecting the price of gasoline and diesel in India. The crude oil that is converted into gasoline and diesel is purchased from the global market and paid for using dollars. Thus, a direct factor is the USD's strength relative to the INR. The price of buying crude oil will rise if the US dollar gains strength. As a result, the cost of the finished goods will likewise increase.

The unexpected quick increase in consumption can be used to explain the increase in crude oil prices in 2004. The consumption increases in 2004 was the greatest in the past twenty years, coming in at 2.9 mbd (3.7 percent), with China accounting for 0.8–1 mbd of the increase. It was also greater than the IEA's mid-2003 predictions by around 3.0 mbd (about 4%). The need for OPEC increased dramatically since non-OPEC producers were unable to boost output in accordance with initial plans. The 30 percent price increase in 2004 seems to have been well within the range predicted by fundamentals in the physical market, given that OPEC's output is close to capacity, meaning a supply curve that is almost vertical, and inelastic short-run demand for oil. Given projected past non-OPEC short-term supply elasticities, crude oil prices might have risen by more than 60% in 2004 even in the absence of an increase in OPEC output, according to estimates. Berkmen et al (2005) The structure of the oil market and causes of high prices; IMF Accessed (14th march 2019)

Increased input costs and higher oil prices both directly and indirectly contribute to inflation. During the 1970s, there was a significant relationship

between inflation and oil prices. Some claim that expensive renewable energy might reinforce the link between rising energy prices and inflation.

### Objective

- To study the various factors and determinants of crude oil pricing.
- To estimate the growth rate of crude oil pricing and foreign exchange rate for the years 2000 to 2021

### Hypotheses

- H0: There is no significant relationship between the foreign exchange rate, inflation, production, imports, consumption, and Carbon emission in determining the annual average crude oil pricing.
- H0: There is no significant relationship between the foreign exchange rate, inflation, production, imports, and consumption, in determining the annual average crude oil pricing.
- H0: There is no significant relationship between the foreign exchange rate, production, imports, and consumption, in determining the annual average crude oil pricing.

### Literature Review

The Indian economy has long been plagued by oil costs. Many of India's macroeconomic indicators frequently get manipulated by an unfavourable oil price shock. Crude oil is essential for both a nation's domestic consumption and the development of its industrial base. Given that India has the second-highest population and is the third-largest user of oil, both its demand for and consumption of oil are rapidly rising.

The factors that influence crude oil prices are debatable and have an unpredictable character. The factors that influence crude oil prices are the subject of differing opinions. One opinion holds that the market dynamics of supply and demand are to blame for how oil prices are behaving. The viewpoint of OPEC, the oil-producing organisation, is an alternative. Other macroeconomic factors that affect oil prices, such as inflation, foreign exchange, imports, production, and consumption of crude oil, are those that have increased during the past ten years in the trading of oil derivatives. All these factors are studied extensively in the review of literature.

The force behind all of the world's economic activities is energy. Crude oil has altered the fortunes of several nations. Its unparalleled significance to the world economy is demonstrated by the fact that oil accounts for 2.5% of global GDP. Companies from across the world would like to take advantage of the prospects that India's population of over a billion people presents if given a favourable business climate. Crude oil supplies around 31% of the world's overall energy requirements. Around 96 million barrels of oil are consumed globally each day. The non-financial commodities segment's largest traded commodity is crude oil. (Daksh Seth, 2016)

There are two perspectives on what influences the price of crude oil. The two perspectives are as follows: one is influenced by basic variables like supply and demand, while the other is influenced by extraneous elements like market power, OPEC decision-making (sanctions), and geopolitical uncertainty. Crude oil is a finite and non-renewable natural resource. In actuality, the cost of an exhaustible resource rises over time. The supply unexpectedly increased from 79.5 mb/d to 83.1 mb/d between 2003 and 2007 in reaction to the rise in crude oil prices. However, even though price increases were made available as a motivator to boost production, the supply of crude oil stagnated from 2005 to 2007. Oil supply mostly depends on OPEC and Middle Eastern nations. The supply of crude oil is essential in determining the prices of the crude oil as the increase need for crude oil is growing rapidly due to the increasing population (Narendra Punati, G and Raghavender Raju. G, 2017)

Contrary to supply, demand for crude oil is influenced by the decisions made by several distinct government policies, businesses and consumption for every household. However, due to its significance for the economy and national security, the demand side is influenced by a variety of private interest groups, the most powerful of which are domestic oil refiners without access to foreign supply sources and governments, who seek to obtain adequate supplies of petroleum from reliable sources. (Elitza Mileva and Nikolaus Siegfried 2007)

The import tariffs increase the cost of crude oil for the average person, whereas the base price is always lower. A regular man's expenses rise as a

result of an increase in the price of petrol or other associated goods. (Firdous A Wani and Syed Mohsin Saif, 2015)

While excess consumption can also raise prices, surplus crude oil production can result in a surplus and lower price. A decline in demand for oil and its price may result from the surge in popularity of alternative energy sources. Higher oil prices are typically linked to the context of global tensions and instability. (Gyagri M. et al, 2018)

The pricing of the crude oil is a significant factor that affects inflation management and generates significant growth in any economy, but particularly in emerging economies. It affects the stock market and inflation advantageously while negatively impacting the GDP and the exchange rate. (Habeeb Ur Rahiman and Dr. Rashmi Kodikal 2019)

Oil is undoubtedly an inflationary force for the economy, which also explains how oil influences the money supply and interest rate. Additionally, gold prices follow those of oil, suggesting that when inflation results from an oil price shock, gold's demand will follow. A method for insuring against inflation becomes more prevalent. Given the substantial amount of oil that India buys, it seems sense that oil leads net exports. (Gupta, and Goyal, 2015)

The degree of investment is impacted by the price of oil since it influences production costs. Increase in cost of production, reduces the firm's profit margin, and lessens investment incentives. This slows down a country's economic growth. It also disrupts its economic activity by affecting its current account balance and foreign exchange reserves. (Alkhateeb & Sultan, 2019).

Geopolitical risk and short-term surges have a strong link. Events related to the weather might greatly impact fluctuations in oil prices, especially in the near term. (Refkselmi et al, 2022)

The global financial crisis (GFC) of 2008 had a big impact on the oil and gas market. Specifically, the decline in US house prices resulted in the fall of the commodity market as a result of the GFC. The fuel, crude Market turbulence during the financial crisis was quite high. (Kyohun Joo et al, 2020)

As India being one of the major consumers of crude oil. The industrial sector, which includes the natural gas and oil industries, has a substantial impact on economic growth and development as

seen by the GDP and per capita income flow. As of the new coding, it represents 15% of India's GDP. (Dr. Sivasubramanian K and Dr. Raju.V, 2021)

Indian industries rely substantially on imported crude oil, and industrial output affects GDP. The price changes for crude oil have an impact on industrial development. Indian economic stability may result from finding a primary energy source other than oil. Oil price regulation and government subsidies are essential conditions for small- and medium-sized industries to survive. (Ahsan Z Rizvi, 2018)

When it comes to the import of crude oil, UAE has consistently been India's first choice, followed by Saudi Arabia, Iraq, Iran, and Malaysia. Similar to this, India's purchase of crude oil is mostly determined by GDP per capita, with the UAE being the country of choice. (Narendra N Dalei and Hiranmoy Roy, 2017)

India has relied largely on the Middle East for its crude oil reserves due to a number of benefits, including the availability of crude, geographic closeness, quick and affordable shipping. The founding members Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela established the Organization of the Petroleum Exporting Countries (OPEC) during the Baghdad Conference on September 10–14, 1960. OPEC is a permanent, intergovernmental organisation. (Sanjay Kumar Kar and Biswajit Roy 2020)

By 2040, demand for crude oil will have peaked, with India being the largest user due to its expanding population. Crude oil now dominates the

international economy. Everyone is affected by the rise in fuel prices. (Dr. Sumanta Bhattacharya and Bhavneet Kaur Sachdev, 2021)

India, being a net importer since our imports are more than our exports, due to which the Indian economic development is heavily dependent on the price we pay for imports. From the articles, it is clear that a variety of factors, including supply, demand, production, imports production, inflation and geopolitical unrest, and the availability of substitute resources, influence the price of crude oil. Additionally, it significantly affects the nation's economic expansion and development.

### Methodology

The variables considered for the study are foreign exchange, inflation, imports, production, consumption and Carbon emission in order to determine whether these variables have a significant impact on crude oil pricing. The data considered for the analysis is from the period 2000 to 2021. Since it is a times series data, seasonality issues may arise.

The tools used for the analysis are Karl Pearson's correlation matrix, descriptive statistics, regression, and growth model.

Correlation is used to find the degree of relationship between the proxy variable and the explanatory variables. Regression is used to statistically determine the influence of dependent variable on the independent variable. Growth model is used to analyse the changes or growth of the variables over the time.

**Table 1 Data Review for the Year 2000 to 2021**

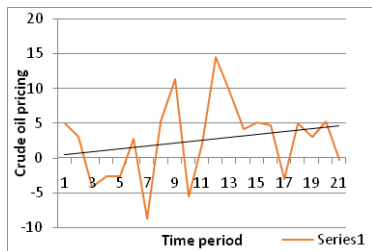
Variable Name	Variable Type	Abbreviations Used	Units	Source
Domestic Annual Average crude oil price	Dependent variable	ACOP	\$ per barrel	Petroleum Planning and Analysis Cell
Foreign Exchange rate	Independent variable	FXRATE	US \$	Reserve Bank of India
Inflation	Independent variable	INF	Percentage	Reserve Bank of India
Production	Independent variable	PROD	Metric tones	Reserve Bank of India
Imports	Independent variable	IMP	Metric tones	Reserve Bank of India
Consumption	Independent variable	CONS	Percentage	Petroleum Planning and Analysis Cell
Carbon emission	Independent variable	Co <sub>2</sub> E	Metric tones	UNFCC



**Analysis**

**Growth Model**

**Figure 1 Trendline for Annual Average Crude Oil Pricing from 2000-2021**



**Source:** Computed from secondary data

Growth model:  $\text{LnY}(\text{crude}) = B1 + B2(\text{time})$

$\text{LnY}(\text{crude}) = B1 + B2(\text{time})$

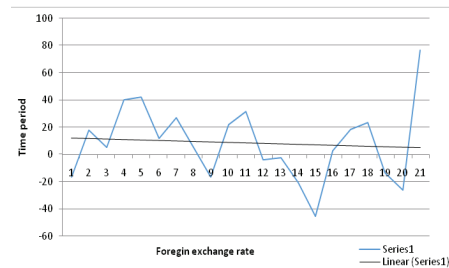
$\text{LnY}(\text{crude}) = 43.858 + 1.692(51)$

From figure 1 we can see the trend of growth in the annual ACOP. From the year 2000 to 2021. In the year 2010 the crude oil pricing was at the highest with a growth percentage of 15 percent approx. the crude oil price was ta the lowest in the year 2006 when the growth rate fell to 8.7 percentage.

Growth model of annual Avg COP is estimated to predict the value of crude oil in the year 2050 which is 91, which means that there will be an increase in

the price of crude oil of 91 percent by the year 2050.

**Figure 2 Represents Trend line for Fixed Exchange Rate from 2000-2021**



**Source:** Computed from secondary data

Growth model:  $\text{LnY}(\text{FX}) = B1 + B2X(\text{time})$

$\text{LnY}(\text{FX}) = 3.67 + 0.02(51)$

From figure two we can understand that the trend of growth of FX RATE, from the year 2000 to 2021. In the year 2020 the FX RATE was at the highest with a growth percentage of 77 percent approx.

Growth model of FX RATE is estimated to predict the value of crude oil in the year 2050 which is 4.69, which means that there will be an increase in FX RATE of 4.69 percent by the year 2050.

**Descriptive Analysis**

**Table 2 Summary Statistics for the Variables Considered**

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Avg COP	22	63.3250	26.9089	22.5517	111.89
FX RATE	22	54.7294	11.1756	41.3485	74.0996
INF	22	6.13636	2.64340	3.33	11.99
PROD	22	34.3636	149.5909	30	38
IMP	22	4.8271	2.4600	58	227
CONS	22	1.3609	56.2212	9.2614	11.5721
CO <sub>2</sub> E	22	1.3609	0.3540	0.89	1.9

**Source:** computed from secondary data.

The above table represents the summary output for the variables crude oil prices, FX rate, INF, PROD, IMP, CONS and Co<sub>2</sub> E. The total no of observations for all the 7 variables is 22. The average for is Avg COP, FX RATE, INF, PROD, IMP, CONS and Co<sub>2</sub> E, is 63.32, 54.72, 6.13, 34.36, 149.59, 3.50, 1.36, respectively. The standard deviation for IMP is 56, whereas the std deviation for CO<sub>2</sub> E is 0.35, this means that the dispersion in CO<sub>2</sub> E is much lesser as the sample variance is less when compared to the

variance in the IMP of crude oil. This also means that there is more consistency in distribution of PROD as compared to the distribution of IMP of crude oil. The standard deviation is second highest for the variable FX rate, which is 11.17, which is followed by Avg COP for which the standard deviation 26.90, which is then followed by PROD that is 2.46 which is high when compared to its mean value of 34.36, next the standard deviation for INF is 2.64, which is followed by the least amount of standard deviation for the

variables CONS and CO<sub>2</sub> which is 3.79 and 0.35. The standard deviation is higher for the variable IMP and least for the variable CO<sub>2</sub> E. The more the standard deviation there is less consistency in the overall distribution of the data.

The minimum and maximum limits tell the limits from which the data can range. The minimum range for the variable crude oil pricing is 22.55

and the maximum is 111.89. The FX rate ranges from 41.3485 to 74.0996. The minimum value for inflation is 3.33 and the max is 11.99. the minimum and maximum range for PROD and IMP is from 30 to 38 and 58 to 227 respectively. whereas CONS ranges from 9.26 to 11.57 and finally for CO<sub>2</sub> E the minimum and maximum value ranges from 1.9 to 22.

### Corelation Matrix

**Table 3 Represents the Correlation Matrix**

	ACOP	FX rate in \$	INF%	PROD MMT	IMP MMT	CONS %	CO <sub>2</sub> E MMT
ACOP	1						
FX RATE in \$	0.8351	1					
INF %	0.5676	-0.2222	1				
PROD MMT	0.7265	0.1735	0.2589	1			
IMP MMT	0.7362	0.8659	0.1462	0.4673	1		
CONS %	0.6061	-0.1957	-0.6617	0.3316	-0.1051	1	
CO <sub>2</sub> E	0.5385	0.8909	0.1126	0.4145	0.9808	-0.0243	1

**Source:** Computed from secondary data.

The above table represents the output for correlation matrix. This tool is used to analyse the degree of relationship between the proxy and explanatory variables. From the output derived we can state that FX rate and avg crude oil prices have a high degree positive correlation coefficient of 83 percentage, which means that FX rate has the maximum degree of correlation with the dependent variable crude oil price. Next in line IMP and PROD also seem to have a high degree of positive correlation

with avg crude oil pricing with a coefficient of 73 and 72 percentage respectively. Followed by CONS which seem to have a medium degree of correlation of 60 percentage on the Avg COP. The independent variable INF seems to have low degree of positive correlation coefficient of 56 percentage on avg crude oil pricing which is then followed by CO<sub>2</sub> emissions with just 53 percentage of correlation on avg crude oil pricing, which has a very low degree positive correlation crude oil pricing.

### Regression Model

**Table 3 Regression Output for the Models Considering AVG Crude Oil Pricing as Dependent Variable**

Independent Variables	Model 1 R <sup>2</sup> = 0.3689 F = (0.0082) ***	Model 2 R <sup>2</sup> = 0.75585 F = (0.00018) ***	Final Model R <sup>2</sup> = 0.875588242 F = (0.0005) ***
FX RATE		-1.4448 (0.0016) *** 0.9699	-6.29245 (0.0008-06) *** 0.6397
INF	-0.2849 (0.4159) SE 5.8924	0.5462 (0.1328) * SE 1.6932	
PROD	1.8854 (0.0765) * SE 3.1041	1.4521 (0.0157) *** SE 1.001	1.6782 (0.0043) ** SE 0.3375

<b>IMP</b>		1.9662 (0.0066) *** SE 0.2109	3.644371 (0.002) *** SE 0.2245
<b>CONS</b>	-1.6370 (0.0132) *** SE 0.6479	1.9985 (0.0263) ** SE 0.9984	-1.7146 (0.0413) ** SE 0.4782
<b>CO2 E</b>	-0.5337 (0.6391) SE 24.6963		

**Source:** Computed from secondary data.

\*\*\*Significant at 1 percent level

\*\*Significant at 5 percent level

\*Significant at 10 percent level

### Model 1

The independent variable considered for the model are INF, PROD, CONS and CO<sub>2</sub> and the dependent variable considered is the pricing of crude oil. The variables are chosen on the basis of correlation output by taking into consideration the variables which had the least degree of correlation in order to eliminate those variables that has least percentage influence on the crude oil pricing

### Regression Model

$Y$  (Average crude oil price) =  $\alpha + \beta_1 X_1$  (inflation) +  $\beta_2 X_2$  (PROD) +  $\beta_3 X_3$  (CONS) +  $\beta_4 X_4$  (CO<sub>2</sub> emission)

$$Y = -183.879 - 0.539(X_1) + 5.852(X_2) - 0.412(X_3) + 80.62(X_4)$$

Each individual coefficient is interpreted as the average increase in the dependent variable for each one unit increase in a given independent variable, assuming that all other independent variables are held constant. If INF, PROD, CONS and CO<sub>2</sub> increases by 1 then the value of crude oil price -0.53, 5.8, 0.41, and 80.62 respectively.

From the regression output we can interpret the R<sup>2</sup> value, which is also called as the simple coefficient of determination, gives the explanatory power of the model, which is also the summary measure of the model. In this case R<sup>2</sup> is equal to 0.3689 which means there is 37 percentage of explained variation, in other word the average crude oil pricing is explained by 37 percentage changes in INF, PROD, CONS, and CO<sub>2</sub>E is explained by ACOP.

To determine the significance of the model we have to interpret the significance F value of the model in this case significance F is 0.008 which is lower than 1%, 5% and 10%. As it is lower than the levels of significance, there is ample evidence to show that the model is statistically significant and reject the null hypothesis.

The standard error of the regression is the average distance that the observed values fall from the regression line. The standard error for the independent variables considered are inflation 5.892, PROD 3.10, CONS 0.64 and CO<sub>2</sub> emission is 24.6. The least standard error has the maximum precession that means cons 0.64 has the maximum precession and CO<sub>2</sub> 24.6 has the minimum precession. To check whether the dependent variables have a significant impact on annual average crude oil pricing we have to check the t value, for all the four variables considered.

The t value for inflation, PROD, CONS and CO<sub>2</sub> emission is -0.28, 1.88, -1.6370, -0.5337 respectively. From the t stat value, we can understand that only for PROD and cons the t stat value is higher indicating that there is a statistically significant on the crude oil pricing. The p value for inflation, PROD, CONS and CO<sub>2</sub> emission is 0.41, 0.07, 0.01, 0.63 respectively which indicates that only PROD and cons are statistically significant, that too only CONS is statistically significant at alpha 1 percent, 5 percent, and 10 percent whereas PROD is only significant at alpha 10 percent. The p value of inflation and CO<sub>2</sub>E is very high which is 0.41 and 0.63 indicating that there is no statistically significant at all three levels of



alpha 1 percent 5 percent and 10 percent. This model proves that only PROD and CONS has a significant influence on the pricing of crude oil.

### Model 2

The independent variable considered for the model are FX RATE, inflation, PROD, IMP, and CONS and the dependent variable considered is the pricing of crude oil. The variables are chosen on the basis of correlation output by taking into consideration the variables which has a significant level of influence on the dependent variable crude oil pricing.

### Regression Model

$Y$  (Average crude oil price) =  $\alpha + \beta_1 X_1$  (FXRATE) +  $\beta_2 X_2$  (inflation) +  $\beta_3 X_3$  (PROD) +  $\beta_4 X_4$  (IMP) +  $\beta_5 X_5$  (CONS)

$Y = 17.929 - 1.446(X_1) + 4.6313(X_2) + 0.8904(X_3) + 0.4148(X_4) + 0.997(X_5)$

Each individual coefficient is interpreted as the average increase in the dependent variable for each one unit increase in a given independent variable, assuming that all other independent variables are held constant. If FX RATE, INF, PROD, IMP AND CONS increases by 1 then the value of crude oil price will increase 1.4, 4.6, 0.89, 0.41, 0.99 respectively.

From the regression output we can interpret the  $R^2$  value, which is also called as the simple coefficient of determination, gives the explanatory power of the model, which is also the summary measure of the model. In this case  $R^2$  is equal to 0.7585 which means there is 75 percentage of explained variation, in other words 75 percentage changes in the explanatory variables which is the FX RATE, inflation, PROD, IMP, and CONS is explained by ACOP.

To determine the significance of the model we have to interpret the significance F value of the model in this case significance F is 0.000 which is lower than 1%, 5% and 10%. As it is lower than the levels of significance, there is ample evidence to show that the model is statistically significant and reject the null hypothesis.

The standard error of the regression is the average distance that the observed values fall from the regression line. The standard error for the independent variables considered are FX RATE 0.96, inflation 1.69, PROD 1.09, IMP 0.21 and CONS 0.99

The least standard error has the maximum precession that means imp 0.21 has the maximum precession and inflation 1.69 has the minimum precession

To check whether the dependent variables have a significant impact on annual average crude oil pricing we have to check the t value, for all the five variables considered.

The t value for FXRATE, inflation, PROD, IMP AND CONS is -1.44, 0.54, 1.45, 1.96 and 1.99 respectively. From the t stat value, we can understand that only for inflation the t stat value is lower indicating that there is no statistically significant on the crude oil pricing.

The p value for FXRATE, inflation, PROD, IMP and CONS is 0.001, 0.132, 0.01, 0.006 and 0.026 respectively which indicates that only inflation is insignificant at all three levels/ percent of alpha. whereas FXRATE and imp are statistically significant, at alpha 1 percent, 5 percent, and 10 percent whereas con is only significant at alpha 5 percent and 10 percent, and insignificant at alpha 1 percent.

This model proves that except for inflation rest four variables are statistically significant in determining the price of the annual crude oil. Since all the variables are significant are significant at all three level/percent of alpha.

### Final Model

The independent variable considered for the model are FXRATE, PROD, IMP, and CONS and the dependent variable considered is the pricing of crude oil. The variables are chosen on the basis of correlation output by taking into consideration the variables which has a significant level of influence on the dependent variable crude oil pricing.

### Regression Model

$Y$  (Average crude oil price) =  $\alpha + \beta_1 X_1$  (FXRATE) +  $\beta_2 X_2$  (PROD) +  $\beta_3 X_3$  (IMP) +  $\beta_4 X_4$  (CONS)

$Y = 52.906 - 4.0254(X_1) + 0.7353(X_2) + 16.67132(X_3) + 0.1431(X_4)$

Each individual coefficient is interpreted as the average increase in the dependent variable for each one unit increase in a given independent variable, assuming that all other independent variables are held constant. If, FX RATE, PROD, IMP and CONS increases by 1 then the Avg COP will increase by -4.02, 0.73, 16.7, 0.14 respectively.

From the regression model we can interpret the  $R^2$  value, which is also called as the simple coefficient of determination, gives the explanatory power of the model, which is also the summary measure of the model. In this case  $R^2$  is equal to 0.8755 which means there is 87 percentage of explained variation, in other word the 87 percentage changes in FXRATE, PROD, IMP, and CONS is explained by ACOP

To determine the significance of the model we have to interpret the significance F value of the model in this case significance F is 0.00059 which is lower than 1%, 5% and 10%. As it is lower than the levels of significance, there is ample evidence to show that the model is statistically significant and reject the null hypothesis.

The standard error of the regression is the average distance that the observed values fall from the regression line. The standard error for the independent variables considered are FXRATE 0.63, prod 0.33, imp 0.22 and cons 0.47. The least standard error has the maximum precession that means imp 0.22 has the maximum precession and FXRATE 0.63 has the minimum precession.

To check whether the independent variables have a significant impact on annual average crude oil pricing we have to check the t value, for all the four variables considered.

The t value for FXRATE, prod, Imp and cons is -6.29, 1.6782, 3.644, and -1.7146 respectively. The stat value of all four variables is very high which means that there exists a statistically significant relationship. The p value for FXRATE, PROD, IMP and CONS IS 0.00081, 0.0043, 0.002, and 0.04 respectively which indicates that FXRATE, PROD, and IMP are significant at all three levels/ percent of alpha. whereas cons is statistically significant, at alpha 1 percent, and 5 percent, and insignificant at 10 percent.

This model proves that FXRATE, PROD, IMP and CONS are the most significant variables in determining the prices of crude oil. The fit of the model  $R^2$  is also the highest for model three compared to model 1 and 2.

### Findings

- By looking into the output derived from the correlation matrix, the variables are chosen

ranging from low degree of relationship to the highest degree of relationship that has a significant influence on the crude oil pricing.

- Multiple regression model has been used in order to analyse the determinants that have significant influence on the pricing of crude oil. On the basis of output generated in correlation matrix the variables considered in the final model that is FXRATE, PROD, IMP and CONS are found to be statistically significant and has the maximum percentage of influence on the crude oil pricing.
- The  $R^2$  which is also called as the simple coefficient of determination gives the explanatory power of the model and also called the summary measure of the model, has significantly improved and the  $R^2$  is the highest in the final model with 87 percent among all three models. The  $R^2$  for the final regression model is 87 percentages which means that there is there is 87 percentage of changes in t FX RATE, IMP, PROD, and CONS, is explained by ACOP.
- It is to found that FX RATE has the maximum influence on crude oil pricing followed by IMP, PROD and CONS.

### Discussion

The influence of various factors that determine the pricing of crude oil have been studied extensively in the review of literature. The very fluctuating nature of crude oil prices was a contributing factor to some of the financial unrest in the Indian economy. The study, which looked at the factors affecting crude oil prices in India, was done to find out why there are so many changes in crude oil prices. Although crude oil prices have varied widely over the previous 60 years without showing any discernible trend, the average price of crude oil was as low as 9.08 \$ in February 1997 and as high as 72.95 U.S. dollars per barrel in 2022. (Raghavendra Raju P) these variations on crude oil prices cause a lot of instability in the economy.

To tackle the fluctuating oil prices and to maintain stability in the economy there were few policies that came to amendment. In terms of foreign policy and oil security, the goal is to increase domestic oil supplies in order to give India access to sufficient, reliable, and affordable hydrocarbon energy. With the adoption of the Hydrocarbon Exploration and

Licensing Policy (HELP) in 2016, there have been substantial changes to government policy. A revenue sharing model has been introduced under HELP, and any generated hydrocarbons are given marketing and price independence. One of the main components of HELP, the Open Acreage Licensing Policy (OALP), seeks to accelerate upstream activities and create an ongoing window of exploration opportunities where exploration and production companies have the freedom to select the hydrocarbon blocks to conduct pertinent activities.

Hence through various research and policies the government of India is also trying to bring down the price and dependence of oil imports from foreign countries.

### Conclusion

Although it is well known that crude oil prices are heavily influenced by a number of macroeconomic factors, there is still some ambiguity about how they will fluctuate over time. The price of oil influences the cost of alternative fuels. It is a significant factor that affects how much an economy grows and regulates inflation, especially emerging economies. Foreign exchange rate, inflation, production, imports, consumption and CO<sub>2</sub> are the factors that are studied extensively under this study. Only the foreign currency rate, imports, production and consumption rate were shown to have a substantial impact on crude oil pricing in the regression output that was obtained.

The value of the rupee is based on the current account deficit under exchange rates. If it's high, the nation needs to sell rupees and acquire dollars, this will definitely increase the pricing of crude oil. As India is the third highest consumer of crude oil in the world its dependence on the imports have been rising significantly over the year which hampers economic growth and causes economic instability.

### References

- Alkhateeb, Tarek Tawfik, and Zafar Ahmad Sultan. "Oil Price and Economic Growth: The Case of Indian Economy." *International Journal of Energy Economics and Policy*, vol. 9, no. 3, 2019, pp. 274-79.
- Berkmen, Pelin, et al. "The Structure of the Oil Market and Causes of High Prices." *International Monetary Fund*, 2005.
- Bhargavi, G., et al. "Review on the Extraction Methods of Crude Oil from all Generation Biofuels in last Few Decades." *IOP Conference Series: Materials Science and Engineering*, 2018.
- Bhattacharya, Sumanta, and Bhavneet Kaur Sachdev. "Can Renewable Energy Reduce the Demand for Crude Oil: An analysis?." *International Journal of Multidisciplinary Research and Growth Evaluation*, vol. 2, no. 6, 2021, pp. 94-98.
- Dalei, Narendra N., et al. "Crude Oil Import of India from its Major Oil Trade Partner Countries: An Empirical Evidence using Panel Data Analysis." *International Journal of Advanced Research and Development*, vol. 2, no. 6, 2017, pp. 726-35.
- Gupta, Priyanshi, and Anurag Goyal. "Impact of Oil Price Fluctuations on Indian Economy." *OPEC Energy Review*, 2015.
- Gyagri, M., et al. "Determinants of Global Pricing of Crude Oil - A Theoretical Review." *International Journal of Petroleum and Petrochemical Engineering*, vol. 3, no. 3, 2018, pp. 7-15.
- Joo, Kyohun, et al. "Impact of the Global Financial Crisis on the Crude Oil Market." *Energy Strategy Reviews*, vol. 30, 2020.
- Kar, Sanjay Kumar, and Biswajit Roy. "Impact of Geopolitics on India's Crude Sourcing and Refinery Business." *Geopolitics of Energy*, vol. 42, no. 2, 2020.
- Mileva, Elitza, and Nikolaus Siegfried. "Oil Market Structure, Network Effects and the Choice of Currency for Oil Invoicing." *Occasional Paper Series no. 77*, 2007.
- Ministry of Petroleum & Natural Gas. *Reducing Dependence of Import of Oil*, 2021, <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1706564>
- Punati, Narendra, and G. Raghavender Raju. "Determinants of Crude Oil Prices in India." *SSRG International Journal of Economics and Management Studies*, vol. 4, no. 10, 2017.
- Rahiman, Habeeb Ur, and Rashmi Kodikal. "Ups and Downs in the Indian Economy: The Impact of Crude Oil Prices." *International Journal of*

*Scientific & Technology Research*, vol. 8, no. 8, 2019, pp. 846-57.

Selmi, Refk, et al. "What Drives most Jumps in Global Crude Oil Prices? Fundamental Shortage. Conditions, Cartel, Geopolitics or the Behaviour of Market Financial." *The World Economy*, 2022.

Seth, Daksh, et al. "Impact of Crude Oil Price Changes on Select Indian Industries." *International Journal of Social Sciences of Management*, vol. 3, no. 2, 2016, pp. 87-92

Sivasubramanian, K., et al. "Measuring the relationship between Crude Oil Price, Stock Market and Gold Price with Reference to India." *International Journal of Finance Research*, vol. 2, no. 1, 2021, pp. 37-45.

Wani, Firdous A., et al. "Impact of Crude Oil on Indian Economy." *International Journal of Modern Management Sciences*, vol. 4, no. 1, 2015, pp. 11-26.

Zaidi, Kiran, et al. "Crude Oil Relationship with Indian Economic Growth and Influence on Industrial Products." *International Journal for Innovative Research in Multidisciplinary Field*, vol. 4, no. 10, 2018, pp. 237-41.

### Appendix

Time period	ACOP \$	FXRATE %	INF %	PROD MMT	IMP MMT	CONS %	Co <sub>2</sub> E MMT
2000	26.92	44.9401	4.01	32	58	3.1	0.89
2001	22.55	47.1857	3.78	32	74	0.4	0.89
2002	26.60	48.5993	4.3	32	79	3.7	0.9
2003	27.98	46.5819	3.81	33	82	3.5	0.91
2004	39.21	45.3165	3.77	33	90	3.6	0.96
2005	55.72	44.1	4.25	34	96	1.4	0.99
2006	62.46	45.307	5.8	32	99	6.7	1.04
2007	79.25	41.3485	6.37	34	112	6.8	1.13
2008	83.57	43.5049	8.35	34	122	3.6	1.19
2009	69.76	48.4049	10.88	33	133	3.2	1.29
2010	85.09	45.7262	11.99	33	159	2.3	1.34
2011	111.89	46.6723	8.91	38	164	5.0	1.41
2012	107.97	53.4376	9.48	38	172	6.0	1.51
2013	105.52	58.5978	10.02	38	185	0.9	1.54
2014	84.16	61.0295	6.67	38	189	4.5	1.66
2015	46.17	64.1519	4.91	37	189	11.6	1.65
2016	47.56	67.1953	4.95	37	203	5.4	1.66
2017	56.43	65.1216	3.33	36	214	5.9	1.73
2018	69.88	68.3895	3.94	36	220	3.4	1.81
2019	60.47	70.4203	3.73	34	226	0.4	1.8
2020	44.82	74.0996	6.62	32	227	-9.3	1.74
2021	79.18	73.918	5.13	30	198	5.1	1.9

#### Author Details

**M Preetha**, III B. A Economics, Stella Maris College (Autonomous), Chennai, Tamil Nadu, India

**Kaviya Nijaritha Joseph**, Assistant Professor, Stella Maris College (Autonomous), Chennai, Tamil Nadu, India,  
Email ID: [kaviyanijaritha@stellamariscollege.edu.in](mailto:kaviyanijaritha@stellamariscollege.edu.in)