AN ANALYSIS OF CONSUMPTION OF PETROLEUM PRODUCTS IN INDIA AND ITS RELATIONSHIP WITH ECONOMIC GROWTH

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Abstract

Energy is vital for the growth of an economy. India, a developing country, needs constant energy availability for its developmental activities. The energy mix of India is comprised of various sources like- coal, lignite, natural gas, electricity from renewable resources, crude petroleum etc. Since India is still in a developing phase, it relies more on imported crude oil which currently accounts for more than 85 percent. The consumption of crude oil or petroleum products is on a continuous surge, it rose by 4.6 percent in the FY 2023-24. Therefore, estimating the consumption of petroleum products in India is required to make correct policy decisions in time. The current study is concerned with the analysis of the consumption of petroleum products in India and its relationship with the economic growth rate. VAR model results found that petroleum product consumption is positively related to the previous lag value of the GDP and is negatively related to its past year's two lag values. Moreover, economic growth Granger causes petroleum product consumption.

Keywords: **energy consumption, economic growth, crude oil, petroleum products, VAR**

Introduction

The transition of energy use has encountered the world. There is a major shift from the use of non-renewable sources of energy like crude oil, coal, natural gas etc., to renewable sources like solar, wind, hydropower etc. However, despite this transition, the dominance of non-renewable sources has not diminished yet. It still holds the key position in the energy mix. India, an oil importing nation is no exception to this. It is the third-largest consumer of crude oil in the world after the USA and China. The current consumption is estimated to be 233.3 million metric tonnes (MMT) in the financial year 2023-24 up from 223 MMT in the previous

year. A rise of 4.6 percent in the consumption of oil products. According to the oil ministry, the increase in the consumption of crude oil was mainly attributed to the increase in the consumption of ATF 11.8 percent, 14.3 percent in naphtha, motor spirit 6.4 percent, 4.4 percent increase in high-speed diesel etc. While the domestic production of crude oil remained the same at approximately 29 MMT.

Literature Review

Wei & Gang (2012) found a unidirectional causality from energy consumption to the GDP of China. While energy consumption had a positive impact on economic growth, economic growth had very little negative impact on energy consumption. Paul & Bhattacharya (2004) in the short-run energy consumption led to economic growth while economic growth led to higher energy consumption in the long-run. Nasreen & Anwar (2014) also found the feedback effect between energy consumption and economic growth both in the short and long run. Asafu-Adjaye (2000) estimated the causal relationship between energy consumption and income for the Philippines, India, Indonesia, & Thailand by using the cointegration and error correction model. The results showed a unidirectional causality runs from energy to income for India and Indonesia in the short run while there is a bidirectional causality from energy to income for Thailand and the Philippines in the long run. Aqeel & Butt (2001) by applying cointegration and Granger causality it was found that economic growth causes total energy consumption. Economic growth also led to an increase in the consumption of petroleum products while the consumption of natural gas and economic growth does not affect each other. Mukhtarov, Mikayilov & Ismayilov (2017) investigated the relationship between energy consumption and economic growth in Azerbaijan between 1990-2015 and found a bidirectional causality between energy consumption and economic growth. Ramkrishna and Rena (2013) studied the causal relationship between energy consumption and GDP in India and found that there exists a bidirectional relationship between the variables.

Data Collection

Time series annual data on petroleum products consumption in thousand metric tonnes and the growth rate of the economy in terms of real GDP has been collected from 1980-81 to 2023-24. The data for real GDP has been taken from the RBI while the data for petroleum products consumption has been taken from the petroleum planning & analysis cell (PPAC).

Selected Variables

GDP- is the real gross domestic product of India annually between 1980-2023. GDP is an indicator of the economic growth of a country.

Petroleum product Consumption- represents the total consumption of petroleum products in India between 1980 to 2023 in thousand metric tonnes.

Research Methodology

The first step in the study would be to check the stationarity of the data for which the Augmented Dickey fuller test and the Phillips-Perron test were used. Since the data was non-stationary, we have taken the first difference in the data to make it stationary. The results showed that after differencing, the data was stationary through the Phillips-Perron test and not by the ADF test. For analyzing the relationship between the variables, the Vector Autoregressive (VAR) model was used and for testing the direction of the relationship Granger causality was applied. Lastly, the stability of the model was checked through the CUSUM stability test.

Figure:1 Product-Wise Consumption of Petroleum Products in India
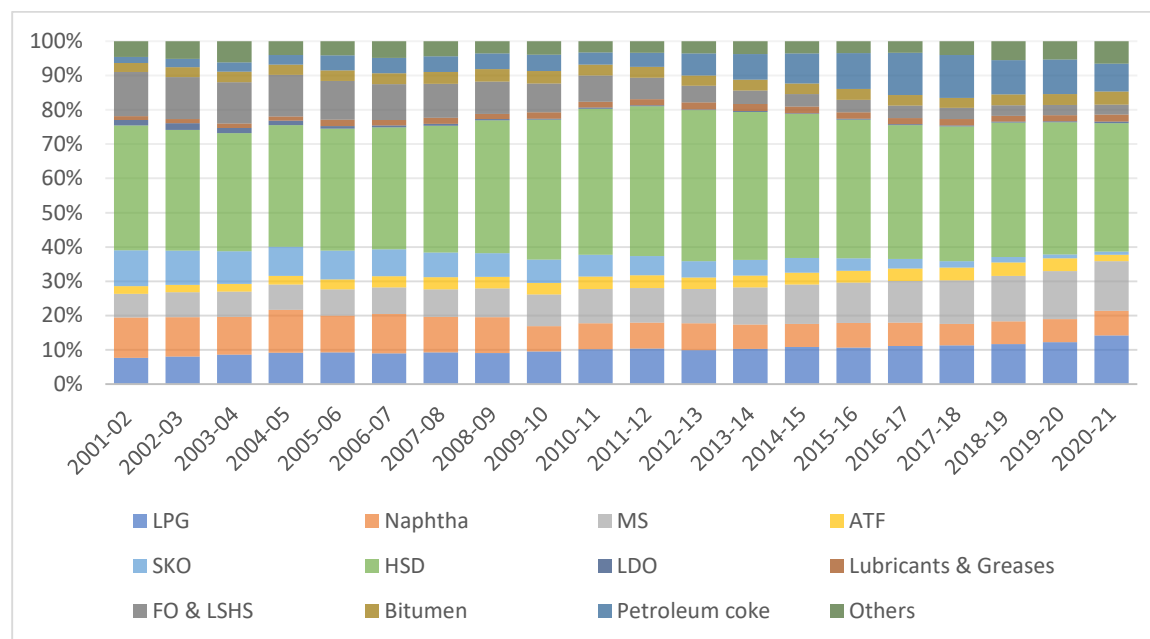
Source: PPAC

Figure 1 above, shows the product-wise consumption of petroleum products in India during twenty years from 2001-02 to 2020-21 in thousand metric tonnes. It can be seen from the figure that the consumption of High-Speed Diesel is the maximum followed by Motor Spirit i.e., petroleum, LPG, and Naphtha throughout the period of study. The consumption of petroleum Coke and FO & LSHS (Furnace Oil, Low Sulphur Heavy Stock) also have a considerable share in the total consumption followed by SKO, ATF, and Bitumen. While the rest of the products Lubricants and LDO have a meagre share.

Figure: 2 Trends in the Consumption of Petroleum Products
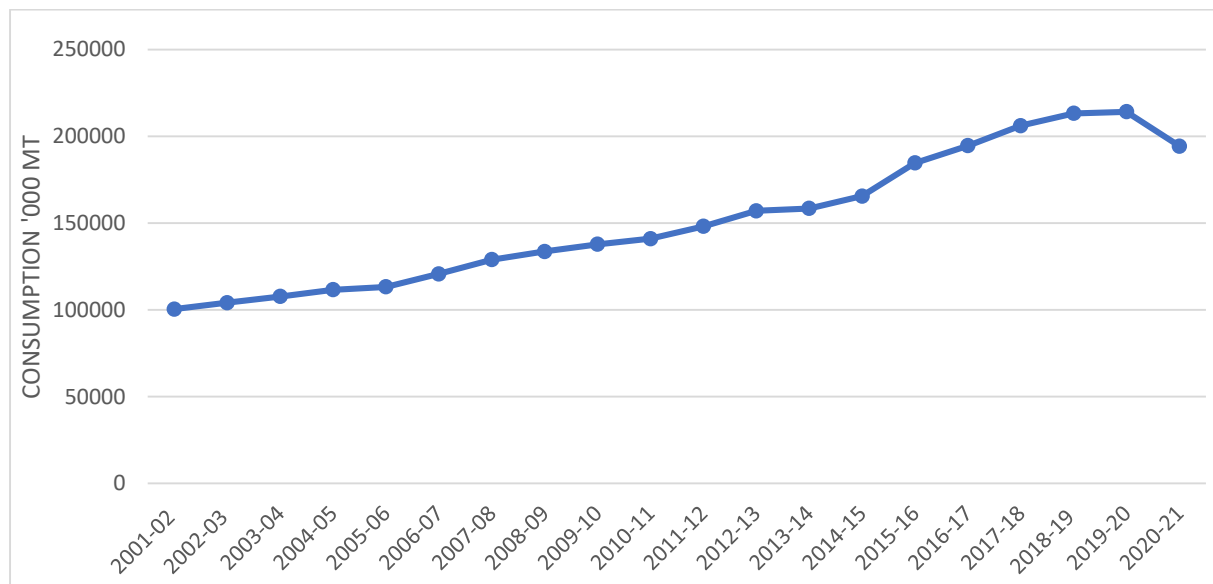
Source: PPAC

Figure 2 above, shows the trends in the consumption of petroleum products in India. The trend line shows the ever-rising consumption pattern of the country during the period concerned with the year 2020 being an exception in which the consumption has shown a downtrend as it was the year of the COVID-19 pandemic. This indicates that the demand for petroleum products is increasing in India and is expected to grow further.

Results and Discussion

Table 1 Definition of the Variables

Variables	Definition
hgdp.l1	Value of GDP at lag one
Cons.l1	Value of petroleum product consumption at lag one
hgdp.l2	Value of GDP at lag two
Cons.l2	Value of petroleum product consumption at lag two

Table 2 Stationarity Test

Variables	Phillips-Perron Test	Result
hgdp	0.01	I(1)
cons	0.01	I(1)

Source: Author's calculation

As can be seen from Table 1 both the variables namely 'hgdp' which represents the real GDP of India and 'cons' which represents the total consumption of petroleum products in India were originally non - stationary however, they both become stationary by taking their first difference i.e., at level I (1).

VAR Model Results

The Vector Autoregressive (VAR) model is a method to analyze the relationship between different time series. The VAR model is different from the univariate autoregressive model because it helps provide a feedback mechanism between the variables. It shows how one variable affects the other variable and in turn affected by another variable. The VAR model relates the current value of a dependent variable with its past value as well as the past value of an independent variable.

The present study focuses on the relationship between economic growth and the consumption of petroleum products in India using a VAR model. It shows how the consumption of petroleum products depends on its past value as well as on the past value of the GDP. Below is the summary of the results of the VAR model used in the study.

The Mathematical Equation for the VAR model

Since there are multiple time series that influence each other, the model uses a system of equations one equation per variable. So, if we have time series we will have a system of 2 equations.

VAR Model equation with 2-time series Y_1 and Y_2

$$Y_{1t} = \alpha_1 + \beta_{11} Y_{1t-1} + \beta_{12} Y_{2t-1} + E_{1t}$$

$$Y_{2t} = \alpha_2 + \beta_{21} Y_{1t-1} + \beta_{22} Y_{2t-1} + E_{2t}$$

Where,

α_1 **and** α_2 = constants or intercepts of the time series Y_1 and Y_2 respectively

β_{11} **and** β_{12} = coefficients of the lags Y_1 and Y_2 of Y_1 time series

β_{21} **and** β_{22} = coefficients of the lags Y_1 and Y_2 of Y_2 time series

Y_{1t-1} **and** Y_{2t-1} = first lag of time series Y_1 and Y_2 respectively

E_{1t} **and** E_{2t} = error terms of the time series.

Since in the above system of equations, each equation is of order one i.e., there is a lag of one time period in both the time series it is known as VAR (1).

Similarly, the Mathematical Equation for the VAR (2) model for the study concerned is

Hgdp = hgdp.l1 + Cons.l1 + hgdp.l2 + Cons.l2 + const…………………………………..(1)

Cons = hgdp.l1 + Cons.l1 + hgdp.l2 + Cons.l2 + const…………………………………..(2)

Table 3 VAR Model Results

| Variables	Estimate	Std. Error	t value	Pr(>|t|)
hgdp.l1	1.74E-03	2.09E-04	8.338	6.29e-10 ***
Cons.l1	1.05E+00	1.72E-01	6.102	5.08e-07 ***
hgdp.l2	-1.60E-03	2.58E-04	-6.21	3.64e-07 ***
Cons.l2	-2.07E-01	1.12E-01	-1.842	0.0738.
const	-8.41E+01	8.31E+01	-1.012	0.3184

Source: author's calculation

Note- *signifies the level of significance: 0.001***, 0.01**, 0.05*

Table 2 above shows the results from the VAR model. We can see that current consumption is influenced by its own past value and the past value of the GDP. The findings of the results suggest that the current value of the consumption of petroleum products in the previous year has a positive impact on the current consumption. The current value of the consumption of petroleum products is positively related to the previous lag value of the GDP i.e., if the GDP was high in the last period, consumption is possible to be higher now but it is negatively related to the previous two years lag values of the GDP which means if the GDP was high in the previous two years current consumption tends to be lower now and all the values are significant. The R-square of the study was 0.66 i.e., 66 percent of the variations in the dependent variable is explained by the independent variable.

The model clearly shows that both recent past values (one lag period) of GDP and consumption are strongly related to the current consumption. While the values of two periods ago are weaker.

Granger causality test

The Granger test results of the study indicate that there runs a unidirectional relationship from GDP to petroleum product consumption i.e., economic growth Granger causes petroleum product consumption and not vice-versa. It means that the past values of the GDP help predict the future values of the consumption of petroleum products in India.

Figure 3 CUSUM Test
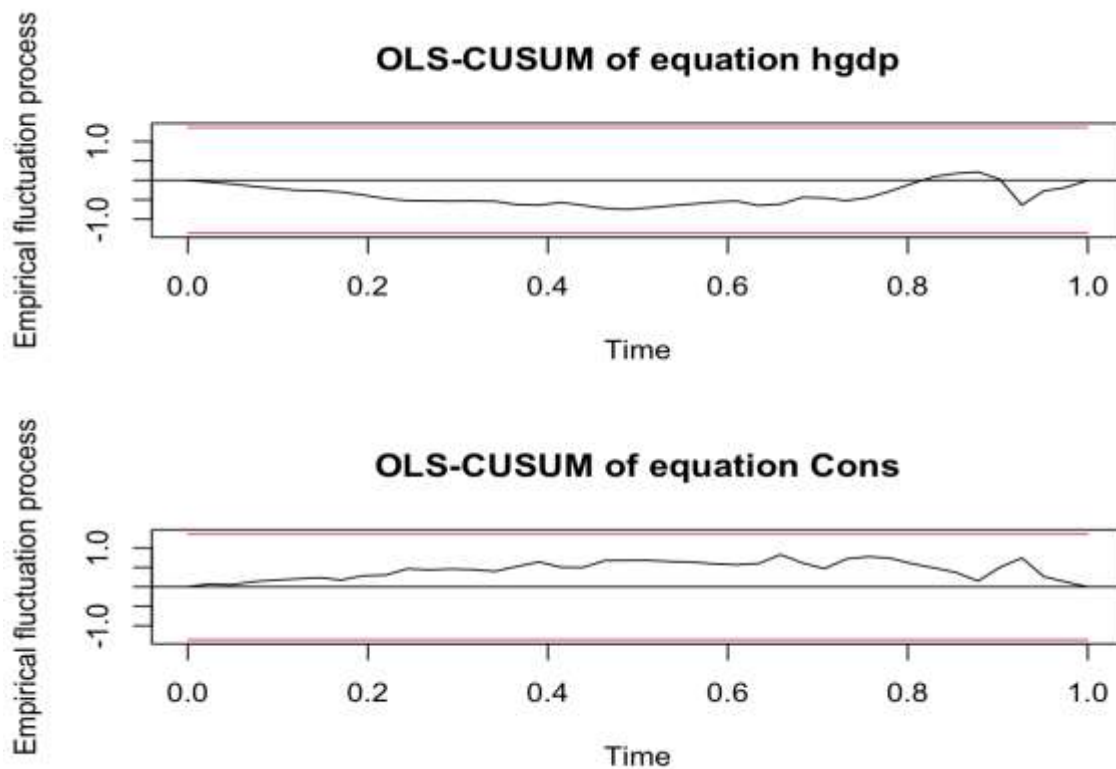
Source: author's creation

The CUSUM test or the cumulative sum test is used to check the stability of the model. It shows whether the cumulative sum of the model exceeds the upper and lower control limits. It can be seen that our model is stable as it satisfies the CUSUM test.

Conclusion

India, being a developing economy and the most populous country in the world requires more energy to develop its various sectors and meet the household demand. The objective of the study was to investigate the relationship between economic growth and the consumption of petroleum products in India using a VAR model. The results of the study show that the current value of the consumption of petroleum products is positively related to the previous value of consumption and GDP. It means if the consumption and GDP values were high in the previous period consumption in the current period is also high. Also, there is a unidirectional relationship between the GDP and the consumption of petroleum products i.e. GDP Granger causes consumption. It shows that as and when a country develops its industrialization process & personal consumption activities increase and demand for more energy resources also increases leading to higher consumption. Hence, the study provides useful insights for policy-making to the government.

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