INDICATORS Vol. 6 (1) (2024)

INDICATORS

Journal of Economics and Business

http://indicators.iseisemarang.or.id/index.php/jebis

THE IMPACT OF RISING FUEL PRICE ON SECTORAL OUTPUT IN INDONESIA

Afiska Primadewi[1], Firmansyah[2]✉

Faculty of Economics and Business, Diponegoro University, Indonesia

Info Artikel

Sejarah Artikel:
Diterima Maret 2024
Disetujui Maret 2024
Dipublikasikan Mei 2024

Keywords:
Fuel, Price, Partial Adjustment Model, Input-Output

Abstract

In 2022, the Indonesian government reallocated fuel subsidies, resulting in an average increase in fuel prices by 30%. This research aims to determine the impact of the fuel price increase on sectoral output and total output in Indonesia. The study utilizes time series data from 1980 to 2022, which is then analyzed using regression analysis with the Partial Adjustment Model (PAM) and Input-Output analysis with the classification of 185 sectors. By simulating a 30% increase in fuel prices, this study found that the fuel price hike would decrease sectoral output and total output. Additionally, the research identified the transportation sector as the most affected sector.

✉Alamat korespondensi:
Fakultas Ekonomika dan Bisnis Universitas Diponegoro
Jl. Prof. Soedharto SH., Tembalang, Semarang 50239, Phone: +622476486851
Email: firmansyah@live.undip.ac.id

INTRODUCTION

Indonesia was once an oil exporter and a member of the Organization of the Petroleum Exporting Countries (OPEC) in 1962. However, Indonesia decided to withdraw its membership because it could no longer meet domestic demand due to high oil consumption, which was not balanced by oil production.

One of the reasons for this high oil consumption is the high consumption of fossil fuels, mainly due to the significantly lower fuel prices in Indonesia compared to other countries. Government subsidies are responsible for keeping fuel prices excessively low in Indonesia. Nevertheless, President Joko Widodo stated that subsidies for fuel primarily benefit the less affluent, constituting only 20% of the total subsidies provided (Presidential Secretariat, 2022). In response to this, the Indonesian government decided to reallocate fuel subsidies into direct cash assistance, which would result in an average 30% increase in fuel prices.

Policies to reduce subsidies and increase fuel prices encounter various challenges. Firstly, the potential for social unrest among the population, often overlooked, can complicate policy evaluation. Secondly, subsidy reductions can lead to politically unmanageable concerns. Thirdly, subsidy cuts will not only affect the more affluent but also impact the less fortunate in society (Setyawan, 2014).

In addition to affecting consumers, the increase in fuel prices will also impact producers. Fuel is a crucial commodity for producers, used as a source of power for machinery and industrial equipment in manufacturing, mining, agriculture, transportation, and construction industries, for example.

The cost of using fuel is considered part of production costs. However, there are currently no substitutes for fuel. Therefore, as fuel prices increase, the production costs borne by producers will also rise. When production costs increase, producers may choose to raise output prices or reduce production output. A reduction in production output means a decrease in the quantity supplied, and according to the law of supply and demand, assuming ceteris paribus, this will lead to an increase in the price of goods.

Every industry is interconnected with other industrial sectors, either upstream or downstream. An increase in demand for the transportation sector, for example, leads to an increased demand for fuel from the upstream petroleum and gas processing sector. This creates a domino effect, resulting in interdependencies between sectors in the economy (Firmansyah, 2006).

The increase in fuel prices will undoubtedly have an impact on the Indonesian economy. Anyars and Adabor (2023) conducted research to determine the impact of changes in oil prices on inflation in Ghana. They analyzed data on the Consumer Price Index (CPI) for the energy, food, and transportation sectors, as well as the core CPI, from 2000Q1 to 2021Q1 using the Nonlinear Autoregressive Distributed Lag (NARDL) method. The research found that the transportation sector would be the most affected compared to other sectors.

Saari et al. (2008) conducted research in Malaysia to assess the impact of an increase in oil prices on production costs. They performed simulations using an input-output model and found that the agricultural sector would be the most affected by the increase in oil prices.

Jiang and Tan (2013) conducted research in China using an input-output model and found that the removal of energy subsidies would significantly impact energy-intensive industries such as electricity production, gas, transportation, storage, and the chemical industry. The research also concluded that the Producer Price Index (PPI) is more sensitive to energy price increases due to subsidy removal compared to the GDP Deflator and Consumer Price Index (CPI). Jiang and Tan (2013) concluded that an increase in energy prices would lead to a general increase in prices.

Consumers aim to maximize their satisfaction by consuming a combination of products. The combination of goods that maximizes an individual's satisfaction can be represented by an indifference curve. However, individuals face budget constraints in their choices to consume goods or services. Limited income imposes cost constraints on individuals, which are represented by a budget line. The combination of indifference curves and budget lines can form an individual's demand curve (Pindyck & Rubinfeld, 2018).

In microeconomics, consumption is considered a component of demand, or it can be said that consumption forms demand. Meanwhile, from a macroeconomic perspective, final demand is formed through the aggregation of household consumption, government spending, investment, and net exports (Dornbusch, Fisher, & Startz, 2018). In this research, it is assumed that all demand is used exclusively for consumption.

In principle, a firm transforms a set of inputs into outputs. Firms can transform inputs into outputs in various ways. The various methods employed by firms to convert input elements into output are summarized through the concept of a production function (Perloff, 2022).

The Leontief production function, or fixed-proportions production function, states that there can be no substitution among inputs. This function assumes that inputs applied to a production process will have fixed proportions (Smid, 2000). Consequently, the isoquant curve will be L-shaped (Miller & Blair, 2009). The Leontief production function can be expressed in the following equation (Smid, 2000):

$$qi = min\left\{\frac{x_{i1}}{a_{i1}}, \cdots, \frac{x_{in}}{a_{in}}, \frac{K_i}{a_{ik}}, \frac{L_i}{a_{iL}}\right\}$$

Where qi represents the output of sector i, x_{ij} denotes the transactions between sector i and sector j. K_i stands for capital, L_i represents labor, and a_{ij} signifies the technology coefficient.

The Leontief production function exhibits the characteristic of constant return to scale, wherein if an input element is increased by a factor of λ, the output will also increase by a factor of λ. However, in input-output analysis, the aspect of technological advancements that could lead to output growth surpassing input growth is not considered (Habuddin & Firmansyah, 2004).

Wassily Leontief developed the Input-Output table as a theoretical framework and practical economic tool in market economics. The Input-Output table provides sectoral data in the form of a matrix that depicts the trade interactions of goods and services as well as the interrelationships among economic entities in a region over a specified period (BPS, 2021).

Input-Output analysis primarily emphasizes the production side. It is also known as inter-industry analysis (Mangiri in Habuddin & Firmansyah, 2004). This analytical method can be utilized to examine the interconnections among industries with the aim of understanding the complexity of the economy and elements that can influence the balance of supply and demand. This model can provide a deeper understanding of interrelated relationships in economic activities and how one sector impacts another.

Based on the background and theory mentioned above, this research aims to determine the extent to which changes in fuel consumption due to changes in fuel prices affect sectoral and total output.

RESEARCH METHOD

Research Variables

The variables used in this study include fuel consumption, fuel prices, and income. Fuel consumption is described by crude oil consumption data. Fuel price variables are described by the average fuel prices (subsidized and non-subsidized) in Indonesia, while the income variable is described by Gross Domestic Product (GDP).

Data Type and Source

The data used in this research are secondary data. This study utilizes time-series data from the period 1980-2022, including crude oil consumption data, fuel prices in Indonesia, Gross Domestic Product (GDP), and the Input-Output Table of 185 Products based on Producer Price. Data is obtained from the official website of British Petroleum, the Central Statistics Agency (BPS), draft Presidential Decisions, and the Handbook of Energy & Economic Statistics of Indonesia (HEESI) publication.

Data Analysis Method

This research involves two stages of data analysis. This is because the Indonesian Input-Output Table does not provide information related to prices. The first stage uses regression analysis to analyze the impact of fuel price changes on fuel consumption. The second stage employs the input-output analysis method, using the results from the first stage as sectoral final demand shocks in the Input-Output Table (I-O).

The Partial Adjustment Model (PAM) is used to estimate changes in consumption due to fuel price changes. This model accommodates lags when changes occur in independent variables. By using consumption as the dependent variable and price and income as independent variables, the short-term equation model is as follows::

$$Lncons_t = \alpha_0 + \alpha_1 Lnavgp_t + \alpha_2 Lngdp_t + \alpha_3 Lncons_{t-1} + \mu_t$$

Where :

$Lncons_t$ = Fuel consumption in year t

α = Constant

β = Regression coefficient

$Lnavgp_t$ = Average fuel prices, both subsidized and non-subsidized, in year t

$\alpha_2 Lngdp_t$ = Income in year t

$\alpha_3 Lncons_{t-1}$ = Lag in fuel consumption

μ_t = Error

Before conducting an analysis of the sectoral output impact due to the increase in fuel prices, it is necessary to estimate changes in sectoral final consumption first. The estimation of changes in sectoral final consumption in this study involves five stages, namely:

1. Calculating changes in fuel consumption.

$$C = \Delta P . E$$

Where C represents the change in fuel consumption (%), ΔP denotes the change in fuel prices (%), and E is the elasticity of fuel consumption. The elasticity used is the short-term coefficient obtained from the regression equation above.

2. Estimating changes in total fuel consumption.

$$C^* = \frac{C}{100} . D . (158{,}99) . (365)$$

Where C* is the estimated change in consumption (thousands of liters per year) and D is the fuel consumption in 2022 (thousands of barrels per day).

3. Estimating changes in sectoral fuel consumption.

$$C_s = \frac{x_{95j}}{Total\ Sectoral\ Consumption\ in\ Sector\ 95.} . C^*$$

Where the coefficient x_{95j} represents the value of sector 95 consumed by sector j.

4. Estimating changes in fuel price.

$$P_1 = P_0 + \Delta P . P_0$$

Where P1 is the estimated change in average fuel prices, P0 is the average fuel price in the year 2022 (in rupiah per liter), and ΔP is the change in average fuel prices (%).

5. Estimating changes in the value of sectoral fuel consumption.

$$f^* = C_s . P_1$$

Where f* represents the change in the value of sectoral fuel consumption.

Input-Output Analysis is a mathematical model used to analyze the relationships between sectors or economic activities. This model is based on the idea that an economic system has interconnections between sectors. Each sector will produce output that is not retained for its own use but becomes input for that sector and other sectors, and it is used for final demand. Sectoral output and total output are obtained with the following equations.

$$X = (I - A)^{-1} f$$

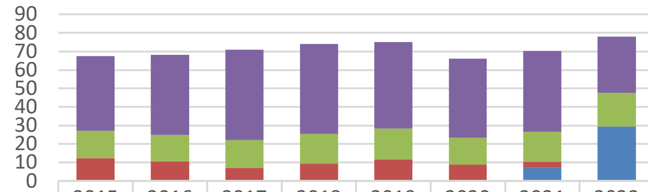
Where $(I\text{-}A)^{-1}$ is the Leontief inverse matrix. This Leontief inverse matrix provides data summarizing all coefficients that explain the impact on the total production of other sectors when there is a production fluctuation in a sector, which is referred to as the multiplier. The new value of f is obtained from the previous estimations.

RESULTS AND DISCUSSION

The price of fuel in Indonesia

Fuel (Bahan Bakar Minyak or BBM) is a crucial commodity in Indonesia. The increasing population contributes to a growing demand for fuel consumption. Moreover, the government provides price subsidies for several fuel products. This situation has led to a continuous increase in fuel consumption in Indonesia, as illustrated in the following chart:

Figure 1 Fuel Demand in Indonesia 2015-2022



	2015	2016	2017	2018	2019	2020	2021	2022
BBM JBU (Million KLL)	40.38	43.25	48.89	48.68	46.76	42.76	43.76	30.47
BBM JBT (Solar and Kerosene) (Million KL)	14.89	14.28	15.04	16.12	16.76	14.48	16.09	18.08
BBM JBKP (Premium) (Million KL)	12.23	10.62	7.05	9.28	11.55	8.84	3.42	0
BBM JBKP (Pertalite) (Million KL)	0	0	0	0	0	0	7.01	29.49

Source : ESDM, 2022

The Indonesian government has a role in regulating fuel prices in the country, based on Government Regulation No. 30 of 2009. Additionally, there is a provision in the Energy Law No. 30 of 2007, Article 7(2), which mandates that both the central and local governments provide subsidy assistance to the economically disadvantaged population. In response to these responsibilities, the Indonesian government, in collaboration with the Ministry of Energy and Mineral Resources (ESDM), allocates funds for fuel subsidies.

The government has the authority to provide fuel subsidies with the following rules (Ministry of ESDM, 2023):

a) Subsidies per liter are calculated as the difference between the retail selling price of Certain Specific Fuels, after deducting taxes, and the base price per liter, which is granted for Certain Specific Fuels.

b) Fixed subsidies are granted for diesel fuel (Minyak Solar).

c) Special Assignment Fuels (BBM Penugasan Khusus) do not receive subsidies, but the government determines the retail selling price. If the government's price determination is lower than the retail selling price (formula), the government must provide compensation to businesses.

Due to government intervention, fuel prices in Indonesia are lower compared to other ASEAN countries. Therefore, in September 2022, the Indonesian government once again adjusted fuel prices (Ministry of ESDM, 2023):-

- Pertalite increased from Rp7,650 per liter to Rp10,000 per liter.
- Solar increased from Rp5,150 per liter to subsidized Rp6,800 per liter.
- Pertamax increased from Rp12,500 per liter to Rp14,500 per liter.

Classical Assumption Tests

- Normality test was conducted using Kolmogorov-Smirnov, showing a probability value of 0.064. This means that the residuals are normally distributed because the probability values are greater than alpha (0.05).
- Multicollinearity test was performed using auxiliary regression, and the model obtained a value of 0.99, which is higher than the R-squared values for the average BBM price variable (0.95) and GDP (0.94).
- Heteroskedasticity test was conducted using Breusch-Pagan, showing a value of Obs*R2 as 3.973941 with a probability of 0.2294. This finding indicates that the probability value

of 0.2643 > alpha (0.05), so the heteroskedasticity assumption is met.

- Autocorrelation test using Breusch-Godfrey obtained a probability chi-square value > 0.05. The table also shows that the F-statistic (0.420411) < F-table (3.23). From this test, it can be concluded that there is no autocorrelation problem in this model.

Regression Test Results

The results shown in Table 1 indicate that the F-statistic value (1387.652) > F-table (2.85) at a 5% error level (0.05). Therefore, H0 is disregarded, and H1 is accepted. This indicates that simultaneously, the variables log BBM price, log GDP, and lag from log BBM consumption significantly affect log BBM consumption.

Based on the regression results in Table 1, it can be seen that:

a. The t-statistic value for the log BBM price variable (|2.963848|) > t-table (1.68488), so H0 is rejected. This means that the log BBM price variable has a significant individual effect on log BBM consumption.

b. The t-statistic value for the log GDP variable (2.476168) > t-table (1.68488), so H0 is rejected. This indicates that the log GDP variable has a significant individual effect on log BBM consumption.

c. The t-statistic value for the lag from the log BBM consumption variable (12.28354) > t-table (1.68488), so H0 is rejected. This indicates that the lag from the log BBM consumption variable has a significant individual effect on log BBM consumption.

Additionally, from the data in Table 1, the R-squared value is 0.990954 (99.1%). From this data, it can be concluded that the independent variables, namely log BBM price, log GDP, and lag from log BBM consumption, can explain 99.1% of the BBM consumption variable, with the remaining 0.9% unexplained by the model.

Based on Table 1, the regression equation is as follows:

LNCONS = 0.38005302445 - 0.0674924231524 (LNPRICE) + 0.0716120585906 (LNGDP) + 0.872605815135 (LNCONS(-1))

Looking at the empirical model above, it is known that the coefficient for the lag from BBM consumption is 0.872606. The long-term coefficient $\alpha_3 = 1 - \delta$, and the adjustment coefficient is as follows:

$\delta = 1 - 0.872606 = 0.127394$

In the following year, when a 1% change in desired BBM consumption occurs, it will be adjusted by 0.127394%. A larger adjustment coefficient indicates a faster adjustment.

From the information in Table 1, the coefficient for the log price is -0.067. This means that in the short term, a 1% increase in BBM price will lead to a -0.067 decrease in BBM consumption. This negative relationship is in line with the law of demand, where an increase in the price of a good leads to a decrease in demand. In addition to showing a negative relationship, this coefficient also indicates that the price elasticity of demand for BBM in Indonesia is inelastic.

The results of the empirical model are consistent with the findings of Dahl and Kurtubi (2001), which show that the price elasticity of total BBM consumption demand in Indonesia is inelastic in both the short and long term. The research is also consistent with the findings of Sa'ad (2008), who applied the ARDL model and concluded that the price elasticity of petroleum demand is inelastic and has a negative relationship.

Table 1. Regression Results

Variable	Coefficient	Std. Error	t-statistik	P
C	0.380053	0.236881	1.604402	0.1169
Ln(avgp)	-0.067492	0.022772	-2.963848	0.0052
Ln(gdp)	0.071612	0.028921	2.476168	0.0178
Lncons(-1)	0.872606	0.071039	12.28354	0.0000

R-squared	0.990954
Adjusted R-squared	0.990240
F-statistic	1387.652
Probability (F-statistic)	0.000000

Source : Secondary data processed using Eviews, 2023

Estimation of Changes in Fuel Consumption

The estimation of changes in fuel consumption is conducted in five stages. The first stage involves calculating the change in fuel consumption.

$$C_{SR} = 30\% \,. -0{,}068 = 0{,}020\%$$

The assumed change in price is 30%, which is used because in 2022, the Indonesian government increased fuel prices by 30% compared to 2021. The elasticity of fuel consumption, -0.068, is the short-term coefficient obtained from previous calculations using the Partial Adjustment Model (PAM).

Once the change in fuel consumption is determined, the next step is to calculate the change in total fuel consumption.

$$C^{*}_{SR} = \frac{0{,}020}{100.1585} . (158{,}99) . (365) = -18.763{,}86$$

From this calculation, it is known that with a 30% increase in fuel prices, aggregate fuel consumption will decrease by 18.8 million liters per year in the short term.

The next step is to use the change in aggregate fuel consumption to determine the change in fuel consumption in each sector. The change in fuel consumption in each sector is then used to find the change in the value of fuel consumption. From this calculation, it is known that there will be a sectoral change in fuel consumption that will be used as a shock in the analysis of the impact on sectoral output.

Impact Analysis

The increase in fuel prices, which will subsequently affect fuel consumption, will undoubtedly have an impact on other sectors. The results of the scenario conducted are shown in Table 2.

Table 2 reveals that the transportation sector is the most affected dominant sector. In the short term, a 30% increase in fuel prices will change the output of the Army sector by -46, 634,666.35, the Air Force sector by -40, 350,874.25, and the Navy sector by -10, 900,610.70. This is related to the dependence of vehicles as a mode of transportation on fuel, which is the primary source of energy. The results of this study are consistent with the research conducted by Dahl and Kurtubi (2001) and Setyawan (2014). Both studies were conducted in Indonesia and found that an increase in fuel prices would have the greatest impact on the transportation sector.

A 30% increase in fuel prices also has a significant impact on the Trade, Except for Motor Vehicles and Motorcycles, Products of Oil Refining and Gas, and Electricity industries. The Electricity industry is highly affected because approximately 35% of the total electricity capacity in Indonesia is generated from fuel oil (Setyawan, 2014). Table 2 also shows that, in aggregate, in the short term, the increase in fuel prices will reduce national output by 364,710,767.65.

Table 2. Ten Sectors with the Largest Sectoral Output Impact

Rank	Industry	Output Change

1.	Ground Transportation Services Other Than Rail Transportation	- 46.634.666,35
2.	Air Transportation Services	- 40.350.874,25
3.	Trade Excluding Automobiles and Motorcycles	- 33.890.980,20
4.	Oil and Gas Refining and Manufacturing Products	- 30.783.729,75
5.	Electricity	- 25.691.494,63
6.	Rental Services and Business Support Services	- 11.222.897,94
7.	Maritime Transport Services"	- 10.900.610,70
8.	"Residential and Non-Residential Buildings"	- 10.892.992,07
9.	"Coal and Lignite"	- 7.710.757,03
10	"Transport Support Services"	- 7.182.222,18
Aggregate Output		-364.710.767,65

Source: Secondary data processed using Excel, 2023

CONCLUSION

Based on the results of the regression analysis and the analysis of the 2016 Input-Output Table with 185 Product classifications, it can be concluded that gasoline prices are inelastic and have a significant negative impact on gasoline consumption. Additionally, it is known that income is inelastic and has a significant positive impact on gasoline consumption. An increase in gasoline prices will have a negative impact on sectoral output and total output. The analysis results indicate that the Land Transportation Services sector, excluding Rail Transportation, Air Transportation Services, Trade, excluding Motor Vehicles and Motorcycles, Petroleum and Gas Refinery Products, and Electricity are the most affected sectors.

REFERENCES

Anyars, S. I., & Adabor, O. (2023). The impact of oil price changes on inflation and disaggregated inflation:. *Research in Globalization, 6*, 100125.

Dornbusch, R., Fisher, S., & Startz, R. (2018). *Macroeconomics* (13th ed.). New York: McGraw-Hill Education.

Firmansyah, F. (2006). *Operasi Matrix dan Analisis Input-Output (I-O) untuk Ekonomi.* Semarang: Badan Penerbit Universitas Diponegoro.

Habuddin, H., & Firmansyah, F. (2004). Dampak Kinerja Ekspor Industri Manufaktur Terhadap Perekonomian Indonesia. *Jurnal Dinamika Ekonomi & Bisnis, 1*(2), 83-102.

Jiang, Z., & Tan, J. (2013). How the removal of energy subsidy affects general price in China : A study based on input-output model. *Energy Policy, 63*, 599-606. doi:http://dx.doi.org/10.1016/j.enpol.2013.08.059

Miller, R. E., & Blair, P. D. (2009). *Input-Output Analysis : Foundations and Extensions.* New York: Cambridge University Press.

Perloff, J. M. (2022). *Microeconomics : Theory and Applications with Calculus* (5th ed.). Pearson Education.

Pindyck, R. S., & Rubinfeld, D. L. (2018). *Microeconomics* (Vol. 9th). United States: Pearson.

Saari, M. Y., Radam, A., & Abdullah, A. M. (2008). The Impacts of Increase in the Domestic Petroleum Price on Cost Production in the Agricultural and Agro-Based Sectors. *International Journal of Business and Society, 9*(1), 37-52.

Sekretariat Presiden. (2022). *Konferensi Pers Presiden Jokowi dan Menteri Terkait perihal Pengalihan Subsidi BBM, 3 Sep 2022*. Taken from https://www.youtube.com/watch?v=gsL6-YtDObA&ab_channel=SekretariatPresiden

Setyawan, D. (2014). The Impacts of the Domestic Fuel Increases on Prices of the Indonesian Economic Sectors. *Energy Procedia 47*, 47-55.

Smid, B. (2000, Agustus). *The Effects of R&D on the Dutch Production Structure.* Taken from IIOA Website: https://www.iioa.org/