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THE IMPLEMENTATION OF ARIMA METHOD IN FORCASTING INDONESIAN CRUDE OIL EXPORT, PRODUCTION AND CONSUMPTION

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Sudati Nur Sarfiah[1], Arina Sabilarrochmah Aripulis[2]✉
[1,2] Universitas Tidar, Magelang, Indonesia
✉ arina.sabilarrochmah.aripulis@untidar.ac.id

Abstract

Petroleum is one of the main sources of energy consumed by the Indonesian people. Indonesia, one of the major oil producers in the world, is currently facing the possibility of oil shortages. Petroleum-based energy sources have limited supplies if they continue to be used. The lack of alternative energy produced to replace petroleum is the reason behind the increasing use of petroleum. To meet domestic oil demand in this scenario, appropriate strategies and policies are needed. Using historical data from 1990-2022, this analysis attempts to project Indonesia's petroleum exports, production, and consumption in 2023-2027. This study uses the Auto Regressive Integrated Moving Average or ARIMA method with the best model for forecasting exports, production, and consumption being (1, 1, 1), (1, 1, 0), and (2, 1, 0), respectively. From the results of the study, it is predicted that oil exports and production have decreased far below oil consumption which shows an increase. This can have a negative impact on the Indonesian economy. Thus, this research can be used as a reference for future policy making.

Keywords: *ARIMA, Petroleum, Exports, Production, Consumption*

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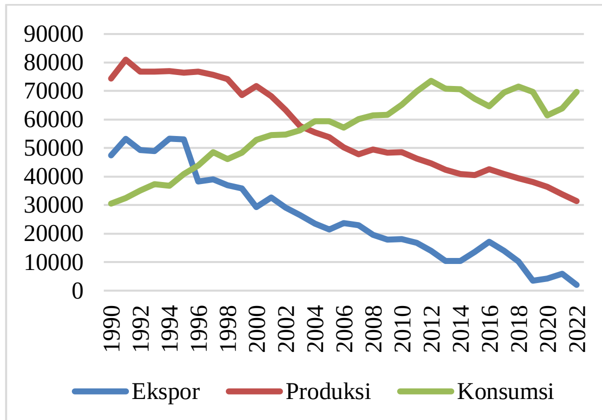
INTRODUCTION

Petroleum is one of the primary energy sources that is widely used in almost all countries. Undoubtedly, that petroleum is used for various needs in every country, including Indonesia, particularly for industrial and transportation needs. In 1977, Indonesia reached its peak or golden age in oil production and began exporting oil to other countries. Because in that year Indonesia discovered oil fields later called the Duri Field and Minas Field that were managed by Chevron. At that time, gasoline consumption was only around 300 thousand barrels per day, while domestic oil production reached 1.68 million barrels per day. Therefore, Indonesia is classified as one of the countries that exports oil and becomes a member of the OPEC organization. However, due to lack of investment and exploration, Indonesia's crude oil production has continued to decline since the 1990s. The oil industry has actually hindered GDP development in recent years, since the average oil production produced from old oil fields failed to meet the target for several years in a row.

Indonesia's oil refinery capacity remains unchanged from ten years ago, indicating that Indonesia's oil production has grown insignificantly. From 2004 until now, the decline in oil production and increase in domestic consumption has made Indonesia an oil importer. As a result, Indonesia was forced to revoke its membership in OPEC from 1962 to 2008. However, in December 2015, Indonesia rejoined OPEC. The image below illustrates the development of Indonesia's petroleum exports, production, and consumption from 1990 to 2022.



Source Asian Development Bank (2023), processed

Figure 1. Comparison of Indonesian Petroleum Exports, Production and Consumption 1990-2022

As exemplified in Figure 1, Indonesia's petroleum exports indicate annual fluctuations before finally declining until Indonesia was forced to revoke OPEC membership. The amount of Indonesian petroleum exports tends to drop instead of increase, although the value of exports does not decrease along with decreasing volume. An increase in price also results in an increase in value. This occurrence is unsatisfying since Indonesia should be able to upsurge its oil exports when crude oil prices rise globally, so that it can generate higher income. However, it happens in the opposite way, and as a result of the production decline, Indonesia was unable to increase its oil export revenues.

From Figure 1, it can be also identified that during the period of 1990-2003, Indonesia's petroleum production was higher than petroleum consumption. However, since 2004, production has been lower than consumption, leading to a wider gap. This indicates that there has been an intersection between the amount of petroleum production and the consumption in Indonesia. In 2022, Indonesia only produced 31.4 million tons of petroleum. This figure only covers around 45 percent of total consumption that reached 69.7 million tons. Thus, in 2022 Indonesia experienced a petroleum supply deficit of around 38.3 million tons (the difference between production and consumption).

The fact that Indonesia's imports are increasing due to the increasing domestic consumption and dramatic decline in production and exports, becomes very detrimental to the country. As a result, the government must import the shortage, as indicated by the gap, if the increase in domestic fuel demand is not aligned with an increase in domestic fuel production. Indonesia's level of dependence on fuel imports is increasingly burdening the Government due to the large number of subsidies required as the direct impact of increase in world's oil prices (Wira & Ciptomulyono, 2007).

It can also be seen that a negative gap is starting to emerge in Indonesia, due to the consumption that exceeds the production. Since alternative energy sources are still not used properly to replace petroleum, especially in developing countries, the amount of oil consumed will continue to increase. The country's oil reserves will become increasingly depleted as a result of the gap that keeps on mounting. Eventually, the oil reserves will slowly run out if this condition continues to happen.

Several relevant studies have been initiated by researchers, such as: Desvina & Siddiq (2014) estimated Indonesia's oil consumption using the Box-Jenkins approach using the (4, 2, 0) model; these findings indicated that 2011 would be less than 2010. However, there was a possibility for an increase in Indonesia's oil consumption between 2012 and 2015. Meanwhile, research conducted by Zhang & Zhou (2023) predicted the future risk value of crude oil using the ARIMA method with a confidence level of 95 percent and 99.5 percent. Long-term crude oil can be a challenge for investors due to price volatility, so effective measures are required to manage market risk. Manowska & Bluszcz (2022) performed research in different places with different models. This research analyzed current (2020) and future (2040) conditions with crude oil consumption variables on the Polish market. By using the

LSTM model to predict crude oil consumption, the results demonstrated the existence of a nonlinear phenomenon with a small statistical data set. Another research conducted by Rahmawati et al. (2019) related to forecasting petroleum production rates in East Kalimantan using the DCA and ARIMA methods. With the (1, 1, 0) model, it resulted in a relatively constant fluctuation forecasting. The level of accuracy of both methods signifies that ARIMA forecasting is better than DCA.

Petroleum or crude oil is a fossil energy source that can produce energy. Petroleum is a non-renewable energy source, meaning that it will run out with all-at-once use. Thus, systematic, planned and coordinated energy conservation strategies are necessary to increase the efficiency of exploiting this energy source as a strategic reserve to meet national energy needs. To increase these opportunities, it is crucial to forecast export values to assess the progress and determine strategic steps. Forecasting is an activity to predict things that may occur in the future and is carried out to make decisions in each field of activity. The basis of long-term planning is forecasting. To develop effective planning, forecasting results must be accurate. The Autoregressive Integrated Moving Average (ARIMA) method is one of the methods that can be used in forecasting. Although this approach excludes independent variables in its implementation, this approach pays close attention to the properties of the historical data that will be used. Historical data must meet the criteria for non-stationary data.

Based on this background, petroleum plays an important role in a ruling country's economy. Previous research also demonstrated various results. Therefore, this research tries to provide a form of forecasting approach with different variables. Normally, research using the ARIMA method employs only one variable, but in this research uses three variables, namely exports, production, and consumption of petroleum in Indonesia as the state of the art, and adds a research period. So, the results of this forecast will be able to deliver an overview of the future condition of Indonesian oil. This research aims to examine trends in oil export, production, and consumption data in Million Tons from 1990-2022. Next, this study is also designated to explore the best model to determine the appropriate estimation for each variable in the future using the ARIMA method.

THEORETICAL BASIS

Crude Oil

Crude Oil or *petroleum* is the basic ingredient used to make gasoline, fuel oil, and various other chemical products. Because petroleum contributes to most of the world's energy consumption, it becomes a vital energy source. Millions of years ago, small plant and animal creatures perished and were buried beneath ancient oceans, giving rise to petroleum. It then converts the buried sand into dirt rich in organic material, which ultimately becomes sedimentary rock. These deposits turn into organic materials rich in hydrocarbons (oil and natural gas) under high pressure. On the other hand, crude oil is a mixture of different hydrocarbon molecules.

Exports

Exports are defined as international trade activities in the form of selling goods and services that are produced domestically for abroad sale (Mankiw, 2006). According to Hecksher Ohlin's Theory, a country will export goods whose manufacture is highly dependent on cheap and abundant production inputs. The country will benefit from this activity because it will increase national income and accelerate the rate of economic expansion (Darwanto, 2004). By performing the exports, a country will receive a certain amount of money in the form of foreign exchange, which is one source of state income. Since the 1980s, Indonesia's foreign trade has shifted. If Indonesia previously focused on oil and gas commodities, non-oil and gas commodities began to dominate trade in 1987. Natural gas mining, crude oil and manufactured oil products are all included in oil and gas exports. Meanwhile, non-oil and gas export commodities include agricultural products such as coffee, tea, spices; manufacturing products such as textiles, processed rubber, processed wood products; and mining products such as copper ore, nickel ore, coal, and so on.

The Theory of Comparative Advantage by David Ricardo states that in a free trade situation, even if a country produces both goods less effectively than another country, trade between the two can still be profitable for both. Commodities with smaller absolute losses are well-known as comparative advantages and they must be produced exclusively in the first country, while commodities with larger absolute disadvantages are known as comparative disadvantages in which case these commodities must be imported. (Salvatore, 2022).

Production

Production is an activity or process where someone creates a product, both goods and services (services) that are used by consumers. Production theory examines how different elements of production should be combined, and how certain technologies should be used to produce a number of goods. So, the economic activity called “production theory” mixes several inputs to create a result or output. According to the law, after output reaches a maximum, adding one more input result in an additional reduction in output or so-called The Law Of Diminishing Return. In the production process, goods or services have added value or use.

Consumption

Consumption is an action that involves reducing or depleting the value of products and services, either directly or over time, to meet demand. In practice, consumption theory explains how people's consumption behavior gives impact to the economy and provides a general description of how people think about consumption. According to Mankiw (2006), the Absolute Income Hypothesis Theory, which reveals that individual consumption is determined solely by their income, is a popular nickname for Keynes's consumption theory.

Previous Research

Research conducted by Wahyudi (2023) entitled "Forecasting Oil Consumption and Production Using the ARINA Model in Indonesia" showed that one of the most important energy sources for a country is oil. Once the largest oil producer in the world, Indonesia is now threatened with an oil deficit. By using historical data from 1980-2021, this study tries to anticipate Indonesia's oil production and consumption in 2022-2023. It is projected that Indonesia's oil consumption is significantly higher than production using the ARIMA model of oil consumption (2, 1, 16) and oil production (3, 1, 9). The country's economy will suffer if this is allowed to continue.

The research by Saleh et al. (2023) entitled "Forecasting the Export Value of Oil and Gas in Indonesia using Autoregressive Integrated Moving Average (ARIMA)" utilized the ARIMA method to predict the value of Indonesian oil and gas exports. As quantitative research, the data covers the period January 2010 to March 2022. Throughout the results and discussion, the ARIMA model (0, 1, 1) with an AIC value of 2047.65 is considered the most suitable for estimating Indonesian oil and gas exports. Then the study estimated 5 periods from April to August 2022.

Maghfiroh et al. (2022) conducted research on "Comparison of Palm Oil Export Forecasting in Indonesia Using the DES Method, Arima Outlier Detection, and MLP". It demonstrated the important strategic role of the palm oil sector, which generates the majority of Indonesia's foreign exchange. Oil palm plantations have the capacity to create jobs and opportunities during industrial production and processing processes, especially for the benefit of local populations. Therefore, in this research, forecasting is one of the factors taken into account in the next stages of oil production and export. The MLP approach was found to have higher forecasting accuracy than ARIMA, which had an error of 0.1166, using the DES method, ARIMA outlier detection, and MLP. The forecast value of oil exports for 2022, determined by MLP, was 2.301633 in May.

While Sa'adah et al. (2017) conducted research entitled "Forecasting Indonesia's Oil Fuel Supply and Consumption Using Dynamic System Models" by estimating the availability and the utilization of gasoline in the future. According to the model, which is a dynamic system, fuel supply can keep pace with gasoline demand until 2016. Between 2017 and 2025, there will not be enough petroleum available to meet domestic demand. It is estimated that fuel consumption will reach 719,048 million barrels and fuel supply will reach 651,092 million barrels in 2025.

The research by Adnyana et al. (2013) related to "Application of Bootstrap on Neural Networks for Forecasting Crude Oil Production in Indonesia" showed the difference between the amount of crude oil produced and consumed because currently the amount of consumption is increasing but not proportionate with the increase in total production. By comparing neural network, ARIMA, and neural network models with bootstrap for predicting Indonesian crude oil production, the neural network emerged as the most effective model. On the other hand, bootstrap eliminates unnecessary input, such as entering two levels of input, leaving the least amount of neural network input.

Based on several previous studies, researchers tried to compare various types of variables, research methodologies, and research findings in an effort to demonstrate the latest research between current research and previous research. Since in previous research there were different results, different techniques, and on average only used one variable, this research employs three more varied and specific variables, such as the variables of export value, production and consumption of petroleum supplies in Indonesia in the period 1990-2022. Then forecasting is carried out using the ARIMA model from 2023-2027.

RESEARCH METHOD

Quantitative method is employed in this research considering that the data in the form of numbers later be processed and explained through Eviews 12 processing. The type of data is time series secondary data from 1990 to 2022 in Indonesia. The data include the value of exports, production, and consumption of petroleum in Million Tons obtained from the Asian Development Bank. Then forecasting is carried out from 2023 to 2027. This research uses the ARIMA (Autoregressive Integrated Moving Average) analysis method to identify trends in a series or collection of data. ARIMA models can be explained as follows:

1. AR Model (Autoregressive)

   Equation for autoregressive model with order p can be formulated as follows:

   $Yt = \beta_0 + \beta_1 \boldsymbol{Y_{t-1}} + e_t$ .... (1)

In which: Yt = dependent variable; Y_{t-1} = First Lag of Y

Or in general the AR model can be formulated, as follows:

$$Yt = \beta_0 + \beta_1 \boldsymbol{Y_{t-1}} + \beta_2 \boldsymbol{Y_{t-2}} + \cdots + \beta_p \boldsymbol{Y_{t-p}} + e_t \quad \text{.......... (2)}$$

with Y = dependent variable; $\boldsymbol{Y_{t-1}}, \boldsymbol{Y_{t-2}}, \boldsymbol{Y_{t-p}}$ = lag of Y; p = AR level; e_t = residual value at time t (nuisance error)

2. MA Model (*Moving Average*)

Equation for *moving average* model with order q can be formulated as follows:

$$Yt = \boldsymbol{\alpha_0} + \boldsymbol{\alpha_1}\, e_t + \boldsymbol{\alpha_2}\, \mathbf{e}_{t-1} \quad \text{.......... (3)}$$

In which: e_t = residual; $\mathbf{e}_{t-1}$ = the first lag order of residual

Or generally MA model can be formulated, as follows:

$$\boldsymbol{Yt} = \boldsymbol{\alpha_0} + \boldsymbol{\alpha_1}\, \boldsymbol{e_t} + \boldsymbol{\alpha_2}\, \mathbf{e}_{t-1} + \boldsymbol{\alpha_3}\, \mathbf{e}_{t-3} + \cdots + \boldsymbol{\alpha_1}\, \boldsymbol{e_{t-q}} \quad \text{.......... (4)}$$

With e_t = residual value; $\boldsymbol{e_{t-1}}, \boldsymbol{e_{t-2}}, \boldsymbol{e_{t-q}}$ = lag of residual; q = MA level

3. ARMA Model (*Autoregresive Moving Average*)

This model is a combination between AR and MA model which later formulated as follows:

$$Yt = \beta_0 + \beta_1 \boldsymbol{Y_{t-1}} + \beta_2 \boldsymbol{Y_{t-2}} + \boldsymbol{\alpha_0}\, e_t + \boldsymbol{\alpha_1}\, \mathbf{e}_{t-1} \quad \text{.......... (5)}$$

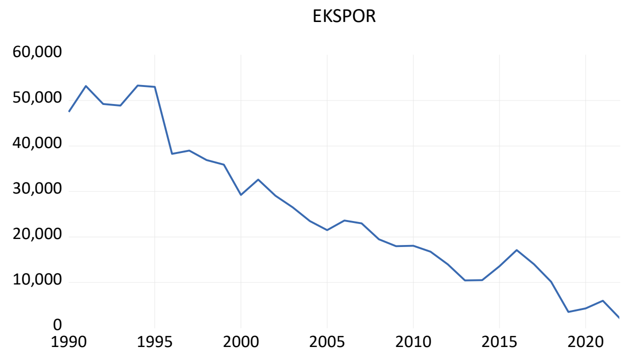
Or in general the ARMA model is formulated, as follows:

$$Yt = \beta_0 + \beta_1 \boldsymbol{Y_{t-1}} + \beta_2 \boldsymbol{Y_{t-2}} + \cdots + \beta_p \boldsymbol{Y_{t-p}} + \boldsymbol{\alpha_0}\, e_t + \boldsymbol{\alpha_1}\, \boldsymbol{e_{t-1}} + \boldsymbol{\alpha_2}\, \boldsymbol{e_{t-2}} + \cdots + \boldsymbol{\alpha_q}\, \boldsymbol{e_{t-q}} \quad \text{........(6)}$$

The first step in calculating ARIMA methods is by plotting the original data, which is the initial step to determine whether the mean and variance of the data are stationary or not. One way to assess data stationarity is to use the Augmented Dickey-Fuller test. It is essential to differentiate if the data is not stationary in the mean. Logarithmic transformation is required if the data variance is not stationary. The provisional model is determined in the second step. Finding the order of p, d, and q will produce an ARIMA model. PACF plots of non-stationary data are used to identify the order of p; the number of differencing operations required to convert non-stationary data to stationary and later be used to determine the order d; and the ACF plot of stationary data is used to determine the order of q. The sequence is preceded with parameter estimation and parameter significance testing. Later, residual tests and diagnostic checks are performed to see if the model is appropriate. The normally distributed residual and the white noise requirements test are employed as in this research as selected tests. After determining the AR or MA order that may be suitable for obtaining forecasts, then the estimated parameter values in the ARMA model are determined based on the results of the t test, Adjusted R Square and Sum Squared Resid, F test, AIC (Akaike Information Criterion), SIC (Schwarz Information Criterion), and HIC (Hannan Quinn Criterion). A good forecasting model should have a high Adjusted R Square value, and low SSR, AIC, SIC and HIC values. The final step is prediction or forecasting with the best model to observe the data in several future periods.

RESEARCH RESULT AND DISCUSSION

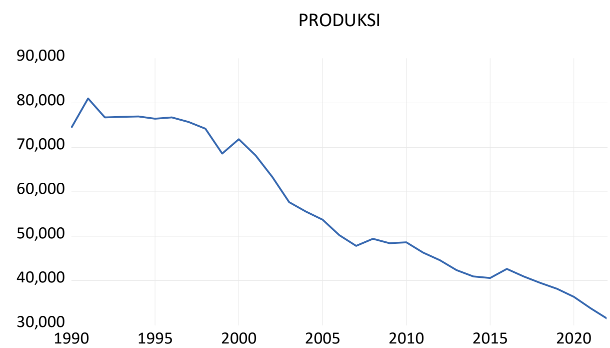
The plot of a time series of Indonesian petroleum export, production, and consumption objects from 1990 to 2022 to get a brief estimation on the shape of the appropriate model. It is proven from figures 2, 3, and 4 that the oil graph data pattern follows a trend. It is possible to conclude that the data are non-stationary on average by noticing Figure 2, which shows the downward trend in petroleum exports. Then the downward trend in Figure 3 is in petroleum production, and the upward trend in Figure 4 is in petroleum consumption. To determine whether there is a unit root or not, the next step is to evaluate stationary data using the Augmented Dickey-Fuller (ADF) test.



Source: EViews 12 (2023)

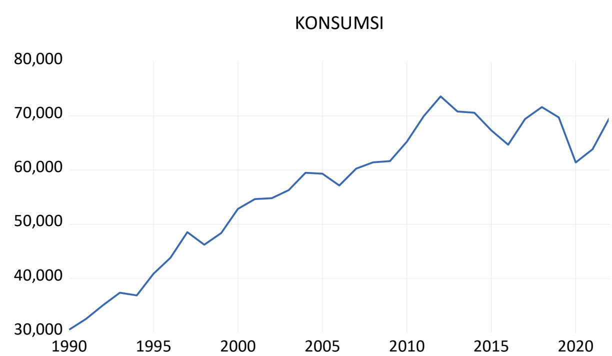
Figure 2. Plot of Indonesian Petroleum Export Data 1990-2022

Source: EViews 12 (2023)



Source: EViews 12 (2023)

Figure 3. Plot of Indonesian Petroleum Production Data 1990-2022



Source: EViews 12 (2023)

Figure 4. Plot of Indonesian Petroleum Consumption Data 1990-2022

Based on Table 2, data on Indonesian petroleum exports from 1990 to 2022 is identified as non-stationary. This can be seen from the probability value of 0.8590 in the ADF test which is higher than the significance limit of five percent (0.05). It is necessary to carry out Lagged differences (Lag 1) because the data is unstable at level. The probability value of petroleum exports in Table 3 changes to 0.0011 following the 1st difference, where the value is no higher than the significance level. Thus, it can be concluded that the export data is stable at the first difference. A model can be created for stationary oil export data and used in ARIMA Least Square Method analysis.

Likewise with data on Indonesian petroleum production and consumption for 1990-2022, it can be notified that oil production and consumption data is not stationary at the level. This can be seen from the probability value in the ADF test, which is greater than the 5 percent significance level (0.05), 0.9688 for oil production and 0.1620 for oil consumption. Since the data is not stationary at the level, it is carried out *Lagged difference* (Lag 1). In Table 3, after the first *difference* is held, the probability value is 0.0000 for oil production and 0.00003 for oil consumption, in which this value is not greater than the significance level. So, it can be concluded that oil production and consumption data are also stationary at 1st differences. Petroleum export data that is already stationary can be continued with the formation of models in the analysis of Least Square Method ARIMA.

Table 2. Stationarity Test at Level

Variable	t-statistic	Critical Value			Prob.	Description
		1%	5%	10%		
Export	-0.591213	-3.653730	-2.957110	-2.617434	0.8590	Not Stationary
Production	0.206624	-3.653730	-2.957110	-2.617434	0.9688	Not Stationary
Consumption	-2.356552	-3.670170	-2.963972	-2.621007	0.1620	Not Stationary

Source: EViews 12 (2023)

Table.3 Stationarity Test at 1st Difference

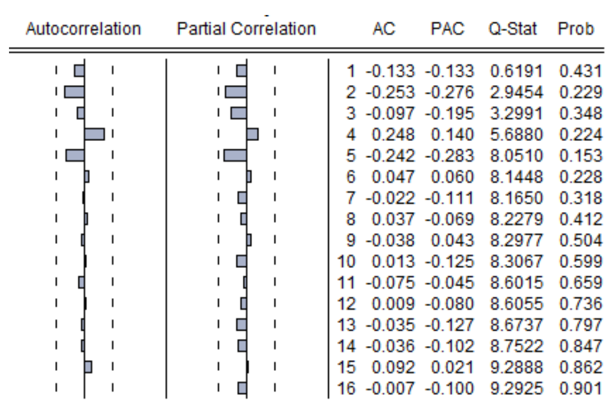
Variable	t-statistic	Critical Value			Prob.	Description
		1%	5%	10%		
Export	-4.555173	-3.679322	-2.967767	-2.622989	0.0011	Stationary
Production	-7.366120	-3.661661	-2.960411	-2.619160	0.0000	Stationary
Consumption	-5.002020	-3.670170	-2.963972	-2.621007	0.0003	Stationary

Source: EViews 12 (2023)

In Table 3, data on exports, production and consumption of Indonesian petroleum have been declared stationary at *first difference*. It signifies the model of research that employs ARIMA. For this reason, the next step is required to carry out a Correlogram test. Correlogram comprises two parts, which are ACF (*Autocorrelation Function*) and PACF (*Partial Autocorrelation Function*). If the ACF value is close to 1 or –1 at a particular lag, this implies that there is a significant correlation at that particular lag. Meanwhile, if the ACF value is close to 0, it implies insignificant correlation at that lag. Then, if PACF is close to 1 or -1 at a particular lag, this indicates a significant correlation at that lag after controlling for the effects of the previous lag.

The following Figure 5, Figure 6, and Figure 7 are correlogram tests for each variable. The partial correlation is already inside the dotted line (Bartlett's line), as depicted in the figure, which displays each bar on the autocorrelation graph. In addition, it is also known that each probability value is higher than 0.05. As a result, it can be said that the data is stationary at the first differential level. This ARIMA model contains three orders: p, d, and q. The AR Order (p) is determined by the Partial Correlation (PAC) value, the MA Order (q) is determined by the Autocorrelation (AC) value, and the Order (d) is defined as the degree of difference when the data is considered stationary. In this study, the order (d) has a value of 1 because the data is stationary at 1st difference.

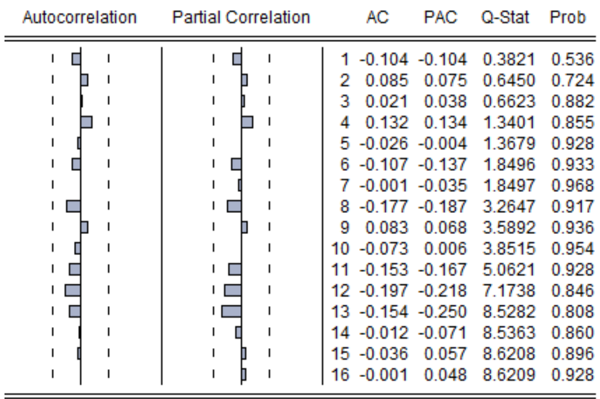
It is illustrated in Figure 5 that the AC and PAC values for oil export data which are close to the dotted line are at lags 2 and 5. Meanwhile in Figure 7 the PAC values for oil consumption which are close to the dotted line are at lags 2 and 7, as well as the AC values which are close to the dotted line are at lags 2 and 9. There are 4 ARIMA models that may be used for forecasting oil export and production data, model 1 is (1, 1, 1), model 2 is (1, 1, 0), model 3 is (0, 1, 1), and model 4 is (2, 1, 2). On the other hand, there are also four models for petroleum consumption, which are model 1 is (1, 1, 1), model 2 is (2, 1, 2), model 3 is (2, 1, 0), and model 4 is (0 , 1, 2).



	AC	PAC	Q-Stat	Prob
1	-0.133	-0.133	0.6191	0.431
2	-0.253	-0.276	2.9454	0.229
3	-0.097	-0.195	3.2991	0.348
4	0.248	0.140	5.6880	0.224
5	-0.242	-0.283	8.0510	0.153
6	0.047	0.060	8.1448	0.228
7	-0.022	-0.111	8.1650	0.318
8	0.037	-0.069	8.2279	0.412
9	-0.038	0.043	8.2977	0.504
10	0.013	-0.125	8.3067	0.599
11	-0.075	-0.045	8.6015	0.659
12	0.009	-0.080	8.6055	0.736
13	-0.035	-0.127	8.6737	0.797
14	-0.036	-0.102	8.7522	0.847
15	0.092	0.021	9.2888	0.862
16	-0.007	-0.100	9.2925	0.901

Source: EViews 12 (2023)

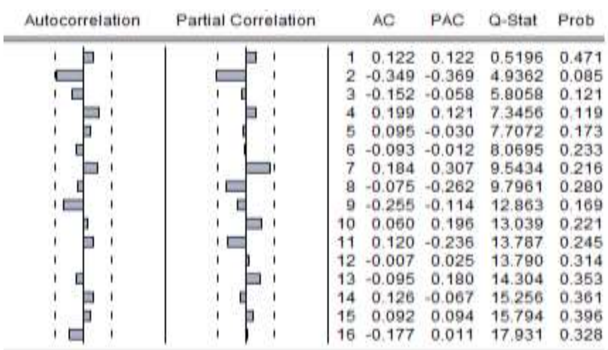
Figure 5. Correlogram Test Results for Indonesian Petroleum Exports



Lag	AC	PAC	Q-Stat	Prob
1	-0.104	-0.104	0.3821	0.536
2	0.085	0.075	0.6450	0.724
3	0.021	0.038	0.6623	0.882
4	0.132	0.134	1.3401	0.855
5	-0.026	-0.004	1.3679	0.928
6	-0.107	-0.137	1.8496	0.933
7	-0.001	-0.035	1.8497	0.968
8	-0.177	-0.187	3.2647	0.917
9	0.083	0.068	3.5892	0.936
10	-0.073	0.006	3.8515	0.954
11	-0.153	-0.167	5.0621	0.928
12	-0.197	-0.218	7.1738	0.846
13	-0.154	-0.250	8.5282	0.808
14	-0.012	-0.071	8.5363	0.860
15	-0.036	0.057	8.6208	0.896
16	-0.001	0.048	8.6209	0.928

Source: EViews 12 (2023)

Figure 6. Correlogram Test Results for Indonesian Petroleum Production



Lag	AC	PAC	Q-Stat	Prob
1	0.122	0.122	0.5196	0.471
2	-0.349	-0.369	4.9362	0.085
3	-0.152	-0.058	5.8058	0.121
4	0.199	0.121	7.3456	0.119
5	0.095	-0.030	7.7072	0.173
6	-0.093	-0.012	8.0695	0.233
7	0.184	0.307	9.5434	0.216
8	-0.075	-0.262	9.7961	0.280
9	-0.255	-0.114	12.863	0.169
10	0.060	0.196	13.039	0.221
11	0.120	-0.236	13.787	0.245
12	-0.007	0.025	13.790	0.314
13	-0.095	0.180	14.304	0.353
14	0.126	-0.067	15.256	0.361
15	0.092	0.094	15.794	0.396
16	-0.177	0.011	17.931	0.328

Source: EViews 12 (2023)

Figure 7. Correlogram Test Results for Indonesian Petroleum Consumption

Model Parameter Estimation

Once alternative models are decided, the next step can be determined, which is estimation. The following Table 4 is a summary of the models that may be selected through testing the Eviews 12 program. Several components to pay attention to regarding the results of the regression analysis, in this research are the Akaike Info Criterion (AIC), Schwarz Criterion (SIC), and Hannan Quinn Criterion values. (HIC).

Table.4 Summary of ARIMA Model Parameter Estimates

Variable	Model	R-Squared	Adjusted R-Squared	Sum Squared Resid	Akaike Info Criterion	Schwarz Criterion	Hannan Quinn Criterion
Export	(1, 1, 1)	0.216535	0.132592	3.65E+08	19.40733	19.59055	19.46806
	(1, 1, 0)	0.020106	-0.047473	4.56E+08	19.49941	19.63683	19.54496
	(0, 1, 1)	0.056570	-0.008494	4.40E+08	19.46606	19.60347	19.51161
	(2, 1, 2)	0.100691	0.004336	4.19E+08	19.48386	19.66708	19.54459
Production	(1, 1, 1)	0.026702	-0.077580	1.84E+08	18.65458	18.83779	18.71531
	(1, 1, 0)	0.016583	-0.051239	1.86E+08	18.60137	18.73879	18.64692
	(0, 1, 1)	0.012851	-0.055228	1.87E+08	18.60486	18.74227	18.65041
	(2, 1, 2)	0.017018	-0.088301	1.86E+08	18.66427	18.84748	18.72500
Consumption	(1, 1, 1)	0.063617	-0.036709	2.73E+08	19.04874	19.23195	19.10947

	(2, 1, 2)	0.155650	0.065184	2.46E+08	18.95488	19.13809	19.01561
	(2, 1, 0)	0.133608	0.073857	2.52E+08	18.91390	19.05131	18.95945
	(0, 1, 2)	0.100568	0.038538	2.62E+08	18.94774	19.08515	18.99329

Source: EViews 12 (2023)

Based on Table 4, it shows that the optimal or best model for petroleum exports is model 1, which is (1, 1, 1) with the largest Adjusted R-Squared value, which is 0.132592, the smallest AIC value, is 19.40733, the smallest SIC value, is 19.59055, and the smallest HIC value, which is 19.46806. Meanwhile, for petroleum production, the best model is model 2, which is (1, 1, 0) with the largest Adjusted R-Squared value, namely -0.051239, the smallest AIC value, which is 18.60137, the smallest SIC value, which is 18.73879, and the smallest HIC value, which is 18.64692. Then for petroleum consumption, the best model is model 3, which is (2, 1, 0) with the largest Adjusted R-Squared value, which is 0.073857, the smallest AIC value, which is 18.91390, the smallest SIC value, which is 19.05131, and the smallest HIC value that is 18.95945. Table 5 represents the detail, as follows:

Table 5. ARIMA Projection Analysis

Variable	ARIMA Model	p	d	q
Export	(1, 1, 1)	1	1	1
Production	(1, 1, 0)	1	1	0
Consumption	(2, 1, 0)	2	1	0

Source: EViews 12 (2023)

Based on Table 5, the appropriate model has been determined to forecast exports, production, and consumption of petroleum. So, the equation can be written as follows:

Petroleum exports (AR 1, MA 1)

$$Yt = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \alpha_0 e_t + \alpha_1 e_{t-1}$$

$$Ekspor_t = -1532.227 + 0.586633_{t-1} - 1.000000_{t-1}$$

Petroleum production (AR 1)

$$Yt = \beta_0 + \beta_1 Y_{t-1} + e_t$$

$$Y_t = \beta_0 + \beta_1 Y_{t-1}$$

$$Produksi_t = -1373.147 - 0.151973_{t-1}$$

Petroleum consumption (AR 2)

$$Yt = \beta_0 + \beta_1 Y_{t-1} + e_t$$

$$Y_t = \beta_0 + \beta_1 Y_{t-1}$$

$$Konsumsi_t = 1155.360 - 0.359818_{t-1}$$

Model Evaluation

Model evaluation or consideration towards the model is carried out after the best model is selected. ACF and PACF correlations were used to analyze residuals to evaluate the model. The model assessment of Indonesia's petroleum exports, production and consumption delivers the following findings.

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.049	0.049	0.0844	
		2	-0.120	-0.123	0.6101	
		3	-0.023	-0.010	0.6292	0.428
		4	0.256	0.247	3.1680	0.205
		5	-0.163	-0.211	4.2368	0.237
		6	0.044	0.145	4.3194	0.364
		7	-0.026	-0.085	4.3496	0.500
		8	0.007	-0.041	4.3521	0.629
		9	-0.070	0.034	4.5808	0.711
		10	-0.040	-0.152	4.6602	0.793
		11	-0.120	-0.047	5.4094	0.797
		12	-0.058	-0.088	5.5899	0.848
		13	-0.092	-0.114	6.0716	0.869
		14	-0.090	-0.063	6.5627	0.885
		15	0.022	0.033	6.5929	0.922
		16	-0.054	-0.105	6.7932	0.942

Source: EViews 12 Output (2023)

Figure 1. Results of Consideration of the Indonesian Petroleum Export Data Model

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.059	0.059	0.1226	
		2	0.074	0.071	0.3223	0.570
		3	0.055	0.047	0.4347	0.805
		4	0.136	0.127	1.1554	0.764
		5	-0.024	-0.046	1.1795	0.881
		6	-0.116	-0.136	1.7414	0.884
		7	-0.041	-0.039	1.8159	0.936
		8	-0.168	-0.169	3.0952	0.876
		9	0.046	0.093	3.1932	0.922
		10	-0.086	-0.035	3.5626	0.938
		11	-0.199	-0.196	5.6167	0.846
		12	-0.250	-0.226	9.0286	0.619
		13	-0.190	-0.226	11.100	0.520
		14	-0.040	-0.027	11.198	0.594
		15	-0.036	0.073	11.283	0.664
		16	0.000	0.049	11.283	0.732

Source: EViews 12 Output (2023)

Figure 2. Results of Consideration of the Indonesian Petroleum Production Data Model

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.138	0.138	0.6728	
		2	0.034	0.015	0.7145	0.398
		3	-0.094	-0.102	1.0426	0.594
		4	0.140	0.171	1.7992	0.615
		5	0.148	0.116	2.6796	0.613
		6	-0.071	-0.139	2.8877	0.717
		7	0.168	0.242	4.1218	0.660
		8	-0.071	-0.136	4.3524	0.738
		9	-0.165	-0.254	5.6428	0.687
		10	0.054	0.270	5.7871	0.761
		11	0.024	-0.106	5.8176	0.830
		12	0.039	-0.118	5.9020	0.880
		13	-0.061	0.265	6.1148	0.910
		14	0.073	-0.070	6.4327	0.929
		15	0.100	-0.022	7.0750	0.932
		16	-0.158	0.034	8.7777	0.889

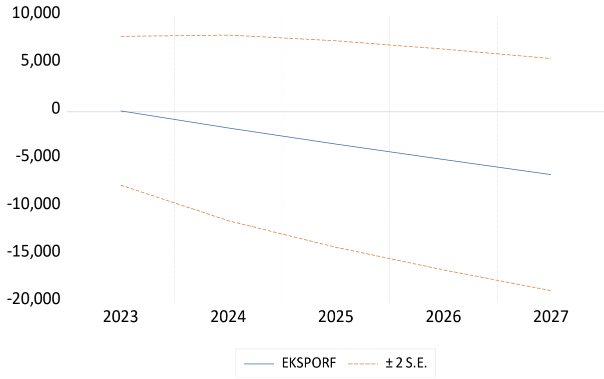
Source: EViews 12 Output (2023)

Figure 3. Results of Consideration of the Indonesian Petroleum Consumption Data Model

From Figure 8, Figure 9, and Figure 10, it can be seen that the AC and PACF values of the residuals give insignificant results until Lag 16. However, the possibility of export, production and consumption of petroleum exceeds the significance threshold of 0.05. Considering that the estimated residual values appear randomly, the ARIMA model is considered as the most appropriate model for these three variables.

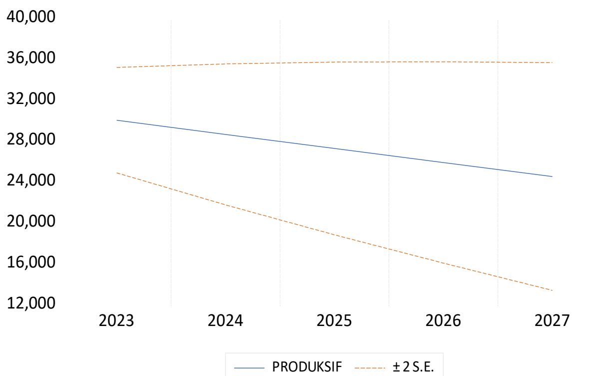
Forecasting

Based on the selection of the best model with ARIMA, petroleum export data (1, 1, 1), ARIMA petroleum production (1, 1, 0), and petroleum consumption (2, 1, 0), it is finally obtained forecasting results for export, production, and petroleum consumption in the next 5 year period, in 2023, 2024, 2025, 2026, 2027 as follows.



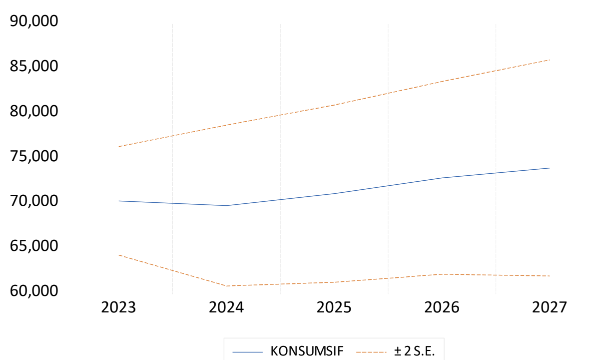
Source: EViews 12 (2023)

Figure 4. Results of Petroleum Export Data Forecasting



Source: EViews 12 (2023)

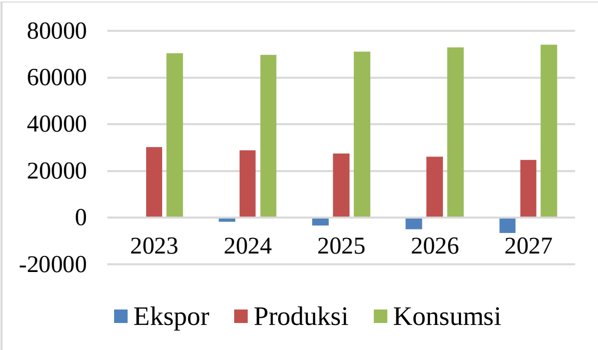
Figure 5. Results of Petroleum Production Data Forecasting



Source: EViews 12 (2023)

Figure 6. Results of Petroleum Consumption Data Forecasting

In Figure 11, it is illustrated the results of future forecasting on petroleum exports using the ARIMA model (1, 1, 1) which has a Mean Absolute Percentage Error (MAPE) value of 19.96574%. It means that the accuracy level of the ARIMA model is counted as 80.03426% (100-19.96574). These findings thus indicate that it is possible to estimate Indonesia's petroleum exports using the ARIMA model. Then, Figure 12 indicates the result of future forecasting on oil production using the ARIMA model (1, 1, 0) which has a Mean Absolute Percentage Error (MAPE) value of 9.788534%. It means that the accuracy level of the ARIMA model is calculated as 90.211466% (100-9.788534). These findings reveal that it is possible to estimate Indonesia's petroleum production using the ARIMA model. Next, Figure 13 demonstrates the result of forecasting oil consumption using the ARIMA model (2, 1, 0) which has a Mean Absolute Percentage Error (MAPE) value of 11.98114%. It means that the accuracy level of the ARIMA model is counted as 88.01886% (100-11.98114). These findings show that it is possible to estimate Indonesia's petroleum consumption using the ARIMA model. The forecasting results will be presented in Figure 14, as follows.



Source: EViews 12 (2023)

Figure 7. Data Forecasting for Indonesian Petroleum Export, Production, and Consumption

The above graph illustrates the entire forecasting data. Based on the forecasting graph, it can be seen that the value of petroleum exports from 2023 to 2027 will experience a decline, even reaching negative numbers. Furthermore, forecasting the value of petroleum production from 2023 to 2027 also shows a regular decline. It means that export and production forecasts are slightly lower than actual values. Meanwhile, the forecasting value of petroleum consumption from 2023 to 2027 shows an increase. This condition shows that high consumption is not followed by the amount of production and export value.

Discussion

One of fossil energy sources that can produce energy is petroleum. Developing good plans through forecasting and establishing firm policies will have an impact on oil production and consumption activities. So that it will provide benefits for individuals, government, and private sector as holders of policy regulations. Furthermore, if petroleum continues to be used, its supply will run out because it is a non-renewable energy source. It is projected that oil exports from Indonesia will decline based on forecast results. Government neglect on the oil industry is the reason behind the fall in petroleum exports, while the value of exports has increased as a result of rising prices. It is important to note that Indonesia has been exporting oil since 2006. This export is not fully handled by the government, but rather by organizations or parties that have agreed in production sharing agreements with the government. Referring to records from Statistics Indonesia, the role of oil exports in overall export performance decreased. The reason is disclosed due to the decreasing price of Indonesian oil (Indonesia Crude Price) and no crude oil exports performed. ICP contracted by 69.8 percent to 20.66 US dollars per barrel. The impact on the role of oil and gas exports, which usually reaches eight to nine percent, finally decreased to only 5.01 percent.

Meanwhile, Figure 14 illustrates the forecasting results for petroleum production are claimed to decrease, while the forecasting results for petroleum consumption are expected to increase. This is consistent with research conducted by Wahyudi (2023) argued that future oil demand is expected to increase, but this trend is inversely correlated with the ongoing decline in oil production. The level of oil consumption in Indonesia is increasing while the level of oil production is decreasing (Sasmitasiwi & Cahyadin, 2008). As a result, Indonesia's oil production industry experienced a deficit.

Following Aprizal et al. (2022) the decline in Indonesia's oil production can be attributed to various factors such as inadequate governance, excessive bureaucracy, unclear regulations and contracts, as well as a lack of exploration and investment in the oil sector. Investors find this an unattractive investment environment, especially when it comes to expensive long-term investments. Eliminating fuel subsidies, even switching to gas, and developing renewable energy are some of the steps Indonesia has taken to anticipate the impending oil shortage and the need to increase investment in the oil sector. The government can prioritize sustainable development and can collaborate with private businesses to increase oil production.

Aligned with the increase of technological knowledge among workers in the petroleum or crude oil industry, both domestic and foreign investment, it can increase production efficiency and draw attention to Indonesia's oil reserves. It is also anticipated that increasing investment and contemporary technological knowledge will provide real concepts for creating alternative energy sources that will increase oil production. In addition, the government can import to meet domestic needs of oil before the deficit of petroleum production. However, imports increase the possibility of depletion of foreign exchange reserves. This is concerning, as it should not lead to further problems in anticipation of existing ones.

Furthermore, based on the results of forecasting constant petroleum consumption, petroleum consumption in Indonesia shows a stable increase. It is due to the population that continues to grow, such as the number of middle-class individuals, and the economic growth as long as fuel demand continues to increase. Due to insufficient domestic production, Indonesia imports between 350,000 and 500,000 barrels of fuel every day from several countries. However, it happens not only in Indonesia but oil reserves in all countries have also fallen rapidly. Considering that Indonesia is an archipelagic country with sufficient oil resources to meet its demand but is currently experiencing severe shortages, this fact is found very challenging.

Therefore, it is unacceptable to rely solely on the use of petroleum because energy needs always increase along with the expansion of industrialization and advances in contemporary technology. The government has dealt with criticism for its long-standing fuel subsidy program, which is primarily funded by the State Revenue and Expenditure Budget

(APBN). Despite the fact that this program was held to help the poor in Indonesia, it is the middle-class segment that benefits most from the subsidized fuel policy. put a lot of pressure on the state budget deficit. Every year, more money is set aside to meet demand for subsidized fuel. Low pricing causes distortions in the market. High inflation resulted from increases in fuel price subsidies and protests. In January 2015, the Indonesian government made the final decision to eliminate petrol subsidies and replace them with diesel subsidies of IDR 1,000 per liter. International bodies such as the IMF and World Bank encourage this activity.

Besides, another policy implemented by the government is to engage in community service projects in partnership with academics to educate the Indonesian people about the importance of reducing the use of oil and the fact that it is a non-renewable natural resource. It is believed that people will use the oil more wisely. Then people can also reduce energy consumption independently, for example by walking. Thus, it is necessary to increase public awareness to be less dependent on transportation so it can help reduce petroleum energy consumption. Moreover, walking gives good or positive influence on health and the environment. In fact, according to research by Fatmawati (2016) walking can reduce anxiety and depression symptoms, which improves the quality of life. That way, people need to learn and increase knowledge regarding these matters and build a culture of maximizing the use of public transportation rather than private transportation.

In order to enable faster economic growth, the direction of energy security and independence policies is to increase energy availability as much as possible depending on domestic resource capabilities combined with reducing the number of imports. Therefore, the best action for implementing the policy is to make petroleum investment more attractive to increase reserves and production as well as the quality of energy infrastructure services provided by fuel, gas and electricity infrastructure. Implementing green energy or clean energy initiatives by using more renewable energy. The final way is to increase the efficiency of energy utilization and keep subsidies on track. Reducing Indonesia's dependence on petroleum imports to meet its consumption needs will result in lower import values and smoother economic growth in the future.

CONCLUSION AND SUGGESTIONS

Based on time series forecasting research using the ARIMA method that is claimed as the most suitable tool for predicting data on petroleum exports, petroleum production and petroleum consumption in Indonesia, the best models are revealed, respectively (1, 1, 1), (1, 1, 0), and (2, 1, 0), for 2023, 2024, 2025, 2026, 2027 petroleum exports and petroleum production will continue to decline every year. Conditions like this are inversely proportional to petroleum consumption which continues to increase every year. As a result, it could be an oil crisis and prices that may rise multiple times. These estimates or forecasts can help the government and other parties in formulating policies so that Indonesia can avoid an oil energy deficit in the future. To overcome the problem of negative inequality where consumption is greater than production, efforts are focused on providing convenience and comfort for oil sector investors, especially in the development of renewable energy. Provided conveniences such as political stability, flexibility of investor choices, and the ability to project future earnings. Therefore, investors should feel comfortable investing their money in Indonesia.

In addition, the government must work hard to strengthen regulations that protect foreign investment in the oil and gas sector, especially human resources. as well as the facilities. To reduce the amount of imported petroleum, the government must set fuel consumption guidelines for the public and the government. In this situation, society must act more strategically in order to prepare for increasing the added value of petroleum, such as by producing goods that are processed into finished goods rather than raw or semi-finished goods, which can be consumed directly by society. Improvement must be made for future research to complete this study since there are still limited locations and variables, so additional and further research is needed related to the importance of petroleum as the main energy source in Indonesia, including whether the country is provided with significant benefits from oil export and import activities or the other way around.

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