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The Relationship between Consumption and Imports of Fuel Oil in Indonesia (Hubungan antara Penggunaan dan Import terhadap Minyak Bahan Api di Indonesia)

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ABSTRACT

This study examines the short- and long-run relationship between consumption and imports of fuel oil in Indonesia using a time series data spanning from 1988 to 2018. A Vector Error Correction Model (VECM) approach has been used in examining the short- and long-term conditions designed based on the theoretical framework of the Keynesian consumption model. The results show that the import and price of fuel oil significantly affect fuel oil consumption in Indonesia. Notably, fuel oil imports and prices disrupt the equilibrium of fuel oil consumption in the short term, although, in the long term, the consumption returns to the equilibrium. Moreover, fuel oil consumption and the exchange rate also significantly affect fuel oil imports in Indonesia. Specifically, the exchange rate disrupts fuel oil imports in the short term, then returns to the equilibrium in the long term. Accordingly, the Indonesian government needs to manage fuel oil imports and exchange rate stability to eliminate short-term disruptions in Indonesia's fuel oil imports.

Keywords: Fuel oil consumption; fuel oil import; exchange rate

ABSTRAK

Kajian ini memeriksa hubungan jangka pendek dan jangka panjang antara penggunaan dan import minyak bahan api di Indonesia dengan menggunakan data siri masa tahunan yang meliputi tempoh 1988 hingga 2018. Pendekatan Vector Error Correction Model (VECM) telah digunakan untuk menguji keadaan jangka pendek dan jangka panjang pemboleh ubah tersebut berdasarkan kepada kerangka teori model penggunaan Keynes. Hasil kajian menunjukkan bahawa import minyak bahan api dan harga minyak bahan api mempunyai kesan yang signifikan terhadap penggunaan minyak bahan api di Indonesia. Hasil kajian juga mendapati import minyak bahan api dan harga minyak bahan api telah mengganggu keseimbangan penggunaan minyak bahan api dalam jangka pendek, walaupun dalam jangka panjang penggunaan bahan bakar minyak kembali ke arah keseimbangan. Tambahan lagi, penggunaan minyak bahan api dan kadar pertukaran juga signifikan mempengaruhi import bahan api minyak di Indonesia. Secara khususnya, kadar pertukaran mengganggu import minyak bahan api dalam jangka pendek tetapi kemudian kembali ke arah keseimbangan dalam jangka panjang. Oleh itu, kerajaan Indonesia perlu menguruskan import minyak bahan api dan mengawal kestabilan kadar pertukaran untuk menghapuskan gangguan jangka pendek terhadap import minyak bahan api di Indonesia.

Kata kunci: Penggunaan minyak bahan api; import minyak bahan api; kadar pertukaran

INTRODUCTION

The effect of fuel prices on the economy has attracted economic researchers' interests in various countries in the past four decades. This attention commenced in the 1970s when the US and several European countries experienced a recession after the 1973 oil crisis, mainly caused by the Middle East conflict or the OPEC oil embargo. This has led to many studies examining the causal relationship between oil shocks and various macroeconomic variables. Many of the early empirical studies found significant adverse effects of the relationship between oil price shocks and GDP; thus, it is used as evidence that oil shocks cause economic recessions (Ashfaq et al. 2020; Solarin 2019).

The effect of fuel oil on the economy can be seen from the supply, demand, or terms of trade (Aydın & Acar 2011; Ayu 2017; Bouri et al. 2019; Monfort et al. 2019; Taghizadeh-Hesary et al. 2015). In terms of supply, rising oil prices reduce production input leading to higher production costs and slower output and productivity. In terms of demand, the rise in oil prices leads to higher general price levels, and demand falls with the decline in real income available for consumption (Pide 2018). In terms of trade, oil importers are faced with worsening trade conditions because demand is falling in these countries, resulting in the transfer of wealth from oil importers to oil exporters.

Despite many previous economic studies on fuel oil, most of them examined fuel's effects on the demand or supply side. Besides, earlier studies on fuel oil examined problems mainly in developed economies, while most ignored exploring essential and controversial topics in the economic context of developing countries (Al-Mulali 2011; Bildirici & Bakirtas 2014; Ediger & Berk 2011). Therefore, this study contributes to the literature by examining the influence and balance of consumption and import of fuel oil in Indonesia as a developing country, with emerging prominence in Southeast Asia. This examination context is even more impressive since Indonesia used to be an oil-exporter before becoming a net importer for the last two decades. This study's results are expected to provide new insights into the literature on oil price shocks in the context of developing countries such as Indonesia. These insights serve as the key for policymakers to understand the response of oil price shocks and aggregate economic activity. Fuel oil is a significant driver of the Indonesian economy because fuel oil consumption stimulates goods consumption for the community's daily needs. Therefore, fuel oil availability is essential in the Indonesian economy in meeting the community's needs. The average increase in fuel consumption from 2009 to 2018 was 3.44%, while fuel oil production in the same period decreased by an average of -2.12%. Consequently, to meet the demand for fuel oil consumption, the import of fuel oil was necessary in the same period, with an average increase of 11.02% (BP Statistical Review of World Energy 2019). An adequate fuel oil production did not match the high consumption of fuel oil. In fact, fuel oil production is expected to decline in the future (Gershon et al. 2019).

In line with Samuelson and Nordhaus (2004), there is a close relationship between consumption and income or output of goods and services in a country. When production cannot meet consumption demands in a certain period, these demands are usually met by imports from other countries. Meanwhile, consumption, production, and import are national economic identities and are therefore related to international trade. Consumption is an output function; because of the above identity, fuel consumption is a function of imported fuel oil. Likewise, in theory, fuel oil imports are a function of fuel oil output and the Indonesian rupiah (IDR) exchange rate against foreign currencies (USD). Thus, fuel oil imports are a function of fuel oil consumption and exchange rate.

This research contributes to the literature by providing a deep understanding of fuel consumption and fuel oil imports in developing countries, i.e. Indonesia. Despite the importance of studying the determinants of economic stability in a country, the most prior analysis was carried out separately and ignored the relationship between fuel consumption and imports. Based on the theory of consumption and import, this paper studies the effects of exogenous variables on the endogenous variables by investigating the short- and long-term equilibriums from both endogenous variables, namely the consumption and import of fuel oil in Indonesia.

The remainder of this paper is organized as follows; the next section presents a literature review while the third part explains the details of the data and methodology for analysis. The fourth section discusses the empirical results, and the last section presents the conclusions and policy implications.

LITERATURE REVIEW

As noted earlier, although previous economic studies had examined various issues related to macroeconomic variables and fuel oil prices, they had overlooked the examination of this important and controversial topic in the context of emerging economies (Babajide 2011; Tobias & Agustin 2011; Zhang & Qu 2015). The exceptions are studies on fuel oil effects that focused on cross-country analysis, including few emerging economies in their research, although they particularly focused on the Gulf Cooperation Council (GCC) countries (Shiu-Sheng & Hung-Chyn 2017; Arouri & Rault 2009). Moreover, these studies focused on the supply side in examining the fuel oil effects on the economy.

One of the studies has examined the long-run relationship between real oil prices and real exchange rates by using a monthly panel of G7 countries from 1972:1 to 2005:10 (Shiu-Sheng & Hung-Chyn 2017). In particular, rather than focusing only on one measure of the oil prices, the study considered different measures of oil prices, including the world oil price, the United Arab Emirates price of oil (Dubai), the British price of oil (Brent), and the US West Texas Intermediate price of oil (WTI). The study showed that real oil prices might have been the dominant source of real exchange rate movements, promoting a cointegrating relationship between real oil prices and real exchange rates.

Another study focused on the relationship between oil prices and stock markets in GCC countries (Arouri & Rault 2009). Most GCC members are major net

oil-exporters and OPEC important members whose economies are excessively dependent on oil prices. Thus, their actions as decision-makers in OPEC may significantly impact GCC stock markets and economic activities. This study used the panel-data approach of Kónya, based on SUR systems and Wald tests with country-specific bootstrap critical values and two different (weekly and monthly) datasets covering the periods from 7 June 2005 to 21 October 2008 and from January 1996 to December 2007, respectively. The findings showed strong statistical evidence of a consistently bi-directional causal relationship for Saudi Arabia.

However, few studies have focused on a single emerging economy in Europe, Africa, or Asia, with more recent studies focusing on China. Moreover, these studies tended to focus on the demand side of fuel oil effects. For example, Qianqian (2011) examined the impact of oil prices on the Chinese economy by applying the cointegration and error correction model. This study found a long-run equilibrium relationship between the oil price and China's output, the consumer price index, the total net exports, and the monetary policy. Notably, the higher oil price could slow down China's economic growth, reduce the total exports, and push up prices. Meanwhile, the study showed authorities are more inclined to adopt a tight monetary policy to curb inflation when faced with higher oil prices.

Limin et al. (2010) examined the relationship between the world oil price and China's macroeconomy using multivariate vector autoregression (VAR). This study showed that the world oil price significantly influences economic growth and inflation in China, and the impact is non-linear. On the other hand, China's economic activity fails to affect the world oil price, which means that the world oil price is still exogenous concerning China's macroeconomy in time series sense, and China has not yet had an oil pricing power in the world oil markets. The structural stability test results demonstrate that there is a structural break in the VAR model because of the reforms of China's oil pricing mechanism. Thus, it is more appropriate to break up the whole sample into different sub-samples to estimate the model.

Outside the Asian region, Ana et al. (2011) analyzed the impact of oil price shocks on GDP growth and inflation in the economy of Spain and its seventeen regions. Their findings provided evidence of a diminishing effect of oil price shocks on GDP growth and inflation from the 1970s to the mid-1980s. However, they showed a renewed impact on both these macroeconomic variables after the mid-1980s. Spain recovered its GDP in the second half of the 1990s and its two inflation periods between 1986-1994 and 1994-2000. In the regions, the influence of oil price shocks on the GDP progressively disappeared while inflation has decreased from 1986 onwards. However, it became significant again ten years later. The most outstanding result of the study is that oil price movements explain at least some of the recent inflation. Therefore, the authors recommended that policy measures to control oil shocks' economic impact should be implemented in the future.

In Africa, Babajide (2011) examined the effects of oil price shocks on Nigeria. The results showed that oil price shocks did not significantly impact most macroeconomic variables in Nigeria. The results of the Granger-causality tests, impulse response functions, and variance decomposition analysis all showed that different measures of linear and positive oil shocks did not affect output, government expenditure, inflation, and the real exchange rate. The test results support the asymmetric effects of oil price shocks by showing that adverse oil shocks significantly affect output and the real exchange rate.

The previous study that is most relevant to our research was carried out by Zhang and Qu (2015), which also examined the effect of fuel oil on the economy's demand and supply sides using cointegration and error correction models. However, their study focused on China as a net exporter.

Meanwhile, this study is based on the theory of consumption and import. As cited in Nicholson (2009), the Keynesian consumption function has three properties of Keynes's conjectures: (i) the marginal desire to consume between zero and one ($0 < c < 1$); (ii) the average tendency to consume that would decrease if the income (output) increased; and (iii) the consumption that was determined by current income (output). However, if this theory is applied to the consumption of certain goods, i.e. fuel oil, then the production (output) of fuel oil will determine consumption.

Referring to the theory of demand (consumption), Nicholson (2009) states that the price of a commodity also affects demand (consumption). Thus, based on theories of macroeconomics and microeconomics, price and output affect consumption. Since the commodity is included in international trade, consumption is the function of production (output) and import. This means that consumption is not only determined by production but also by imports. In other words, consumption is affected by the price and import of the commodity.

According to Zhang and Qu (2015), the availability of domestic fuel oil, besides through self-production, is also fulfilled by import. Thus, when domestic production is insufficient, import can be used to meet domestic demand. This is associated with international trade; hence, the exchange rate of a country plays an important role in transactional payments.

Income or domestic output and IDR exchange rate are the determinants of domestic import (Blanchard 2017). The implication of this theory and import function, a reduced form is needed because domestic output is an identity such as consumption in international trade.

Accordingly, consumption of the defined commodity and exchange rate (IDR against USD) affect the import function.

Few studies have focused on Indonesia's unique context, one of the important economies in Southeast Asia and an oil-exporter which has turned into a net importer. The previous study by Elinur et al. (2010) focused solely on the supply-side, especially in predicting the supply and consumption based on the users and type of energy in Indonesia. Similarly, Akhmad and Amir (2018) also examined the supply fuel oil in Indonesia, but overlooked the issue's demand side. To gain a comprehensive understanding of the topic, more studies are needed to extend prior studies by conducting a rigorous and comprehensive analysis by incorporating the relationship between consumption and import of fuel oil in the context of Indonesia. To fill in the gaps of the previous studies, this present study aims at contributing to the literature by examining the effects of fuel oil, by taking into account both demand and supply sides, on the Indonesian economy as a fuel oil importer. In addition, this study also observes the equilibrium between consumption and import in the short and long term.

METHODOLOGY

In order to analyze the equilibrium of fuel consumption and imports, the secondary data sources from 1988 to 2018 were utilized. The data were collected from BP Statistical Review of World Energy, 2019, including fuel oil consumption, fuel oil imports, fuel oil prices, and exchange rate. The description of the variables used in this study is summarized in Table 1.

This study used the Vector Error Correction Model (VECM) to uncover the equilibrium in the short and long term. The econometric VECM model in this study was designed based on the Keynes's consumption theory (Mankiw 2016), which was used as the basic model that can be written mathematically as follows:

$$C = \overline{C} + cY,\ \overline{C} > 0,\ 0 < c < 1 \qquad (1)$$

where C is the fuel oil consumption, Y is the fuel oil production or output, $\overline{C}$ is the constant, and c is the marginal propensity to consume for fuel oil. According to the theory, there are implications for the consumption of fuel oil as a commodity. As such, the consumption model is introduced with the price of fuel oil modified without constant, so that it can be written in the form of an equation as shown below:

$$C_t = c_1 Y_t + c_2 P_t + U_{ct} \qquad (2)$$

where C_t is the fuel consumption in year t, c_1 is the marginal desire to consume fuel oil and c_2 is the price that affects fuel consumption, Y_t is the production of fuel oil in year t and U_{ct} is the error term for the fuel oil consumption model in year t. Indonesia's own fuel production cannot fulfill domestic consumption; therefore, the government imports fuel oil. Accordingly, this study also uses import theory. The fuel oil import model can be written mathematically as follows:

$$M_t = \alpha_1 Y_t + \alpha_2 E_t + U_{mt} \qquad (3)$$

where M_t is the import of fuel oil in year t, and E_t is the real exchange rate of IDR against the USD in year t. Furthermore, the concept of consumption, production, and import in the international economy becomes the identity equation in which,

$$C_t = Y_t + M_t \text{ or } Y_t = C_t - M_t \qquad (4)$$

Thus, the model in equations (2) and (3) above changes when equation (4) is substituted into models (2) and (3). Therefore, the equation (2) model becomes equation (5) as follows:

$$\begin{aligned}
C_t &= c_1(C_t - M_t) + c_2 P_t + U_{ct} \\
C_t &= c_1 C_t - c_1 M_t + c_2 P_t + U_{ct} \\
C_t - c_1 C_t &= -c_1 M_t + c_2 P_t + U_{ct} \\
(1 - c_1) C_t &= -c_1 M_t + c_2 P_t + U_{ct} \text{ or} \\
C_t &= \frac{c_1}{(c_1 - 1)} M_t + \frac{c_2}{(1 - c_1)} P_t + \frac{1}{(1 - c_1)} U_{ct} \text{ or} \\
C_t &= \lambda_1 M_t + \lambda_2 P_t + U_{1t} \\
\text{where } \lambda_1 &= \frac{c_1}{(c_{1-1})},\ \lambda_2 = \frac{c_2}{(1 - c_1)},\ U_{1t} = \frac{1}{(1 - c_1)} U_{ct}
\end{aligned} \qquad (5)$$

The fuel oil consumption model estimated in equation (5) is used as the basic model which will uncover the effect and find out the equilibrium of fuel oil consumption in Indonesia in the long term and short term. Besides, the import model in equation (3)

TABLE 1. Description of variables

Variable	Description
Fuel oil consumption	Consumption of thousand barrels of crude oil every day
Fuel oil import	Import of thousand barrels of crude oil every day
Fuel oil prices	Crude oil price is in USD/barrel
Exchange rate	Local currency unit against USD

changes by substituting equation (4) into equation (6) as follows:

$$\begin{aligned} M_t &= \alpha_1(C_t - M_t) + \alpha_2 E_t + U_{mt} \\ M_t &= \alpha_1 C_t - \alpha_1 M_t + \alpha_2 E_t + U_{mt} \\ M_t + \alpha_1 M_t &= \alpha_1 C_t + \alpha_2 E_t + U_{mt} \\ (1+\alpha_1) M_t &= \alpha_1 C_t + \alpha_2 E_t + U_{mt} \\ M_t &= \frac{\alpha_1}{(1+\alpha_1)} C_t + \frac{\alpha_2}{(1+\alpha_1)} E_t + \frac{1}{(1+\alpha_1)} U_{mt} \quad \text{or} \\ M_t &= \gamma_1 C_t + \gamma_2 E_t + \gamma_3 U_{2t} \end{aligned} \tag{6}$$

where $\gamma_1 = \frac{\alpha_1}{(1+\alpha_1)}$, $\gamma_2 = \frac{\alpha_2}{(1+\alpha_1)}$, $U_{2t} = \frac{1}{(1+\alpha_1)} U_{mt}$

Equation (6) is the import model that estimates the effect of fuel oil consumption and the IDR exchange rate on fuel oil imports in Indonesia and find out the long term and short term balance of fuel oil imports in Indonesia.

After the basic model has been defined for fuel consumption and import, the next step is conducting a VECM test to each basic model. VECM is a method that can estimate the long-term and short-term relationships of time-series data with other time-series data. Long-term relationships are analyzed using cointegration equations on the VECM test results. Meanwhile, the short-term relationship is analyzed using the error correction model test of the dependent variable from the VECM test results (Damodar, 2003).

There are several econometrics procedures for estimating the VECM model. First, the unit root test to see the stationarity was carried out in order to provide a stable model using the Augmented Dickey-Fuller test (ADF-test) and the Philips-Perron test (PP-test). Second, the lag length criteria were defined using LR, FPE, AIC, SC, and HQ criteria. The selected lag is the lag with the most significant level (*) signs. Third, a cointegration test using the Johansen cointegration method was conducted to see the equilibrium of the long-term relationship between the independent and dependent variables. Using equation (5) as the basic model, the model used to find out the equilibrium of the long term relationship was formulated as in equation (7):

$$\log(C_t) = \lambda_0 + \lambda_1 \log(M_{t-1}) + \lambda_2 \log(P_{t-1}) + U_{1t} \tag{7}$$

where, C_t is the fuel oil consumption in year t, λ_0 is the constant, λ_1 is the coefficient of fuel oil import, λ_2 is the coefficient of fuel oil price, M_{t-1} is the fuel oil import in year t_{-1}, P_{t-1} is the fuel oil price in year t_{-1} and U_{1t} is the error term for fuel oil consumption in year t. Furthermore, to see the long-term equilibrium of fuel oil imports in Indonesia, the basic model in equation (6) turned into the long-term equation (8) as follows:

$$\log(M_t) = \gamma_0 + \gamma_1 \log(C_{t-1}) + \gamma_2 \log(E_{t-1}) + U_{2t} \tag{8}$$

where, M_t is the fuel oil import in year t, γ_0 is the constant, γ_1 is the coefficient of fuel oil consumption, λ_2 is the coefficient of the exchange rate, C_{t-1} is the fuel oil consumption in year t_{-1}, E_{t-1} is the exchange rate in year t_{-1} and U_{2t} is the error term for fuel oil import in year t.

Fourth, VECM was carried out to see the short-term relationship between fuel oil consumption and imports in Indonesia. To see the short-term equilibrium of fuel oil consumption in Indonesia, the study used equation (5) as the basic model, which turned into the short-term equation (9) as follows:

$$\begin{aligned} \log(\Delta C_t) = {} & \lambda_0 + \lambda_1 \log(\Delta C_{t-1}) + \lambda 2 \log(\Delta M_{t-1}) + \\ & \lambda_3 \log(\Delta P_{t-1}) + \lambda_4 \, ECT1_{t-1} + \varepsilon_{1t} \end{aligned} \tag{9}$$

Furthermore, to see the short-term equilibrium of fuel oil imports in Indonesia, the study used the equation (6) as the basic model, which turned into the short-term equation (10) as follows:

$$\begin{aligned} \log(\Delta M_t) = {} & \gamma_0 + \gamma_1 \log(\Delta M_{t-1}) + \gamma_2 \log(\Delta C_{t-1}) + \\ & \gamma_3 \log(\Delta E_{t-1}) + \gamma_4 \, ECT2_{t-1} + \varepsilon_{2t} \end{aligned} \tag{10}$$

where, Δ is the first difference, $ECT1_{t-1}$ and $ECT2_{t-1}$ are the error correction terms (ECT), created from the long-term interrelationship. The long-term causality was estimated by the significance of coefficient of lagged ECT by using t-statistics, ε_{1t} and ε_{2t} are error terms assumed to be uncorrelated with each other and were normally distributed with mean of zero.

In this study, Johansen cointegration test was utilized to solve the long-term relationship. It was applied where the variables were Δ, then the stationary variable in the equation would be solved by performing pre-test of the variable in order to determine the order of integration. If a single variable was found instead of Δ, this would conceal itself through a cointegrating vector whose space was covered by the only stationary variable in the model.

The Johansen cointegration test was further developed into the Engle-Granger cointegration test, in which the test used trace statistical analysis and/or test statistics for maximum eigenvalues and critical values at the 5% confidence level. If the trace test and/or the maximum eigenvalue is greater than the critical value when $\alpha = 5\%$ or the p value is smaller than the significance value, then the analyzed model has a cointegration relationship (Enders 2014). Johansen's methodology takes its starting point in the vector autoregression (VAR) of order p given by (Hjalmarsson & Österholm 2007):

$$y_t = \mu + A_1 y_{t-1} + \ldots + A_p y_{t-p} + \varepsilon_t \tag{11}$$

where y_t is the nx1 vector of variables that are integrated of order one – commonly denoted I(1) – and t ε is the nx1 vector of innovations. This VAR can be re-written as in (12):

$$\Delta y_t = \mu + \prod y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-1} + \varepsilon_t \quad (12)$$

where

$$\prod = \sum_{i=1}^{p} A_i - I \text{ and} \Gamma_i = -\sum_{j=i+1}^{p} A_j \quad (13)$$

Johansen proposed two different likelihood ratio tests of the significance of these canonical correlations, thereby reducing the reduced rank of the Π matrix: the trace test and maximum eigenvalue test, as shown in equations (14) and (15).

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln\left(1 - \hat{\lambda}_i\right) \quad (14)$$

$$J_{max} = -T \ln(1-\hat{\lambda}_{r+1}) \quad (15)$$

Here T is the sample size and $\hat{\lambda}_i$ is the i:th largest canonical correlation. The trace test tests the null hypothesis of r cointegrating vectors against n cointegrating vectors' alternative hypothesis. On the other hand, the maximum eigenvalue test tests the null hypothesis of r cointegrating vectors against the alternative hypothesis of r +1 cointegrating vectors.

RESULTS AND DISCUSSION

This section presents the statistical analysis and interpretation of the estimation results based on the methodology section's approach, consisting of the unit root, Johansen Cointegration, and VECM results.

DESCRIPTIVE STATISTICS ANALYSIS

Indonesia experienced the highest growth in fuel oil consumption in 1990 at 14.53 percent, while the lowest condition occurred in 2015, amounting to -8.05 percent. The average growth in fuel consumption during 1988 to 2018 was 4.21 percent, which means that fuel oil consumption has increased by about 4.21 percent annually. Based on the standard deviation of fuel oil consumption, the data deviation distance measured from the average data value is 5.02%. Furthermore, the highest growth in fuel oil imports was in 2004, amounting to 227.78 percent, while the lowest condition occurred in 2003 at -167.47 percent. The average growth in fuel oil imports during 1988 to 2018 was 1.70 percent, which means that fuel oil imports increase by about 1.70 percent annually. Based on the standard deviation of fuel oil imports, the data deviation distance measured from the average data value is 5.02 percent.

Meanwhile, the highest growth in fuel prices was in 2000 at 53.38 percent, while the lowest was in 2015 at -47.12 percent. The average growth in fuel oil prices from 1988 to 2018 was 5.77 percent, which means that fuel oil price has increased by about 5.77 percent every year. Based on the standard deviation of fuel oil prices, the distance to the measured data deviation from the average data value is 6.63 percent.

Finally, the highest exchange rate growth was in 1998 at 376.98 percent, while the lowest condition occurred in 2013 at -32.09 percent. The average exchange rate growth during 1988 to 2018 was 15.45 percent, which means that exchange rate growth has increased by around 15.45 percent every year. Based on the standard deviation of the exchange rate growth, the data deviation distance measured from the average data value is 21.99%.

The amount of production, consumption, and import in thousand barrels of fuel oil every day from 1988 to 2018 can be seen in Figure 1 below.

Figure 1 shows that the average fuel oil imports over the past ten years reached 653 million barrels and the average increase in fuel oil imports was 1.70%. The annual fuel oil imports' observations show that the highest increase in fuel imports occurred in 2010 by 26.68%, whereas the import quantity was 408 million barrels. The same period shows an increase in fuel consumption by 7.14%, while fuel oil production experienced a relatively small increase of 0.88%. Furthermore, the standard deviation amounts to 626 million barrels, which means that the positive dispersion of imported fuel oil is 679 million barrels. This indicates that between 2010 and 2012, fuel oil imports were above positive dispersion, implying an extraordinary increase in fuel oil imports.

The above conditions are in line with the rise in fuel consumption over the past ten years in Indonesia with an average of 1,604 million barrels and an average increase in fuel consumption of 4.21%. Thus, the average percentage of fuel oil consumption increases is higher than the average percentage of imported fuel oil. Meanwhile, the standard deviation is 368 million barrels, which means that the positive dispersion of fuel consumption is 1,972 million barrels. This shows that fuel consumption above the positive dispersion is in line with the import of fuel oil in Indonesia. In addition, this high increase in fuel consumption is in proportion to the increasing number of private vehicles in Indonesia (Akhmad & Amir, 2018). However, when annual conditions were observed in 2015, fuel oil imports decreased by 12.63%. In addition, the fuel oil imports from 2016 to 2018 were above the average import of fuel oil per year. Meanwhile, fuel consumption from 2016 to 2018 was also above the annual average consumption of fuel oil.

The consumption and import of fuel oil are inseparable from changes in the IDR exchange rate

TABLE 1. Descriptive Statistics Analysis

Variable	Mean	Std. Dev.	Max	Min
C	4.21	5.02	14.53	-8.05
M	1.70	7.19	227.78	-167.47
P	5.77	6.63	53.38	-47.12
E	15.45	21.99	376.98	-32.09

Source: Author's calculations.

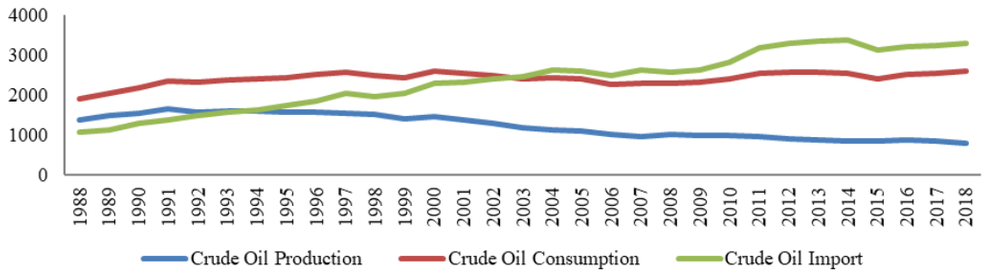

FIGURE 1. The amount of production, consumption, and import of fuel oil in Indonesia (in thousand barrels every day).
Source: BP Statistical Review of World Energy, 2019.

against the USD and the increase of fuel oil price, which can be seen in Figure 2 below.

Figure 2 shows that the highest increase in fuel prices is 35.68% with an average price of 1.15%. Over the past ten years, the highest rise in fuel prices occurred in 2011 due to decreased fuel production and an increase in fuel consumption. This is motivated by the government's policy to raise fuel prices. Besides, the standard deviation is 21.96% which means that the positive dispersion limit for price development is 23.11%. This certainly shows a remarkable increase in fuel prices in 2011. Aimon (2012) argues that the problem stems from the continuous increase in world oil prices and inadequate domestic fuel oil production to meet domestic needs. Meanwhile, the steady increase in the number of private vehicles increases domestic fuel oil demand. This certainly has an impact on fuel consumption in Indonesia.

Meanwhile, the IDR to USD exchange rate experiences an average increase in IDR depreciation against the USD of 0.30%, with a standard deviation of 5.96%. This means that the positive dispersion is 6.26% which clearly shows that the highest IDR appreciation against the USD occurred in 2008 with 16.37%, at which time the IDR exchange rate was IDR 10.409/USD 1. Therefore, the increase in fuel oil imports cannot be separated from the IDR exchange rate against the USD. Furthermore, the rise in fuel oil imports is also inseparable from the development of fuel consumption. Meanwhile, fuel consumption is also corresponding to the development of fuel oil imports.

UNIT-ROOT RESULTS

Based on the univariate explanation regarding the import, consumption, and price of fuel oil and the exchange rate of IDR to the USD above, the estimation results of fuel consumption are influenced by fuel oil imports. Consequently, it is necessary to analyze the relationship of balance in the short and long term using the VECM approach. Based on the methodology section's description, the econometric techniques for estimating the VECM model for the equation of fuel consumption and imports are summarized in Table 3 to Table 7 below.

Table 3 shows that fuel oil consumption, fuel oil imports, fuel oil prices, and exchange rate are stationary at the first difference, with a 1% significance.

Table 4 shows that the optimum lag length used to analyze the fuel oil consumption equation is 1

Table 5 shows that the optimum lag length used to analyze the fuel oil import equation is 1.

JOHANSEN COINTEGRATION TESTS

Table 6 shows that each hypothesis' p value is 0.0021 and 0.0430 smaller than $\alpha = 5\%$ (the max-eigen statistic is greater than the critical value when $\alpha = 5\%$ for each hypothesis). Thus, based on this analysis, it can be concluded that the results of the cointegration test using maximum eigenvalue statistics indicate that two cointegration equations can be formed. Cointegration is a test used to see the stationarity of a non-stationary combination of linear variables constructing the

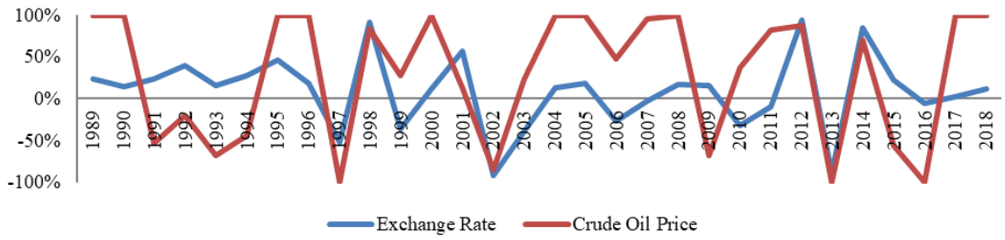

FIGURE 2. The changes in the IDR exchange rate against the USD and the price of fuel oil in Indonesia (in percent).
Sources: Central Bank of Republic Indonesia, 2019 and BP Statistical Review of World Energy, 2019.

TABLE 3. The result of the unit root test

Variable	Augmented Dickey-Fuller Test (ADF)		Phillips-Perron Test (PP)	
	Level	First Difference	Level	First Difference
Fuel oil consumption (C_t)	0.8167	0.0002***	0.7940	0.0000***
Fuel oil import (M_t)	0.8962	0.0007***	0.8880	0.0007***
Fuel oil price (P_t)	0.5170	0.0006***	0.5170	0.0007***
Exchange rate (E_t)	0.6490	0.0000***	0.7574	0.0000***

Indicates significance level *** 1%, ** 5%, * 10%. Source: Author's calculations.

TABLE 4. The results of the lag length criteria for the equation of fuel oil consumption

Lag	LR	FPE	AIC	SC	HQ
0	NA	6.10e+11	35.64989	35.79387	35.69271
1	137.6861*	3.00e+09*	30.33020	30.90613*	30.50146*
2	13.68462	3.04e+09	30.31264*	31.32051	30.61233
3	7.834616	4.02e+09	30.51845	31.95827	30.94658
4	10.00680	4.45e+09	30.47034	32.34211	31.02692

Source: Author's calculations.

TABLE 5. The results of the lag length criteria for the equation of fuel oil import

Lag	LR	FPE	AIC	SC	HQ
0	NA	6.52e+15	44.92702	45.07100	44.96983
1	130.5235*	4.38e+13	39.91875	40.49468*	40.09000*
2	11.25203	5.01e+13	40.02281	41.03069	40.32251
3	13.03640	4.89e+13	39.92263	41.36245	40.35077
4	13.39275	4.25e+13*	39.63267*	41.50444	40.18925

Source: Author's calculations

TABLE 6. The result of the cointegration test for fuel oil imports (maximum eigenvalue test)

Hypothesized	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.195278	32.13854	30.56721	0.0021
At most 1	0.153815	18.18207	15.32785	0.0430
At most 2	0.023561	1.467581	3.490228	0.2691
At most 3	0.015283	1.365437	4.635201	0.3204

Source: Author's calculations.

TABLE 7. The result of the cointegration test for fuel oil imports (trace test)

Hypothesized	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.231452	35.08714	31.24531	0.0035
At most 1	0.185091	30.81925	14.26810	0.0240
At most 2	0.057116	1.671851	4.391072	0.4521
At most 3	0.032010	1.401947	6.391039	0.5301

Source: Author's calculation.

variance structure of the time series model, and aims to determine the long-term stability of these variables (Enders, 2014).

Based on the calculation results in Tables 6 and 7, it can be seen that fuel oil price and fuel oil imports affect fuel oil consumption and will achieve an equilibrium of fuel oil consumption in the long term. Although fuel oil consumption is unbalanced in the short term, but it will eventually balance out in the long term. Thus, fuel oil imports are unavoidable in meeting the demand for domestic fuel oil consumption in the long term. This shows that domestic fuel oil consumption demands have a strong level of dependence on the future. Thus, fuel oil imports can trap the Indonesian economy should there be any problems with the price and import of fuel oil.

Furthermore, fuel oil imports will reach their equilibrium in the long term, despite a short-term imbalance of fuel oil imports caused by fuel oil consumption and exchange rates. However, fuel oil imports will eventually return to their balance in the long term. The Indonesian government must maintain and control the balance of fuel imports in the short and long term. This is to avoid disruption in the accessibility for people, goods, and Indonesia's production process. Ultimately, this could lead to an economic crisis in the real sector and in the distribution of goods and services.

VECM RESULTS

The VECM used in this study is a one-way analysis, which focuses on analyzing the consumption and imports of fuel oil in Indonesia. Meanwhile, other variables such as oil prices and exchange rates act as the control variables

$$\log(C_t) = -6.212498 + 0.274053 \log(M_{t-1}) + 0.134343 \log(P_{t-1}) + U_{1t} \quad (16)$$
$$[10.5163][4.39959]$$

where, the value in [ ] is t-statistics.

Equation (16) summarizes the results of long term estimates for the equation of fuel oil consumption. The fuel imports and fuel oil price in the previous period significantly affect the fuel oil consumption in Indonesia's current period. The fuel oil imports increased by 1 percent in the previous period, while the fuel oil consumption increases by 0.274053 percent in the current period. Likewise, fuel oil prices increased by 1 percent in the previous period, while the fuel oil consumption increases by 0.134343 percent in the current period. This means that the elasticity of fuel oil consumption to the price of fuel oil and imported fuels oil is not elastic.

Meanwhile, the increase in fuel oil prices and imported fuel oil is greater than the increase in fuel oil consumption. This condition is in line with the theory. Thus, if the Indonesian government can reduce fuel oil imports, this will reduce fuel oil consumption, except if domestic fuel oil production increases, which will increase fuel oil consumption. This study's findings are consistent with Bacon and Kojima (2008), who found that the net oil import volume ratio affected domestic oil consumption (import dependence). Thus, fuel oil imports affect the amount of domestic fuel oil consumption.

$$\log(M_t) = 9.894875 - 3.987342 \log(C_{t-1}) + 1.417747 \log(E_{t-1}) + U_{2t} \quad (17)$$
$$[-13.5343][6.09562]$$

where, the value in [ ] is t- statistics.

Equation (17) summarizes the results of long term estimates for the equation of fuel oil import. The fuel oil consumption and exchange rate of the IDR against the USD in the previous period significantly affect the fuel oil imports in Indonesia's current period. Fuel oil consumption increased by 1 percent in the last period, while the fuel oil imports decrease by 3.987342 percent in the current period. This means that fuel oil consumption depends on fuel oil imports. Likewise, the IDR exchange rate against the USD increased by 1 percent in the previous period, while the fuel oil imports increase by 1.417747 percent in the current period. This finding means that despite an increase or decrease in the IDR exchange rate against the USD, fuel oil imports will increase. This condition shows that the level of dependence on fuel oil does not concern the IDR's exchange rate against the USD, as fuel oil imports will continue to increase. Therefore, although different equations estimate it, the results are not much different from fuel oil imports on Indonesia's fuel oil consumption.

$$\log(\Delta C_t) = -0.020538 + 0.132147 \log(\Delta C_{t-1}) + 0.014001 \log(\Delta M_{t-1}) + 0.050013 \log(\Delta P_{t-1})$$
$$[-3.16404][3.32779][3.23558][2.56643] \quad (18)$$

$$-0.467164 ECT1_{t-1} + \varepsilon_{1t}$$
$$[-3.05033]$$

where, the value in [ ] is t- statistics.

Equation (18) summarizes the results of short term estimates for the equation of fuel oil consumption. The ECT1 coefficient is negative, indicating that the VECM model is backward. The imbalance will be corrected to the long term balance based on previous information, i.e., the information accommodated in the ECT1 variable. The ECT1 coefficient is significant for the VECM model of fuel oil consumption. This shows that the adjustment process occurs in the short term and long term that the imbalance in fuel oil consumption will always be corrected towards a long term balance position with a speed of adjustment coefficient of 0.467164 percent per year. In the short term, there is an imbalance between changes in fuel consumption, changes in fuel oil imports, and changes in fuel prices in the previous period to changes in fuel consumption in the current period. Changes in fuel oil consumption, changes in fuel oil imports, and fuel oil prices changes in the previous period significantly affect changes in fuel oil consumption in the current period. This condition also implies that the government needs to be careful in importing fuel oil because it can interfere with the transition into more sustainable fuel consumption. Therefore, this imbalance is caused by the irregularity in the increase in fuel oil imports and will ultimately disrupt the Indonesian economy. Thus, if new problems arise with fuel oil imports, this will disrupt the balance of fuel consumption in the short term and lead to long-term imbalances. Likewise, if there is a change in fuel prices, the government needs to be careful in terms of domestic and international price increases. Therefore, the long-term balance or relationship between the two variables needs to be considered.

$$\log(\Delta M_t) = 0.129109 - 0.0805783 \log(\Delta M_{t-1}) + 0.379728 \log(\Delta C_{t-1}) - 0.219182 \log(\Delta E_{t-1})$$
$$[2.98827][-3.31321][2.28841][-3.64628] \quad (19)$$

$$-0.223369 ECT2_{t-1} + \varepsilon_{2t}$$
$$[-2.90050]$$

where, the value in [ ] is t- statistics.

Equation (19) summarizes the results of short term estimates for the equation of fuel oil imports. The ECT2 coefficient is negative, indicating that the VECM model is backward. The imbalance will be corrected to the long-term balance based on previous information, i.e. the information accommodated in the ECT2 variable. The ECT2 coefficient is significant for the VECM model of fuel oil imports. This shows that the adjustment process occurs in the short term and long term that the imbalance in fuel oil imports will always be corrected towards a long-term balance position with a speed of adjustment coefficient of 0.223369 percent per year. In the short term, there is an imbalance between changes in fuel oil imports, changes in fuel oil consumption and changes in the exchange rate of the IDR against the USD in the previous period to changes in fuel oil imports in the current period. Changes in fuel oil imports, fuel oil consumption changes, and changes in the IDR exchange rates against the USD in the previous period significantly affect changes in fuel oil imports in the current period. Therefore, the Indonesian government must closely regulate the IDR exchange rate policy through a controlled floating exchange rate system. This will prevent a disruption of the fuel oil imports balance in the short term. A disturbed balance of imported fuel oil will affect fuel consumption. Meanwhile, fuel consumption increases from time to time in accordance with domestic fuel needs.

CONCLUSION

Fuel consumption and fuel oil imports are inseparable in the Indonesian economy because fuel consumption cannot be fully met by fuel production. Fuel consumption and imports are mutually influential for meeting the needs of the community. A problem with one aspect will lead to problems in other aspects. Thus, imports can upset the balance of fuel consumption in the short term while the exchange rate can also upset the balance of fuel consumption in the short term.

The concept of consumption and import of fuel oil needs serious attention from economic policymakers in Indonesia because the two concepts disrupt the equilibrium in the short term, although in the long term it will return to the equilibrium. Therefore, the Indonesian government needs to regulate fuel oil so properly that the balance of fuel consumption does not become a problem in the short term. It is also hoped that a proactive policy will be implemented to stabilize the IDR exchange rate to avoid the persistent problem of balancing fuel imports in the long term. The policy that can be taken by the Indonesian government to control oil consumption is the need to maintain the quota of subsidized oil consumption so as not to exceed the planned amount. This step can be done by establishing a collaboration between the Ministry of Energy and Mineral Resources and the state oil company (PT. Pertamina Persero) to control oil consumption. The Indonesian government can also control oil imports by promoting renewable energy such as geothermal energy, unconventional gas such as shale gas, hydropower, and

wind power as substitute products to reduce fuel oil imports.

The limitation of this study is that it only analyzes the period 1988 to 2018. Thus, further research is suggested to extend the study by analyzing data for more than 30 years, especially quarterly data. Besides, further research may extend the study by analyzing fuel oil production variables involving cross-countries perspective. It is hoped that such research will provide more understanding regarding the long-term balance of endogenous variables.

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