DIGITALES ARCHIV

ZBW – Leibniz-Informationszentrum Wirtschaft
ZBW – Leibniz Information Centre for Economics

Hung Tran Van; Onyusheva, Irina; Ušakov, Denis et al.

Article

Impedimental policies impacting shrinking world solar industry eco-economic development

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Hung Tran Van/Onyusheva, Irina et. al. (2018). Impedimental policies impacting shrinking world solar industry eco-economic development. In: International Journal of Energy Economics and Policy 8 (4), S. 21 - 27.

This Version is available at:
http://hdl.handle.net/11159/2133

Kontakt/Contact
ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics
Düsternbrooker Weg 120
24105 Kiel (Germany)
E-Mail: *rights[at]zbw.eu*
https://www.zbw.eu/

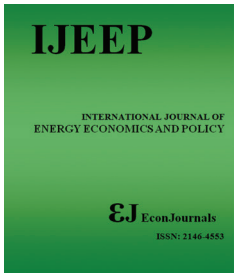
Standard-Nutzungsbedingungen:
Dieses Dokument darf zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden. Sie dürfen dieses Dokument nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, aufführen, vertreiben oder anderweitig nutzen. Sofern für das Dokument eine Open-Content-Lizenz verwendet wurde, so gelten abweichend von diesen Nutzungsbedingungen die in der Lizenz gewährten Nutzungsrechte. Alle auf diesem Vorblatt angegebenen Informationen einschließlich der Rechteinformationen (z.B. Nennung einer Creative Commons Lizenz) wurden automatisch generiert und müssen durch Nutzer:innen vor einer Nachnutzung sorgfältig überprüft werden. Die Lizenzangaben stammen aus Publikationsmetadaten und können Fehler oder Ungenauigkeiten enthalten.

https://savearchive.zbw.eu/termsofuse

Terms of use:
This document may be saved and copied for your personal and scholarly purposes. You are not to copy it for public or commercial purposes, to exhibit the document in public, to perform, distribute or otherwise use the document in public. If the document is made available under a Creative Commons Licence you may exercise further usage rights as specified in the licence. All information provided on this publication cover sheet, including copyright details (e.g. indication of a Creative Commons license), was automatically generated and must be carefully reviewed by users prior to reuse. The license information is derived from publication metadata and may contain errors or inaccuracies.

ZBW Leibniz-Informationszentrum Wirtschaft
Leibniz Information Centre for Economics

Mitglied der Leibniz-Gemeinschaft



International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2018, 8(4), 13-20.

Study of Fuel Oil Supply and Consumption in Indonesia

Akhmad[1]*, Amir[2]

[1]Faculty of Economics and Business, University of Muhammadiyah, Makassar, Indonesia, [2]Faculty of Economics and Business, University of Muhammadiyah, Makassar, Indonesia. *Email: akhmad09@yahoo.co.id

ABSTRACT

The consumption of fuel oil (BBM) in Indonesia for the last 10 years is increasing along with the increase in economic growth and the number of population. The increase in fuel oil consumption is not accompanied with the increase in domestic oil production. The research aimed to find out factors influencing fuel oil supply and consumption and forecasting the supply and consumption in Indonesia in the future. The research used time series data for 1997-2016. The research used econometrics model with simultaneous equation system. The model of simultaneous equation system built was consisted of 11 structural equations and 2 identic equations. The result of analysis indicated that factors influencing the supply of fuel oil were world oil price and the supply of oil in the previous year. In addition, factors influencing the consumption of fuel oil were fuel oil price and fuel oil consumption in the previous year. The result of forecasting indicates that fuel oil consumption in Indonesia up to 2025 is increasing in average of 4.07% for gasoline, 2.99% for kerosene, and 3.19% for diesel per year. In addition, the price of fuel oil in Indonesia was estimated to increase in average of 3.76% for gasoline, 3.87% for kerosene, and 3.19% for diesel, whereas, import of fuel oil increased in average of 4.83% per year.

Keywords: Time Series, Simultaneous Equations, Supply and Consumption of Fuel Oil
JEL Classifications: C32, Q4, Q47

1. INTRODUCTION

The consumption of energy in Indonesia for the last 10 years indicates an increase in average of 7-8% per year along with the increase in population and better economic growth. The condition requires better energy availability to support the economic activities and social dynamics of the society. However, there are various challenges and obstacles to fulfill the need of energy, among others, crude oil production that tends to increase while the acceleration in renewable new energy development that is expected to become the new backbone of national energy is not maximal. The condition causes Indonesia to be vulnerable to global energy market since some of the consumption, especially petroleum products, are fulfilled through import (the Ministry of Energy and Mineral Resources, 2016).

Indonesia as an archipelago state and has a large number of population needs high movement/transportation. Transportation sector service is the most important basic need for the society to support the fulfillment of the basic needs, such as clothing, food, and house. The role of transportation is closely related to the need of energy, 90% of the energy is in form of fuel oil (BBM). National Energy Board (2016) stated that the consumption of fuel oil in transportation sector in Indonesia tends to grow by 8.6% per year, higher than the household consumption of 3.7%, power plants of 4.6% and smaller than the growth in industrial consumption of 9.1%. The reserve of fossil-based fuel oil, which is the non-renewable resource, is very limited of 4.7 billion barrel. The reserve is sufficient for consumption for 15 years if no new oil wells found through exploration and no energy diversification conducted.

Consumption of fuel oil energy for transportation sector is dominated by road transportation, which is 88% of total fuel oil consumption in transportation sector, particularly diesel and gasoline. Along with the increase in the number of motor vehicles, better quality fuel oil is needed both fossil-based and renewable non-fossil based fuel, which is biofuel or environmentally friendly bioenergy. The growth of transportation sector is estimated to be high in the future. The number of vehicles is increasing every year (6-8%), especially motor bike and car as well as the growth of travel, especially travel by private vehicles causing the high rate

of growth in fuel oil demand (the Secretary of National Energy Board, 2016).

With the diminishing reserve of fossil energy and the increase in energy consumption, it threatens the economic development of Indonesia. Therefore, various efforts need to be conducted to encourage the use of efficient energies along with an intensive search of new fossil energy resources and the development of renewable alternative energy resources (Elinur, 2010).

The main cause of inefficiency in energy utilization is cheap energy policy by the government of Indonesia. Tambunan (2006) stated that cheap energy policy through large subsidies has negative impacts. First, the high dependency on crude oil energy resources. Low price is disincentives for energy diversification as well as conservation effort (Elinur, 2012). Second, fuel oil subsidy in APBN (state budget) threatens the fiscal sustainability of the government (Akhmad, 2014). Third, the less optimum of other energy resources utilization, such as natural gas and coal that have larger reserve than crude oil or new and renewable energies (Kuncahyo et al., 2013). Fourth, the rampant of fuel oil smuggling abroad causing higher demand level than the actual need. Fifth, the rampant of mixing fuel oil activity that harm the state and general consumers. Sixth, price signal distorts investment feasibility in the downstream sectors of oil and gas.

Other indicators indicating the waste in energy utilization in Indonesia is energy intensity. Energy intensity is a comparison between the amount of energy consumption to PDB (gross domestic product) per capita. The more efficient a country is, the smaller its intensity. To date, energy subsidies applied by the government causes energy waste since the use is less optimal. It is reflected in the relatively high energy intensity, which is 482 TOE (ton-oil-equivalent) per a million USD. It means, to produce a value added (gross domestic product) of USD 1 million, Indonesia would need energy of 482 TOE. Meanwhile, Malaysia only need 439 TOE/million USD and the average intensity of 100 energy of developed countries joined in the Organization for Economic Co-operation and Development (OECD) is only 164 TOE/million USD. It indicates a large potential of energy savings in Indonesia (Bureau of Statistics, 2015).

Factors influencing fuel oil consumption are: The length of road (Xiao et al., 2007), the number of vehicles (Kenworthy and Laube, 2002; Fwa, 2005), the behavior of road users (Directorate General of Land Transportation, 2008), vehicle speed (Caroline, 2007; Nanang et al., 2008; Rodrigue, 2004; Taylor and Linsay, 2004), and type of machine (Taylor and Linsay, 2004). In addition, fuel oil consumption is also influenced by the number of population, land use, and population density (Kenworthy and Laube, 2002; Verameth et al., 2007). Hassan et al. (2018) found that industrial growth in Sub-Saharan Africa is highly depended on the supply of energy thus policies on energy preservation effort give negative impact on industrial growth.

Fuel oil availability issue for Indonesia is very important to fulfill the need of the society and to improve economic growth. Therefore, government needs to maintain balance between economic growth and the availability of fuel oil as one of requirements to achieve developed and sustainable economic development. Thus, it is interesting to conduct a study to analyze the supply and consumption of fuel oil in Indonesia. Therefore, the research aimed to find out factors influencing the supply and consumption of BBM in Indonesia and forecast the supply and consumption of BBM in Indonesia in the future.

2. DATA AND RESEARCH METHOD

The research used time series data in the period of 1997-2016. Data used consisted of data of fuel oil supply, fuel oil price, fuel oil consumption and government revenue and expenditures. Data was obtained from Bureau of Statistics, the Ministry of Energy and Mineral Resources, the Ministry of Finance, and Central Bank of Indonesia.

The research used econometrics model with simultaneous equation system. The model of simultaneous equation system built consisted of 13 equations where 11 equations were structural equations and 2 equations were identity equations. The model was divided into four blocks, namely: (1) Block of fuel oil supply, (2) block of fuel oil price, (3) block of fuel oil consumption, and (4) block of government revenue and expenditures.

2.1. Block of BBM Supply Equation

2.1.1. Domestic fuel oil production

Domestic fuel oil production was influenced by the world oil price, increase in crude oil input for oil refineries, the capacity of oil refineries, and the domestic fuel oil production in the previous year. The equation of domestic fuel oil production was formulated as follows:

$$BBMDt = a_0+a_1POILW_t+a_2TIMT_t+a_3KKMt+a_4LPBBMD_{t-1}+U_1 \quad (1)$$

The sign of expected estimated parameter: $a_1, a_2, a_3 >0$ and $0<a_4<1$.

2.1.2. Import of fuel oil

Import of fuel oil was influenced by the final consumption of fuel oil, the number of land transportation, the domestic fuel oil production, Rupiah exchange rate, and import of fuel oil in the previous year. The equation of import of fuel oil was formulated as follows:

$$IBBMt = b_0+b_1\ CBBMt+b_2JTDIt+b_3\ PBBMDt+b_4NTRPt +b_5LIBBM_{t-1}+U_2 \quad (2)$$

The sign of expected estimated parameter: $b_1, b_2, >0$; $b_3, b_4<0$ and $0<b_5<1$.

2.1.3. Fuel oil supply

Fuel oil supply is the domestic fuel oil production added with import of fuel oil and subtracted by export of fuel oil. The formula of fuel oil supply as follows:

$$YBBMt = PBBMDt+IBBMt-XBBMt \quad (3)$$

2.2. Block of Fuel Oil Price

2.2.1. The equation of domestic crude oil price

The price of domestic crude oil was influenced by the final consumption of fuel oil, fuel oil supply, government expenditure for fuel oil subsidies, world crude oil price, and domestic crude oil price in the previous year. The equation of domestic crude oil price is formulated as follows:

$$RPBBMTt = c_0+c_1CBBMt+c_2YBBMt+c_3GSBBMt+c_4POILWt+c_5LRPBBMT_{t-1}+U_3 \quad (4)$$

The sign of expected estimated parameter: c_1, $c_4>0$; c_2, $c_3<0$, and $0<c_5<1$.

2.2.2. The equation of gasoline price

The price of gasoline was influenced by gasoline consumption, fuel oil supply, government expenditure for fuel oil subsidies, world crude oil price, and price of gasoline in the previous year. The equation of gasoline price is formulated as follows:

$$RPBENt = d_0+d_1CBENt+d_2YBBMt+d_3GSBBMt+d_4POILWt+d_5LRPBEN_{t-1}+U_4 \quad (5)$$

The sign of expected estimated parameter: d_1, $d_4>0$; d_2, $d_3<0$, and $0<d_5<1$.

2.2.3. The equation of kerosene price

Kerosene price was influenced by kerosene consumption, fuel oil supply, government expenditure for fuel oil subsidies, world crude oil price, and kerosene price in the previous year. The equation of kerosene price is formulated as follows:

$$RPMTt = e_0+e_1CMTt+e_2YBBMt+e_3GSBBMt+e_4POILWt+e_5LRPMT_{t-1}+U_5 \quad (6)$$

The sign of expected estimated parameter: e_1, $e_4>0$; e_2, $e_3<0$, and $0<e_5<1$.

2.2.4. The equation of solar oil price

Solar oil price was influenced by the consumption of solar oil, fuel oilsupply, government expenditure for fuel oil subsidies, world crude oil price, and solar oil price in the previous year. The equation of solar oil price is formulated as follows:

$$RPDSt = f_0+f_1CDSt+f_2YBBMt+f_3GSBBMt+f_4LPOILWt+f_5LRPDS_{t-1}+U_6 \quad (7)$$

The sign of expected estimated parameter: f_1, $f_4>0$; f_2, $f_3<0$, and $0<f_5<1$.

2.3. Block of BBM Consumption Equation

2.3.1. Gasoline consumption

Gasoline consumption was influenced by gasoline price, gross domestic product, fuel oil supply and gasoline consumption in the previous year. The equation of gasoline consumption is formulated as follows:

$$CBENt = g_0+g_1RPBEN_t+g_2PDB_t+g_3YBBM_t+g_4LCBEN_{t-1}+U_7 \quad (8)$$

The sign of expected estimated parameter: $g_1<0$; g_2, $g_3>0$ and $0<g_4<1$.

2.3.2. Kerosene consumption

Kerosene consumption was influenced by kerosene price, gross domestic product, fuel oil supply, and kerosene consumption in the previous year. The equation of kerosene consumption is formulated as follows:

$$CMTt = n_0+h_1RPMT_t+h_2PDB_t+h_3YBBM_t+h_4LCMT_{t-1}+U_8 \quad (9)$$

The sign of expected estimated parameter: $h_1<0$; h_2, $h_3>0$ and $0<h_4<1$.

2.3.3. Solar oil consumption

Solar oil consumption was influenced by solar oil price, gross domestic product, fuel oil supply, and solar oil consumption in the previous year. The equation of solar consumption is formulated as follows:

$$CDSt = i_0+i_1RPDSt+i_2PDBt+i_3YBBM_t+i_4LCDS_{t-1}+U_9 \quad (10)$$

The sign of expected estimated parameter: $i_1<0$; i_2, $i_3>$and $0<i_4<1$.

2.4. Block of Government Revenues and Expenditures

2.4.1. Government revenues

Government revenue was influenced by domestic fuel oil production, import of fuel oil, tax, government revenues in the previous year. The equation of government revenue is formulated as follows:

$$TRGt = j_0+j_1PBBMDt+j_2TIBBM_t+j_3TAXt+j_4LTRG_t+U10 \quad (11)$$

The sign of expected estimated parameter: j_1, j_2, $j_3>0$ dan $0<j_4$ 1.

2.4.2. Government expenditures

The equation of government expenditure was formed in identity equation. The equation of government expenditure was the sum of non-subsidy government expenditure added with government expenditure for fuel oil subsidies and government expenditure of non-subsidy fuel oil, and it is formulated as follows:

$$TGEt = GNSt+GSBBMt+GSNBBMt \quad (12)$$

2.4.3. Expenditure of fuel oil subsidies

Expenditure of fuel oil subsidies was influenced by government revenue, Rupiah exchange rate against the USD in the previous year, final consumption of fuel oil and expenditure of fuel oil subsidies in the previous year. The equation of expenditure of BBM subsidy is formulated as follows:

$$GSBBM_t = k_0+k_1TGE_t+k_2LNTRP_{t-1}+k_3CBBM_t+k_4LGSBBM_{t-1}+U_{11} \quad (13)$$

The sign of expected estimated parameter: k_1, $k_3>0$; $k_2<0$ dan $0<k_4<1$.

2.5. Identification of Model and Model Estimation Method

The model of fuel oil supply and consumption in Indonesia developed in the research was a simultaneous equation model where the behavior of its variable was determined simultaneously. The identification of model was determined based on order condition as a requirement of necessity and rank condition as a requirement of sufficiency. According to Koutsoyiannis (1977), Juanda (2009), the formulation of identification of structural equation model based on order condition is determined by:

$$(K-M)>(G-1) \quad (14)$$

Where:
K: Total variables in the model, which is endogenous and pre-determined variables
M: The number of endogenous and exogenous variables included in one certain equation in a model.
G: Total equation in a model, which is the number of endogenous variables in a model.

Based on the order condition, if:
(K-M)>(G-1): The equation is stated as over identified
(K-M)=(G-1): The equation is stated as exactly identified
(K-M)<(G-1): The equation is stated as unidentified.

The result of identification for each structural equation should be exactly identified or over identified. Therefore, due to the simultaneity the parameter estimators with ordinary least square method were inconsistent and bias thus alternative estimation method was needed (Juanda, 2009).

In this research, model estimation method used was 2SLS (two stage least square) since the method is suitable for over identified simultaneous equation and it could be used in a relatively small number of sample and it is insensitive to model modification (re-specification), both for structural analysis and simulation and forecasting analysis. Data processing was conducted using computer software program of SAS Version 9.1.

2.6. Model Simulation and Forecasting

After model was validated and fulfilled the statistic criteria, the model could be used as a basic model of simulation and forecasting. Some scenarios of simulation to be conducted in the study were: (1) An increase in world oil price by 10%, (2) a decrease in fuel oil subsidy expenditures by 20%, (3) the combination of an increase in world oil price by 10% and a decrease in BBM subsidy expenditure by 20%.

Method used in the forecasting was stepwise auto-regression (STEPAR) method, which is the combination of time trend model and auto-regressive model. Stepwise auto-regression method is a forecasting method that firstly conducts forecasting on exogenous variables using linear trend. After the values of exogenous variables are obtained, forecasting on the development of endogenous variables was conducted using energy consumption and supply model in Indonesia economy that has been built.

3. RESEARCH RESULTS

Model specification used in the research had been modified several times since there were found several estimation results that inconsistent to the theory and several parameter estimations that insignificant. In the end, a model was obtained with result performance of parameter estimation that was representative to describe the phenomenon of fuel oil supply and consumption in Indonesia.

Model estimation using 2SLS (two stage least square) method resulted factors influencing the endogenous variables in the model, where there were 11 structural equations from 4 blocks and it showed good result as a whole.

3.1. Result of Estimation of Fuel Oil Supply Model

The result of model estimation of fuel oil production (Table 1) indicates that: World oil price had negative and significant influence on domestic fuel oil production. It indicates that if world oil price increases the domestic fuel oil production will decrease. In addition, the fuel oil production in the previous year had positive and significant influence on domestic fuel oil production. Variable of the addition of crude oil input for refineries and the capacity of oil refineries had positive but insignificant influence. The value of elasticity of domestic fuel oil production on world oil price was 0.1859. It means that the domestic fuel oil production is irresponsive to world oil price. If world oil price increases by 1% the domestic fuel oil production will decrease by 0.1859%, ceteris paribus.

The result of model estimation on import of fuel oil obtained that fuel oil consumption and import of fuel oil in the previous year had positive and significant influence on import of fuel oil. Meanwhile, domestic fuel oil production and Rupiah exchange rate against USD had negative and significant influence on import of fuel oil. The elasticity of fuel oil consumption to import of fuel oil was 0.2120. It means that the import of fuel oil was irresponsive to fuel oil consumption. If the consumption of fuel oil increases by 1% the import of fuel oil will increase by 0.2120%. The elasticity of fuel oil production and Rupiah exchange rate to import of fuel oil was −0.3413 and −0.3019, respectively. It means that fuel oil production and Rupiah exchange rate were irresponsive to import of fuel oil. If fuel oil production and Rupiah exchange rate in the previous year increases by 1% the import of fuel oil will decrease by 0.3413% and 0.3019%, respectively.

3.2. Result of Estimation of Fuel Oil Price Model

The result of model estimation on domestic crude oil price obtained that: Domestic crude oil price was positively and significantly influenced by fuel oil subsidies, world crude oil price and domestic crude oil price in the previous year, whereas fuel oil consumption and fuel oil supply had positive but insignificant influence. The result of elasticity calculation indicates that all variables were irresponsive to domestic crude oil price.

The result of model estimation on gasoline price obtained that domestic gasoline price was negatively and significantly influenced by supply of fuel oil and positively and significantly influenced by government fuel oil subsidies and gasoline price

in the previous year, whereas world oil price had positive but insignificant influence. Moreover, final consumption of fuel oil had negative but insignificant influence. The result of elasticity calculation indicates that all variables were irresponsive to domestic gasoline price.

The result of model estimation on kerosene price obtained that domestic kerosene price was positively and significantly influenced by kerosene price in the previous year; whereas world oil price and fuel oil subsidies had positive but insignificant influence. In addition, final consumption of kerosene and supply of fuel oil had positive but insignificant influence. The result of elasticity calculation indicates that all variables were irresponsive to domestic kerosene price (Table 2).

The result of model estimation on diesel price obtained that domestic diesel price was positively and significantly influenced by diesel price in the previous year. Whereas, government fuel oil subsidies had negative and significant influence. In addition, world oil price had positive but insignificant influence. Further, final consumption of diesel and supply of fuel oil had negative but insignificant influence. The result of elasticity calculation indicates that all variables were irresponsive to domestic diesel price.

3.3. Result of Estimation of Fuel Oil Consumption Model

Result of model estimation on gasoline consumption obtained that gasoline consumption was positively and significantly influenced by gasoline consumption in the previous year and negatively and significantly influenced by gasoline price. In addition, gross domestic product, supply of fuel oil had positive but insignificant

Table 1: Results of estimation equation of fuel oil supply

1. Equation of domestic fuel production (PBBMD)						
Variables	**Estimates**	**P>(T)**	**Elasticity**	**Variable name**	**F value**	**R^2**
Intercept	271074.5	0.0251	-	Intercept	32.09	0.8004
POILW	−343.5142	0.0345	−0.1859	World oil prices		
TIMT	0.045999	0.4917	0.4143	Increase in crude oil inputs for refineries		
KKM	1.697810	0.3011	0.3730	Refinery capacity		
LPBBMD	0.451925	<0.0001	-	Domestic fuel production the previous year		
2. Equation of import of fuel oil (IBBM)						
Intercept	−50506.71	0.2206	-	Intercept	99.11	0.8770
CBBM	0.320033	0.1120	0.2120	Final consumption of fuel oil		
JTDI	0.24649	0.0304	0.2706	Number of land transportation		
PBBMD	−0.54619	0.0304	−0.3413	Domestic fuel production		
NTRP	−0.012028	0.5815	−0.3019	Rupiah exchange rate against USD		
LIBBM	0.831304	<0.0001	-	Import of fuel oil the previous year		

Table 2: Estimation results of fuel oil price

1. The equation of domestic crude oil price (RPBBMT)						
Variables	**Estimates**	**P>(T)**	**Elasticity**	**Variable name**	**F value**	**R^2**
Intercept	63894.889	0.6038	-	Intercept	832.09	0.9604
CBBM	−0.075999	0.7917	−0.1143	Fuel oil consumption		
YBBM	−0.697810	0.4211	−0.1430	Supply of fuel oil		
GSBBM	−0.547832	0.0211	−0.3142	Government expenditure on fuel subsidies		
POILW	0.604110	0.0111	0.4941	World oil prices		
LRPBBMT	0.151925	0.0232	-	The price of domestic crude oil the previous year		
2. Gasoline price equations (RPBEN)						
Intercept	−12506.19	0.4406	-	Intercept	68.45	0.7964
CBEN	−0.432033	0.6220	−0.1120	Consumption of gasoline		
YBBM	−0.134649	0.0304	−0.3206	Supply of fuel oil		
GSBBM	−0.326649	0.0211	−0.3201	Government expenditure on fuel subsidies		
POILW	0.432028	0.9815	0.1309	World oil prices		
LRPBEN	0.831304	<0.0001	-	Gasoline consumption the previous year		
3. The equalization of kerosene price (RPMT)						
Intercept	950619.7	0.2206	-	Intercept	55.43	0.7775
CMT	−0.241033	0.7321	−0.0132	Kerosene consumption		
YBBM	−0.186641	0.4404	−0.2706	Supply of fuel oil		
GSBBM	−0.124321	0.2132	−0.1231	Government expenditure on fuel subsidies		
POILW	0.000028	0.3215	0.2214	World oil prices		
LRPMT	0.442301	<.0001	-	Kerosene price of previous year		
4. Solar oil price equation (RPDS)						
Intercept	66506.99	0.2206	-	Intercept	31.54	0.6978
CDS	−0.773044	0.7120	−0.0220	Consumption of diesel oil		
YBBM	−0.996649	0.1704	−0.1806	Supply of fuel oil		
GSBBM	−0.543650	0.0121	−0.3214	Government expenditure on fuel subsidies		
POILW	0.000028	0.2015	0.0019	World oil prices		
LRPDS	0.831304	<0.0001	-	Diesel oil prices the previous year		

influence. The result of elasticity calculation indicates that all variables were irresponsive to domestic gasoline consumption (Table 3).

The result of model estimation on kerosene consumption obtained that kerosene consumption was positively and significantly influenced by kerosene consumption in the previous year, whereas, gross domestic product, supply of fuel oil had positive but insignificant influence. In addition, kerosene price had negative but insignificant influence. The result of elasticity calculation indicates that all variables were irresponsive to domestic kerosene consumption.

The result of model estimation on diesel consumption obtained that diesel consumption was positively and significantly influenced by diesel consumption in the previous year and significantly and negatively influenced by diesel price. In addition, gross domestic product and supply of fuel oil had positive but insignificant influence. The result of elasticity calculation indicates that all variables were irresponsive to domestic diesel consumption.

3.4. Result of Estimation of Government Revenue and Expenditure Model

The result of model estimation on government revenue parameters obtained that government revenue was positively and significantly influenced by total tax and government revenue in the previous year. Whereas, fuel oil production and total import of fuel oil had positive but insignificant influence on government revenue. The result of elasticity calculation indicates that all variables were irresponsive to government revenue (Table 4).

The result of model estimation on government fuel oil subsidies obtained that government fuel oil subsidies was positively and significantly influenced by government expenditures on fuel subsidies in the previous year. Whereas, total government expenditures, Rupiah exchange rate in the previous year and fuel oil consumption had positive but insignificant influence on government fuel subsidies. The result of elasticity calculation indicates that all variables were irresponsive to government fuel subsidies.

3.5. Policy Simulation

Policies applied by the government as well as the changes in external factors occurred could bring positive and negative impacts

Table 3: Estimation results of oil fuel consumption

1. Gasoline consumption equation (CBEN)						
Variables	**Estimates**	**P>(T)**	**Elasticity**	**Variable name**	**F value**	**R^2**
Intercept	−65434.86	0.0238	-	Intercept	111.09	0.8324
RPBEN	−0.324388	0.0017	0.1414	The price of gasoline		
PDB	0.986710	0.2211	0.1733	Gross domestic product		
YBBM	0.321340	0.3214	0.2132	Supply of fuel oil		
LCBEN	0.851925	<0.0001	-	Gasoline consumption the previous year		
2. Kerosene consumption equation (CMT)						
Intercept	28894.88	0.0908	-	Intercept	13.09	0.5904
RPMT	0.332421	0.7917	0.0143	The price of kerosene		
PDB	0.123010	0.4021	0.1420	Gross domestic product		
YBBM	0.231431	0.2132	0.3212	Supply of fuel oil		
LCMT	0.851925	<0.0001	-	Kerosene consumption the previous year		
3. Solar oil consumption equation (CDS)						
Intercept	804321,82	0.1038	-	Intercept	79.09	0.8804
RPDS	0.321229	0.0417	0.0143	Price of diesel oil		
PDB	0.543211	0.3211	0.1730	Gross domestic product		
YBBM	0.321321	0.2101	0.2311	Supply of fuel oil		
LCDS	0.851925	<0.0001	-	Diesel fuel consumption the previous year		

Table 4: Result of estimated government revenue and expenditure

1. Government revenue equation (TRG)						
Variables	**Estimates**	**P>(T)**	**Elasticity**	**Variable name**	**f value**	**R^2**
Intercept	8544.88	0.4532	-	Intercept	17.09	0.6604
PBBMD	0.321432	0.3917	0.2143	Domestic fuel production		
TIBBM	0.327810	0.3221	0.1730	Total imports of fuel oil		
TAX	2.043221	0.0213	0.0221	Tax		
LTRG	0.432543	<0.0001	-	Government revenue the previous year		
2. Spending equation fuel subsidies alone government (GSBBM)						
Intercept	72194.93	0.1038	-	Intercept	244.54	0.8704
TGE	0.231210	0.7917	0.0143	Total government expenditures		
LNTRPt−1	0.321431	0.1611	0.1921	Rupiah exchange rate against USD previous year		
CBBM	0.123212	0.1205	0.1120	Oil fuel consumption		
LGSBBM	0.851925	<0.0001	-	Government expenditure on fuel subsidy the previous year		

on every endogenous variables included in a simultaneous equation system. Therefore, simulation conducted in the research consisted of: (1) A decrease in the fuel oil subsidies by 20%; (2) an increase in world oil price by 10%; and (3) the combination of a decrease in fuel oil subsidies by 20% and an increase in world oil price by 10%. The result of simulation is displayed in Table 5.

The result of the first simulation indicates that if the government decreases the fuel subsidies by 20%, the price of gasoline, kerosene and diesel would increase above 2%, in average, whereas the consumption of gasoline, kerosene, and diesel decreases by 0.02%, in average. Further, the result of the second simulation indicates that if the world oil price increases by 10%, the price of gasoline, kerosene and diesel increases by 0.5%, in average, whereas, domestic fuel oil consumption only decreases by 0.02%. Further, the result of the third simulation, which was the combination of a decrease in fuel oil subsidies by 20% and an increase in world oil price by 10%, causes the price of gasoline, diesel, and kerosene increases by 2.5%, in average, whereas consumption of gasoline, diesel, and kerosene decreases by 0.03%.

3.6. Forecasting Fuel Oil Consumption and Supply in Indonesia for Period of 2018-2025

Forecasting fuel oil consumption, supply and price in Indonesia economy needed to be conducted to obtain an illustration about the future condition thus it can be used in economic-energy planning and development in Indonesia. Forecasting was conducted from 2018 to 2025. The limit of forecasting in 2025 was referred to the Blue Print of Energy Development in Indonesia that has been set up to 2025.

The result of forecasting indicates that fuel oil consumption in Indonesia up to 2025 will increase by 3.91%, 2.99%, and 3.81% per year, for gasoline, kerosene, and diesel, respectively. Moreover, the price of fuel oil in Indonesia was estimated to increase by 2.45%, 1.58%, and 2.09% per year for gasoline, kerosene and diesel, respectively. Whereas, import of fuel oil increases by 5.49%, in average (Table 6).

4. CONCLUSION AND POLICY IMPLICATIONS

The result of model estimation obtained that factors influencing the supply of fuel oil were world oil price and fuel oil supply in the previous year. Factors influencing the price of fuel oil were fuel oil consumption and world oil price. Whereas, factors influencing fuel oil consumption were fuel oil price and fuel oil consumption in the previous year.

The result of simulation indicates that if the government increases the fuel oil subsidies by 20%, the price of gasoline, kerosene

Table 5: The result of simulation

Variables	Basic value	Change (%)		
		Simulation 1	Simulation 2	Simulation 3
Domestic fuel production	3085605,4	0,001	0,005	0,005
Import of fuel oil	1262374,2	−0,003	−0.095	0,096
Supply of fuel oil	3245981,15	−0,016	−0,005	−0,018
Domestic crude oil price	239580,6	0,303	0,589	0,696
Gasoline price	60762,21	2,068	0,561	2,403
Kerosene price	14354,21	2,301	0,504	2,505
Price of diesel oil	27424,23	2,409	0,604	2,724
Gasoline consumption	4311867,55	−0,021	−0,018	−0,034
Consumption of kerosene	562027,8	−0,026	−0,014	−0,034
Consumption of diesel oil	249839,35	−0,021	−0,025	−0,039
Government revenue	9636651,3	−0,228	−0,103	−0,313
Government expenditures	7809321,73	−0,204	1,102	−1,202
Expenditure subsidies on fuel oil	1169541,21	−20,00	0,127	−20,00

Table 6: Results of forecasting pricing and consumption of Indonesian fuel

Variables name	Unit	2018	2025	Growth (%)
Domestic fuel production	Thousand barrels	266.237,87	273.235,73	0,38
Import of fuel oil	Thousand barrels	225.735,58	322.546,03	5,49
Supply of fuel oil	Thousand barrels	491.973,45	595.781,76	3,01
Domestic crude oil Price	Rupiah./barrels	266.719,40	336.732,32	3,75
Gasoline price	Rupiah/barrels	989.278,75	1.159.278,90	2,45
Kerosene price	Rupiah./barrels	859.260,90	954.460,75	1,58
Price of solar oil	Rp./barrels	957.260,40	1.097.268,55	2,09
Gasoline consumption	Thousand barrels	401.867,55	511.888,50	3,91
Consumption of kerosene	Thousand barrels	62.027,80	75.027,80	2,99
Consumption of solar oil	Thousand barrels	149.839,35	189.839,75	3,81
Government revenue	Billion rupiah	956.366,30	1.004.566,50	0,72
Government expenditures	Billion rupiah	977.366,20	1.017.367,40	0,58
Expenditure subsidies on fuel oil	Billion rupiah	369.541,21	377.540,35	0,31

and diesel increases above 2%, whereas the consumption of gasoline, kerosene and diesel decreases about 0.02%, in average. Further, the result of simulation indicates that if the price of world oil price increases by 10%, the price of gasoline, kerosene and diesel increases by 0.5%, in average, whereas the domestic fuel oil consumption decreases by 0.02%. The result of the third simulation, which was the combination of a decrease in fuel oil subsidies by 20% and an increase in world oil price by 10%, caused the price of gasoline, diesel, and kerosene increases by 2.5%, in average, whereas consumption of gasoline, diesel, and kerosene decreases by 0.03%.

The result of forecasting indicates that fuel oil consumption in Indonesia up to 2025 increases by 4.07%, 2.99%, and 3.19% per year, for gasoline, kerosene, and diesel, respectively. Moreover, the price of fuel oil in Indonesia was estimated to increase by 3.76%, 3.87%, and 3.19% per year for gasoline, kerosene and diesel, respectively. Whereas, import of fuel oil will increase by 4.83%, in average.

As time goes by, fuel oil consumption experiences an increase due to the increase in the number of population and vehicles as well as the need of fuel oil in other sectors. On the supply side, the reserve of fossil energy, especially oil is decreasing thus the government need to increase investment in production and processing aspects as well as conversion in the use of fuel oil-based energy by industrial sectors to other types of energy. In addition, government needs to try to shift the use of non-renewable resource energy to renewable resource energy, such as the utilization of energy from water and wind, biofuel (biomass, biodiesel, biogas, and so on), and other sustainable energy resources.

REFERENCES

Akhmad. (2014), The impact of compensation for fuel price increase against poverty in Indonesia. Academica Journal of Political Science and Social Sciences Faculty of Social, Tadulako University, 6, 21-30.

Caroline, S. (2007), Advanced traffic control system impacts on environmental quality in a large city in a developing country. Journal of The Eastern Asia for Tranportation Studies, 7, 255-267.

Central Bureau of Statistics. (2015), Indonesia Energy Statistics. Jakarta: Central Bureau of Statistics.

Directorate General of Land Transportation Ministry of Transportation. (2008), General Planning of Massar Transportation Development in Java Island. Jakarta: Directorate General of Land Transportation Ministry of Transportation.

Elinur, D.S., Priyarsono, M., Tambunan M., Firdaus, M. (2010), Development of energy consumption and supply in Indonesian economy. Indonesian Journal of Agricultural Economics, 2(1), 237-250.

Elinur. (2012), Analysis of Consumption and Supply of Energy in Indonesian Economy. Doctoral dissertation. Graduate School, Bogor Agricultural University.

Fwa, T.F. (2005), Sustainable Urban Transportation Planning and Development Issue and Chalenges for Singapore. Department of Civil Engineering of Singapore.

Hassan, S., Ismail, A.D., Muhammad, R.D. (2018), Energy consumption and manufacturing performance in sub-Saharan Africa: Does income group matter? International Journal of Energy Economics and Policy, 8(1), 1-4.

Juanda, B. (2009), Econometrics Modeling and Assumptions. Bogor (ID): PT Penerbit IPB Press.

Kenworthy, J., Laube, F. (2002), Urban transport patterns in a global sample of cities and their lingkages to transport infrastucture, land-use, Economics and Environment, 8, 5-19.

Koutsoyiannis, A. (1977), Theory of Econometrics: An Introductory Exposition of Econometric Methods. 2nd ed. London: The MacMillan Press Ltd.

Kuncahyo, P., Fathallah, A.Z., Semin, S. (2013), Analysis of potential prediction of biodiesel raw materials as diesel fuel gas supplement in Indonesia. Journal of Engineering Pomits, 2(1), 1-10.

Ministry of Energy and Mineral Resources. (2006), Handbook of Energy and Economic Statistic of Indonesia. Jakarta: Center for Data and Information on Energy and Mineral Resources. Ministry Energy and Mineral Resources.

Nanang, P.M., Jacub, C., Driejana, R., Tamin, Z. (2008), Background for Optimization of Feul Consumtion at Congested Network Using Hydrodynamic Traffic Theory. Proceeding PSTPT International Simposium.

National Energy Council. (2016), Indonesia Energy Outlook 2016. Jakarta: Secretary General of the National Energy Council.

Rodrigue, J.P. (2004), Transportation and the Environment. USA: Department of Economics and Geography Hafstra University.

Secretariat of National Energy Council. (2016), Outlook Energy Indonesia 2016. Jakarta: Secretariat of National Energy Council.

Tambunan, M. (2006), The Second High Cycle of World Oil (Energy) Price Crisis: Challenges and Option. Washington, USA: Global Dialogue on Natural Resources.

Taylor, B., Linsay, B. (2004), Public Attitudes to Transport Issue. Finding from The British Social Attitudes Surveys.

Verameth, V., Miyamoto, K., Rujopakam, V. (2007), An empirical study of land use/transport interaction in Bangkok with operation model application. Journal of The Eastern Asia Society for Transportation Studies, 7, 1250-1265.

Xiao, L., Daimon, H., Marimoto, A., Koike, H. (2017), A study and traffic behavior on high income people in Asia developing countries. Journal of the Eastern Asia Society for Transportation Studies, 7, 1222-1235.