

FACTORS AFFECTING DEMAND OF BIODIESEL IN INDONESIA

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(Received: October 6, 2022; Accepted: October 24, 2024)

ABSTRACT

Unfortunately, the increase in demand for fossil fuel-based energy is not accompanied by the amount of production. One solution to meet energy needs is to diversify energy using biodiesel. Biodiesel is a biofuel substitute for diesel which is considered more environmentally friendly, for example biodiesel made from palm oil has been identified as an important component in achieving the renewable energy mix target set by the government. The government issued a 2025 energy mix target law to accelerate the development of the biodiesel industry. This research conducted on February until August 2022 sought to analyze the factors that influence biodiesel demand in Indonesia using linear regression analysis to determine the relationship between variables. The data used was quarterly data taken from an average of three months a year starting from 2019-2021. The research results showed that the factors that influenced biodiesel demand are gross domestic product, exchange rates, biodiesel prices, and mandatory biodiesel programs. All variables used in this research have a positive influence on biodiesel consumption.

Key words: demand, GDP, price, exchange rate, mandatory

INTRODUCTION

With the limited production of petroleum resources, it is necessary to diversify energy by using new and renewable energy (Handaya et al. 2022; Waramit 2012). The development of biofuel as renewable energy is currently based on Presidential Regulation Number 5 of 2006 concerning National Energy Policy, where one of the targets of this regulation is that by 2025 the use of biofuel will be 5% of the primary energy mix. To achieve this target, Minister of Energy and Mineral Resources Regulation Number 32 of 2008 concerning the Provision, Utilization and Trading Procedures of Vegetable Fuels (Biofuel) as Other Fuels was stipulated. The biofuels referred to in this ministerial regulation are biodiesel, bioethanol and pure vegetable oil. This ministerial regulation was subsequently revised three times until finally the Minister of Energy and Mineral Resources Regulation Number 12 of 2015 was issued which took effect on April 1 2015. As an implementation of this ministerial regulation, the government implemented a mandatory biodiesel program or the obligation to mix biodiesel with diesel fuel. In this program, the percentage of biodiesel utilization in several sectors increases gradually as stated in the ministerial regulation (Table 1).

Mandatory biodiesel is a policy that requires the substitution of biofuels for fossil fuels, provided that oil levels have been determined. Mandatory biodiesel has also succeeded in reducing GHG emissions by 24.6 million tons of CO₂ in 2021. In 2023, mandatory application of biodiesel will

reach B35 with a mixture of biodiesel and fossil fuels of 35%. The implementation of the mandatory biodiesel policy not only has a positive impact on the environment by reducing greenhouse gas emissions, but also provides economic benefits by saving the country's foreign exchange. This reflects the Indonesian government's commitment to reducing dependence on fossil fuels and encouraging the use of renewable fuels. This policy will continue to increase gradually, accompanied by quality improvements and quality standard tests (Wijaya et al. 2017).

Table 1. Biodiesel use based on ESDM Regulation No. 12/2015 (%).

Sectors	April 2015 (%)	January 2016 (%)	January 2020 (%)	January 2025 (%)
Micro Enterprise, Agriculture	15	20	30	30
Transportation	15	20	30	30
Electricity Generation	25	30	30	30
Commercial	15	20	30	30

Source: Coordinating Ministry for Economic Affairs of the Republic of Indonesia, 2018

There are several challenges faced in the process of developing palm oil biodiesel energy in Indonesia, including market uncertainty (Obado et al. 2009; Purwanto et al. 2016; Widyastuti and Nugroho 2020). Environmental issues related to the negative impacts caused by oil palm plantations have caused a significant decline in biodiesel exports to European and American countries. Meanwhile, the domestic market for biodiesel energy is still very limited to PT Pertamina in the transportation sector and has not been fully applied to the industrial and power generation sectors (Nuva et al. 2019). The issue of biodiesel pricing policy is also a factor that causes biodiesel to have difficulty competing with the price of diesel oil, because the price of diesel is still much lower than biodiesel. Obstacles in expanding the reach of the biodiesel market are the limited availability of biodiesel infrastructure and the distribution of locations of biodiesel producers, the majority of which are on the islands of Java and Sumatra (Sadewo 2012).

Previous research on factors influencing demand concluded that demand for biodiesel in Indonesia shows an increase (Miranti 2013) where this increase in demand for biodiesel can be achieved more optimally by paying more attention to the price of palm oil (Mirawati et al. 2023). Meanwhile Wijastuti et al. 2020 and Sadewo 2012 show that the factors that significantly influence the supply of biodiesel in Indonesia are the price of fuel oil and the price of biodiesel. Research on European Union palm oil policy and challenges for Indonesia's economic diplomacy shows that vegetable oil from EU countries causes widespread deforestation but produces a small production volume, in contrast to Indonesian palm oil which uses less land but produces a larger production volume (Suwarno 2019). The mechanism for implementation of biodiesel use in Indonesia was also studied (Wirawan et al. 2024). Based on the description above, this research sought to analyze the factors that influence biodiesel demand in Indonesia. The novelty of this study is that not much research has been done on biodiesel demand using GDP as variable, while the limitation of this article is that the data used is only for three years.

MATERIALS AND METHODS

The research design used in this research is a descriptive quantitative approach using secondary data in the form of monthly time series data for the 2019-2021 period where the data consists of gross domestic product (GDP) data from the Central Statistics Agency, the exchange rate in rupiah

from the Ministry of Trade of the Republic of Indonesia, biodiesel consumption, biodiesel prices and the Mandatory Biodiesel Program from the Ministry of Energy and Mineral Resources of the Republic of Indonesia as well as other data sources including journals, books and other relevant agency publications.

The data used in the research is secondary data. This research required the following data, including: gross domestic product (GDP), the rupiah exchange rate against the United States dollar, biodiesel consumption, biodiesel prices, and the mandatory biodiesel program. All data required is monthly time series data for the 2019-2021 period obtained by literature study from books, journals, research reports, mass media, statutory regulations, as well as official publications from related agencies. The data was then analyzed using multiple linear regression Ordinary Least Square (OLS).

Based on demand theory, factors that may have an influence on the quantity demanded of an item are the price of the item itself (Sukirno 2013). Apart from that, the exchange rate or currency exchange rate and the ongoing mandatory biodiesel program also have an influence in determining the amount of biodiesel demand. The following is the regression model:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon.$$

namely:

- Y = Demand of biodiesel
- X₁ = Gross Domestic Product (Billion Idr)
- X₂ = Exchange rate (Idr)
- X₃ = Biodiesel price (Idr/liter)
- X₄ = Mandatory program
- α = Constant
- β₁-β₄ = Regression Coefficients X₁ – X₄
- ε = Error term

In carrying out multiple linear regression analysis, there are several classic assumption tests that must be carried out so that the research results are valid with the data used which is theoretically unbiased, consistent, and the regression coefficient estimates are efficient. Among these are: normality test, multicollinearity test, autocorrelation test, and heteroscedasticity test. The regression model was also tested for feasibility by looking at the coefficient of determination (R²). Hypothesis testing is carried out in two ways, namely simultaneous parameter testing (F-test) and partial parameter testing (T-test).

RESULTS AND DISCUSSION

Overview of biodiesel in Indonesia. Figure 1 shows the required biodiesel program is being carried out through the collection and use of palm oil plantation funds in Indonesia. The rule offers a chance to use the money collected from export taxes on palm oil products to support the development of biodiesel. Indonesia's biodiesel output climbed from 3.66 million kiloliters (B-20) in 2016 to 6.17 million kiloliters (B-20) in 2018 because to the biodiesel incentive. Following the introduction of the required B-30, the amount of biodiesel produced also increased, rising from 8.59 million kiloliters in 2020 to 8.98 million kiloliters in 2021 and 11.81 million kiloliters in 2022. The government plans to allocate 13.15 million kiloliters of biodiesel in 2023 after the mandatory B-35 policy goes into effect in early February. The implementation of Presidential Regulation No. 61/2015 on the Collection and Use of Palm Oil Plantation Funds and Government Regulation No. 24/2015 on plantation fund collection has served as a guiding principle for Indonesia's ongoing mandated biodiesel program. The rule offers a chance to use the money collected from export taxes on palm oil products to support the development of biodiesel. Indonesia's biodiesel output climbed from 3.66 million kiloliters (B-20) in 2016 to 6.17 million kiloliters (B-20) in 2018 because to the biodiesel incentive. Following the

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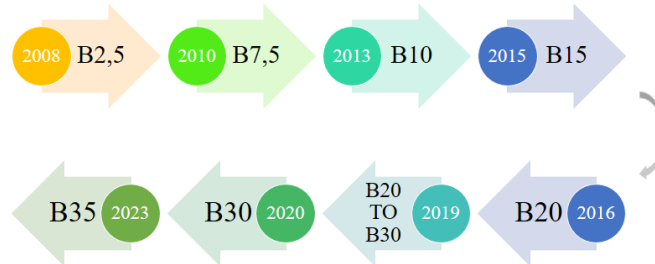


Figure 1. Milestone Program Mandatory Biodiesel
Source: PASPI (2024)

Domestic biodiesel consumption has increased from 119 thousand kiloliters in 2009 to 10.42 million kiloliters in 2022. The proportion of domestic biodiesel consumption to production has also shown an increase. For example, in 2009, around 63 percent of biodiesel production was used for domestic consumption. This proportion continues to increase until it reached 98 percent of biodiesel production used for domestic consumption in 2020. However, domestic biodiesel consumption was also only around 20 percent of its production in 2011. Meanwhile, biodiesel production shows that the Indonesian biodiesel industry still has great potential to produce biodiesel to meet domestic needs and reduce dependence on imports (Fig. 2).

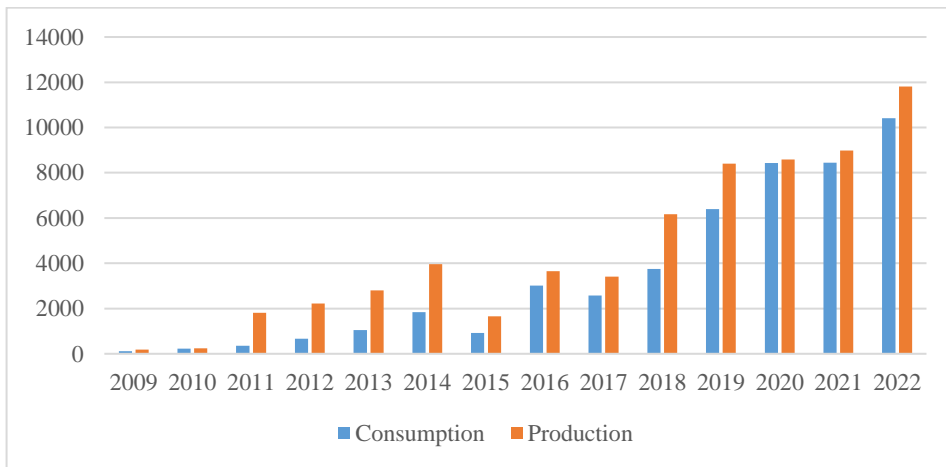


Figure 2. Consumption and production of biodiesel
Source: PASPI (2024)

Classic assumption test

A. Normality test is a test used to determine distribution of the residual values. The results of the normality test using the Shapiro-Wilk test showed that the variables X1, X2, X3, X4, X5 have a

significance value of 0.255. The residual value is normally distributed as the significance value is greater than 0.05.

B. Multicollinearity test was carried out to determine whether there was a correlation between the independent variables. The results of the multicollinearity test using the Variance Inflation Factor (VIF) test show that the variables X1, X2, X3, X4, X5 have a VIF value of 5.65. There is no multicollinearity or correlation between independent variables as the VIF value is less than 10.

C. Autocorrelation test. This was carried out to determine the relationship between the residuals in period t and the previous period. The results of the autocorrelation test using the Durbin-Watson test show that the variables X1, X2, X3, X4, X5 have a value of 1.607. The values from the results of this test are compared with the Durbin-Watson table using a k value of 5 and n of 36. Based on the Durbin-Watson table for the values k=5 and n=36, the lower limit (dL) is 0.987 and the upper limit (dU) is 1.587. The value 1.607 is between $dU \leq d \leq 4 - dU$ or $1.587 \leq 1.607 \leq 4 - 0.987 = 2.413$ so it can be concluded that there is no relationship between the residuals in period t and the previous period.

D. Heteroscedasticity test is carried out to determine whether there is a similarity in variance from the residuals of one observation to another. The variance distribution of the residuals is spread randomly and does not form a particular pattern (Fig. 3). Thus, this model is free from indications of heteroscedasticity.

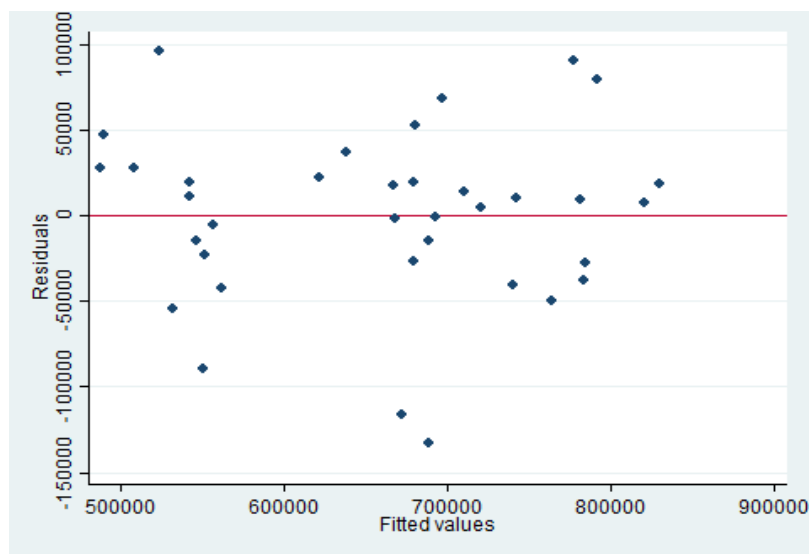


Figure 3. Residual variance distribution graph

E. Hypothesis testing can be done in two ways, namely simultaneous and partial hypothesis testing. Simultaneous test results (F-Test) showed the calculated F value is 24.44 and the F table for $\alpha = 0.05$ is 2.53. The calculated F value is greater than the table F value, so it can be concluded that the variables gross domestic product (X1), exchange rate (X2), diesel price (X3), biodiesel price (X4), and government policy (X5) simultaneously influence biodiesel consumption.

F. Test the feasibility of the model. The feasibility of a regression model can be based on the value of the coefficient of determination (R²). The coefficient of determination of the model in this study is 0.8029 or 80.29%, which means that the GDP, exchange rate, diesel price, biodiesel price and policy

dummy variables can explain variations in biodiesel consumption of 80.29% while 19.71 The remaining % is explained by other variables not used in this analysis.

G. Partial test results (T-test). The purpose of carrying out the T-test is to determine the level of significance of the independent variables, whether the regression coefficient in the model is statistically significant or vice versa. This test is seen from the probability value of the t-statistic. The calculation results show that the GDP variable has a significant value of 0.078 or <0.10, so it can be concluded that the GDP variable has an effect on biodiesel consumption at a real level of 10%. The exchange rate variable has a significant value of 0.046 or <0.05, so it can be concluded that the exchange rate variable influences biodiesel consumption at a real level of 5%. The policy variable has a significant value of 0.002 or <0.01, so it can be concluded that policy has an effect on biodiesel consumption at a real level of 1%. The variables diesel price and biodiesel price do not have a significant effect at the real level of 1% or 5% and 10%. (Table 2).

Regression linear analysis. Table 2 shows the results of linear regression. All the variables gave a positive effect of biodiesel demand, below is the model regression:

$$Y = - 1193735 + 0.9998 X_1 + 47.854 X_2 + 19.386 X_3 + 123568 X_4 + \varepsilon$$

Table 2. Regression analysis results

Variable	Coefficient	Std. Err.	T	P > T
Constant	- 1193735	580969,2	-2,05	0,064**
GDP	0,9997935	0,519737	1,92	0,064**
Exchange rate	47,8535	23,79553	2,01	0,053**
Biodiesel price	19,38648	9,788835	1,98	0,057**
Mandatory program	123568,4	580969,2	3,57	0,001***

Source: Secondary Data, 2022 Note: significant 1%, ***; significant 10% **

1. Gross Domestic Product (X1)

GDP has a significant impact on biodiesel consumption at a 10% level. The coefficient value of the GDP variable is 0.9998 and is positive, which means if GDP increases by one billion-rupiah, biodiesel consumption will increase by 0.9998 kiloliters, ceteris paribus, or other conditions are assumed to remain constant. According to the research hypothesis, GDP has a positive influence on biodiesel consumption. The results of this study are consistent with an earlier study where GDP significantly affects Indonesia's biodiesel consumption at a 1% significance level with a positive coefficient (Miranti 2013). Furthermore, the per capita GDP of the Philippines, Indonesia, Malaysia, Thailand, and Japan, according to statistical calculations, had a significant positive influence on biodiesel consumption in those countries (Mahanani et al. 2020).

According to the demand theory, income affects the quantity demanded (Mankiw 2011). The increase in national income affects the rise in national biodiesel consumption. The economic growth of a country can also be seen based on the national income of that country (Sukirno 2013; Yamali and Putri 2020). Economic development is assumed to be directly proportional to the level of energy use (Mahanani et al 2020). Meanwhile, there will be an increase in energy consumption of 1.05% if the per capita GDP of a country in the Southeast Asian region increases by 1% (Rezki 2011). It is known that

the increase in energy consumption will have a positive impact on economic growth in the short term (Melati et al. 2023). In the long term, the increase in Indonesia's energy consumption affects the decline in economic growth, as Indonesia is an importer of crude oil and tends to rely on this energy source, so the government has to spend more on oil imports as well as subsidies. Based on the research findings, the government continues to promote the use of biodiesel as one of the efforts to diversify energy in order to minimize the negative impact on Indonesia's economic growth, resulting in an increase in biodiesel consumption.

2. Exchange Rate (X2)

Exchange rate is one of variables in an open economy system (Dzakiyah et al. 2018). The significance value of the exchange rate variable is 0.053, meaning the exchange rate has a significant effect on biodiesel consumption at the 10% level. The coefficient value of the exchange rate variable is 47.854 and is positive, which means that if the exchange rate increases by one unit, biodiesel consumption will increase by 47.854 kiloliters, *ceteris paribus*, or other conditions are considered constant and positively affect biodiesel consumption. A 10% increase in crude oil prices results in a 0.28% depreciation of the US dollar exchange rate (Fratzscher et al. 2014). This percentage decrease in the exchange rate is not proportional to the increase in crude oil prices paid, which, when calculated in rupiah, would be higher overall.

In addition, earlier research also showed that the exchange rate has a significant and positive impact on Indonesia's biodiesel consumption (Miranti 2013). This research explained that if the exchange rate of the rupiah against the US dollar increases, the foreign exchange spent on importing solar fuel also increases. Based on this, to reduce the cost of importing diesel fuel, the government is striving to increase the use of biodiesel biofuels. The foreign exchange savings resulting from the implementation of the mandatory biodiesel program even reached 937.84 million US dollars within a four-month period in 2018 (Silalahi et al. 2020). The blending of pure biodiesel and diesel fuel adds complexity to the distribution of biodiesel compared to the distribution of petroleum fuel. Generally, the price of biodiesel is always above the mean of Platts Singapore Oil Price (Sadewo 2012), but the government provides incentives in the form of payments for the price difference between biodiesel and diesel.

3. Biodiesel Price (X3)

The biodiesel price has a significant effect on biodiesel consumption at a 10% significance level. The coefficient of the biodiesel price variable is 19.386 and is positive, showing that if the biodiesel price increases by one unit, biodiesel consumption will increase by 19.386 kiloliters, assuming other conditions remain constant. Relaxation in the mandatory biodiesel program is conducted in accordance with the Minister of Energy and Mineral Resources Regulation No. 24 of 2021, which stipulates certain provisions exempted from the blending obligation, one of which is for personal use and not for sale. The factors causing the still minimal use of biodiesel from non-mandatory sectors are that the use of biodiesel fuel can cause deposits in machine filters, the gap in awareness of biodiesel products between the people of Sumatra and outside Sumatra, and the existing obstacles in the distribution pattern of biodiesel (Oktarina et al. 2019). Similar findings also indicated that there are issues in the biodiesel supply chain where a mixture of pure biodiesel and diesel fuel is required, adding complexity to the distribution of biodiesel compared to the distribution of petroleum fuel (Silalahi et al. 2020). Generally, the price of biodiesel is always above the mean of Platts Singapore Fuel Oil price (Sadewo 2012), but the government provides incentives in the form of payments for the price difference between biodiesel and diesel.

4. Mandatory Biodiesel Program (X4)

The policy has a significant impact on biodiesel consumption at a 1% significance level. The program dummy variable is used to differentiate between the B20 and B30 programs. The coefficient

value of the program dummy variable is 123568 and is positive, which means that the increase from the B20 program to the B30 program raises biodiesel consumption by 123568 kiloliters, assuming *ceteris paribus*. With the increasing percentage of pure biodiesel blend from 20% in the B20 program to 30% in the B30 program, the demand for pure biodiesel to be mixed with diesel fuel has increased. The rise in the program from B20 to B30 also drives an overall increase in biodiesel consumption. There was an increase in biodiesel production and a decrease in biodiesel exports after the implementation of the B20 program compared to before the B20 program (Pangaribowo et al. 2021). Therefore, the B20 program encourages an increase in mandatory biodiesel consumption in the domestic sector, which leads to an increase in production in the upstream sector. With a small significance value, it can be said that biodiesel consumption is greatly influenced by the mandatory biodiesel program, so to increase biodiesel consumption and meet the primary energy mix target, the government can increase the obligation to use biodiesel in the fuel oil mixture. The coefficient of determination value of the regression model in this study is 0.7867, meaning that the variables GDP, exchange rate, biodiesel price, and program mandatory can be explained by 78.67%, while the remaining 21.33% is explained by other variables not included in this research model.

CONCLUSION

GDP, currency rates, biodiesel costs, and mandated biodiesel programs are the elements that impact demand for biodiesel and have a positive impact on biodiesel usage. GDP has a beneficial effect on the use of biodiesel because it increases economic activity, which in turn increases demand for energy as a production input. Increases in exchange rates have a favorable effect on the use of biodiesel as a fossil fuel substitute since they have an impact on the government's budget for importing crude oil. Consumption of biodiesel will benefit from the strategy since the expansion of the B20 program to B30 will change the quantity of biodiesel combined with fossil fuels. The relationship between biodiesel and diesel cannot be considered a substitute because the price of biodiesel has a positive impact on its consumption. This is because biodiesel is required to be used and because the government offers subsidies that make the cost of biodiesel the same as that of diesel. The fact that the mandated program has been loosened for private interests further suggests that the energy requirements of required biodiesel users are the source of the current demand for biodiesel. Promotions about the advantages of using biodiesel are one way to promote awareness among individual users and ensure that the demand for biodiesel comes from sources other than the required sector.

ACKNOWLEDGEMENT

The authors thank the Universitas Padjadjaran for the financial support.

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