

Research article

# The Link between Crude Palm Oil and Crude Oil Price in Various Periods of the Biodiesel Mandatory Policy in Indonesia

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**Abstract:** The biodiesel policy brought changes in the analysis of crude palm oil (CPO) prices. Supply and demand are no longer the main factors, but the correlation between CPO and crude oil prices. The main objective of this study is to provide an empirical study of the relationship between CPO and Indonesian Crude oil Price (ICP) in various periods of mandatory biodiesel policy in Indonesia. Using the Ordinary Least Square (OLS) method of time series data from 2001-2021, this study shows that in general CPO and ICP are positively and significantly correlated, but the price link is very dependent on the biodiesel policy that is implemented. ICP and CPO are positively and significantly correlated in the biodiesel mandatory period with limited subsidies (2006-2015) and in the biodiesel mandatory period with incentives which combined with progressive CPO export levies tariff (2020-2021). ICP and CPO are not correlated during the mandatory biodiesel period, combined with incentives and a fixed CPO export levy tariff (2016-2019). When CPO and ICP prices are strongly and significantly correlated, stock increases are not associated with a decrease in CPO prices. However, when the CPO and ICP prices are not significantly correlated, the stock increase is followed by a decrease in the CPO price. CPO price stabilization only occurs during the biodiesel mandatory period, combined with incentives and a fixed CPO export levy tariff.

**Keywords:** Biodiesel, palm oil, CPO, crude oil, mandatory policy

**JEL Classification:** C32, H25, O13, Q28, Q48.

**Abstrak:** Kebijakan biodiesel membawa perubahan dalam analisis harga minyak sawit mentah (CPO). Penawaran dan permintaan bukan lagi menjadi faktor utama, melainkan korelasi CPO dan minyak mentah. Penelitian ini bertujuan untuk melihat keterkaitan harga CPO dan minyak mentah Indonesia (ICP) pada berbagai periode kebijakan mandatori biodiesel di Indonesia. Dengan menggunakan metode analisis *Ordinary Least Square* (OLS) data deret waktu dari 2001 sampai dengan 2021, penelitian ini menunjukkan secara umum CPO dan ICP berkorelasi positif dan signifikan, tetapi secara khusus hubungannya sangat bergantung pada kebijakan biodiesel yang dijalankan. ICP dan CPO berkorelasi positif dan signifikan pada periode mandatori biodiesel subsidi terbatas (2006-2015) dan mandatori biodiesel insentif selisih harga yang dikombinasikan dengan tarif pungutan ekspor progresif (2020-2021). ICP dan CPO tidak berkorelasi pada saat mandatori insentif selisih harga dikombinasikan dengan tarif pungutan ekspor tetap (2016-2019). Pada saat harga CPO dan ICP berkorelasi kuat dan signifikan, kenaikan stok CPO tidak diasosiasikan dengan penurunan harga CPO. Namun, saat harga CPO dan ICP tidak berkorelasi, kenaikan stok CPO diikuti penurunan harga CPO. Stabilisasi harga CPO hanya terjadi pada periode mandatori biodiesel insentif selisih harga yang dikombinasikan dengan tarif pungutan ekspor tetap.

**Kata Kunci:** Biodiesel, minyak sawit, CPO, minyak mentah, kebijakan mandatori

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## **1. INTRODUCTION**

In March 2015, CPO prices fell 31 percent year on year. According to Irawan et al. (2021); Johari et al. (2015); and Lestari & Oktavilia (2020) stated that the decline in CPO prices was due to excess supply and declining demand. However, Dutta et al. (2021) and Priyati & Tyers (2016) argued that CPO price fluctuations were caused by crude oil prices. At the same time, the biodiesel industry, as one of the downstream products of CPO, was on the verge of bankruptcy. The decline in crude oil prices and the imposition of Anti-Dumping Import Duty by the European Union on Indonesian biodiesel (Zuhdi et al., 2021) caused biodiesel exports to stop. The decline in demand for biodiesel reduced the utility of the biodiesel industry below 30 percent in 2015. Biodiesel production was only 1.65 million kilo liters from the total installed capacity of 7.5 million kilo liters.

To enhance CPO prices and maintain industrial downstream, the Government of Indonesia used a mandatory biodiesel policy. The policy has been initiated in 2006 and then the minimum requirement for blending was set in October 2008. However, throughout the mandatory period, the realization of blending biodiesel with diesel never reached the required target (Mayasari et al., 2019). According to Zuhdi et al. (2021) the uncompetitive price of biodiesel with diesel and limited subsidies are the causes of the low realization of biodiesel use in Indonesia. Different from the demand for food which is influenced by population and income, the demand for biodiesel is strongly influenced by policy (Naylor & Higgins, 2017). To achieve the objectives, the Government of Indonesia made several policy changes, including (1) the selling price of biodiesel no longer refers to the price of diesel fuel, but the price of CPO as biodiesel raw material; (2) the difference between the selling price of biodiesel and diesel is covered through biodiesel incentives; and (3) the source of financing for biodiesel incentives comes from CPO export levies which are managed by a Palm Oil Fund Board (BPDPKS) so that they do not use the budget state mechanism.

The changes in biodiesel policy created debate among stakeholders. The imposition of export levies will be transmitted to oil palm plantations through lower CPO prices. However, on the other hand, the creation of new demand through mandatory biodiesel will increase the CPO price. The Government of Indonesia stated that the policy will increase energy security and achieve the energy mix target by 2025. From a macroeconomic perspective, domestic use of biodiesel will reduce the trade balance deficit by increasing CPO export prices and decreasing diesel import volume (Murti, 2017). Although according to research by Halimatussadiyah et al. (2021), the impact of the mandatory biodiesel policy on the trade balance deficit is ambiguous because it depends on the price of CPO and crude oil. As the largest CPO exporter in the world, but also as an importer of crude oil, analysis of CPO and crude oil prices is very important for Indonesia. Empirical study by Prabheesh & Laila (2020) concludes that changes in CPO prices have a greater effect on Indonesia's Gross Domestic Product (GDP) than changes in crude oil prices. Furthermore, the same research shows that falling crude oil prices have a greater impact on Indonesia's GDP than increases in crude oil prices. Changes in CPO prices also affect the real exchange rate (Aprina, 2014). Study by Sukiyono et al. (2017) reported that plasma smallholders are vulnerable to fluctuations in CPO prices due to the obligation to pay debts for the development of their plantations. Therefore, this study aims to see the relationship between CPO and ICP prices in various periods of biodiesel policy in Indonesia.

Theoretical studies show biodiesel policy is the main determinant of biodiesel prices. The price of biodiesel, which depends on biodiesel policy, makes biodiesel policy the main factor that affects the supply and demand forces in the biodiesel market. Demand for biodiesel can occur only through mandatory policies (Drabik et al., 2014). However, Cadillo-Benalcazar et al. (2021) show that biodiesel producers will only produce biodiesel as long as there is a profit. Research by De Gorter et al. (2015) argued that biodiesel creates a new era in which crude oil prices affect vegetable oil prices and the strength of the relationship is determined by biodiesel policy through biodiesel prices. Biodiesel policies that force biodiesel prices to compete with diesel prices create a link between vegetable oil prices and crude oil, but biodiesel policies that do not pay attention to price levels break the linkage.

Surveying the literature to understand biodiesel policy is not an easy task. There have been many studies discussing biofuel policies (including biodiesel) and their relationship to biodiesel feedstock prices. One of the most important findings from previous research is the changing relationship between agricultural commodity prices and energy through biodiesel prices. (Paris, 2018) found a strong and positive relationship between vegetable oil prices and crude oil prices. However, biodiesel production which is only 1 percent of crude oil production has no effect on crude oil prices (Naylor & Higgins, 2017). Meanwhile, Peersman et al. (2021) stated that fluctuations in agricultural commodity prices did not relate to biofuel policy, but to global business cycles. The varying results require more empirical research.

Prior to the development of the biodiesel industry, analysis of CPO prices generally used the theory of supply and demand (Arintoko, 2021). Study by Arkeman et al. (2015) stated that the effect of biodiesel demand on CPO prices is very small, less than 5%. Similarly (Kochaphum et al., 2013) found that there is no effect of biodiesel development in Thailand on CPO prices. The expansion of biodiesel has increased the interest of researchers. (Arshad et al., 2012) concluded that crude palm oil price both in the short and long terms, is causally related to changes in the crude oil price and palm oil stock. Meanwhile (Sanders et al., 2014; Singagerda et al., 2018) assume that the price of CPO is not related to the price of crude oil. In general, previous studies have not included the mandatory biodiesel policy as an analysis variable. If there is no change in the mandate, then we cannot identify the effect of the mandatory biodiesel policy on the relationship between CPO and ICP prices. Only when the mandatory biodiesel policy is combined with the levy tariff policy, variations in the linkages between CPO and ICP prices can be identified. The main objective of this study is to provide an empirical study of the relationship between CPO and Indonesian Crude oil Price (ICP) in various periods of mandatory biodiesel policy in Indonesia.

## **2. RESEARCH METHODS**

### *2.1. Data collection*

This study uses secondary data obtained from various sources. Observation of CPO and ICP price data collected 252 which is monthly data from January 2021 to December 2021. The CPO price data used is FOB Dumai sourced from Oil World (also known as ISTA Mielke), a private party that provides high-accuracy data that is a reference for industry players (Gerasimchuk & Koh, 2013). The FOB Dumai price was chosen because it is the reference for CPO prices in Indonesia. The integrated CPO market shows the application of the Law of One Price, the same product is sold at the same price in various markets and is only distinguished by transportation costs (Kustiari, 2017). The monthly ICP data in this study is sourced from the Ministry of Energy and Mineral Resources whose units are converted to USD/ton. The CPO stock data used is sourced from Malaysia Palm Oil Board (MPOB) due to the unavailability of stock data from official agencies in Indonesia.

### *2.2. Research Model*

This research used an econometric model with the simple linear regression method (Ordinary Least Squared/OLS). Econometric modelling is intended to estimate the relationship between two variables. The relationship between two variables can be analyzed using the correlation method, but the relationship cannot be directly interpreted as a causal relationship (Schwerdt & Woessmann, 2020). The causal relationship can be analyzed, among others, by econometric models by testing hypotheses based on an economic theory with facts that occur.

The OLS method is often used to analyze the linear relationship between two variables built in the model. In this study, the price of CPO is thought to be influenced by the price of crude oil and stock so the regression is carried out on time series data. The current approach to time series regression requires the data to be stationary before making model estimations. However, if the residuals meet the classical assumptions, the model is still valid (Juanda, 2018). In this study, CPO FOB Dumai will be used as the dependent variable. The independent variables used in this study are Indonesian Crude oil Prices (ICP).

$$Pcpi = \alpha_0 + \alpha_1 Picpi + \varepsilon_i \tag{1}$$

To see the correlation between CPO and ICP prices in various periods of mandatory biodiesel policy, a dummy variable which is interacted with the ICP variable is added so that the equation model becomes:

$$Pcpi = \alpha_0 + \alpha_1 Picpi + \alpha_2 dummy_{policy_i} + \alpha_3 dummy_{policy_i} \times Picpi + \varepsilon_i \tag{2}$$

The mandatory biodiesel policy dummy variable has 4 categories according to the biodiesel policy that applies. In order to avoid the omitted variable bias, a control variable in the form of CPO stock is added so that the equation model becomes:

$$Pcpi = \alpha_0 + \alpha_1 Picpi + \alpha_2 dummy_{policy_i} + \alpha_3 dummy_{policy_i} \times Picpi + \alpha_4 Stock_i + \varepsilon_i \tag{3}$$

where,  $Pcpi$  is the price of CPO FOB Dumai in the  $i$ -month (USD/ton),  $Picpi$  is the ICP month- $i$  (USD/ton), and stock  $i$  is the CPO stock in the month  $i$  (million ton). While dummy policy consist of D1 = 1 when the mandatory limited subsidized biodiesel policy period is implemented and is 0 for others, D2 = 1 during the mandatory biodiesel policy period with incentives for price difference combined with the CPO export levy rate, the value is 0 for others, and D3 = 1 during the mandatory biodiesel policy period, the price difference incentives are combined with the progressive CPO export levy rate and is 0 for the others, and is an error.

### 3. RESULTS AND DISCUSSION

#### 3.1. Descriptive statistic and correlation

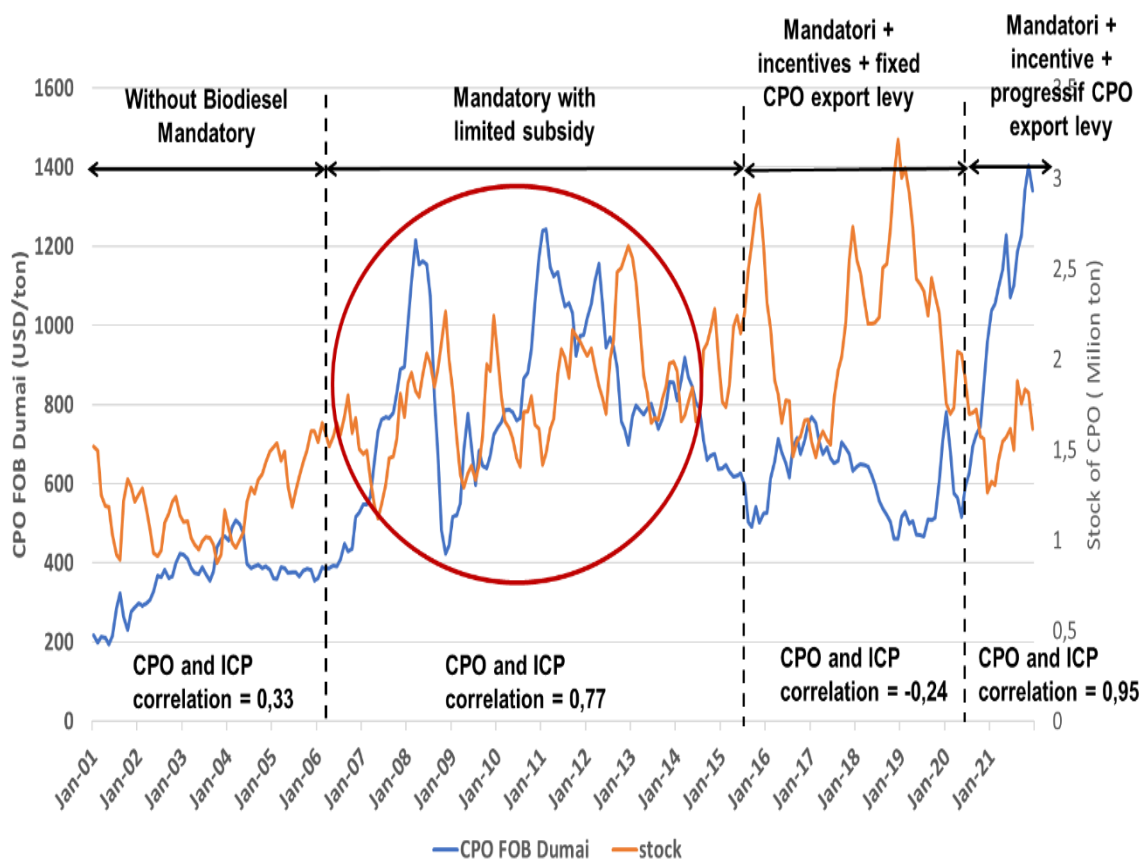
The CPO Price and ICP in the last twenty years has been fluctuated. The CPO price variable has a maximum value of 1.403 USD/ton and a minimum 194,13 USD/ton, which is quite different. The fluctuation can also be seen from the relatively large standard deviation value. The ICP use to be lower compared to CPO Price. Although both fluctuated, ICP tends to be lower than CPO prices. ICP variable has a maximum value 992,35 USD/ton and a minimum 130 USD/ton. While CPO stock relatively stable, variable has a maximum value of 3,21 million ton and has a minimum value 0,87 million ton. In summary, the descriptive analysis of the variables used in this study can be seen in Table 1.

**Table 1.** Descriptive statistics of main variables, 2001-2021

Variables	Obs.	Mean	Min	Max	Std. Dev
CPO Price	252	659,01	194,13	1.403,00	263,03
ICP	252	472,26	130,00	992,35	213,53
Stock	252	1,73	0,87	3,21	0,48

Source: Author's calculation

The mandatory biodiesel policy in Indonesia has brought changes to the CPO price analysis. Prior to the mandatory biodiesel policy, CPO prices could be analyzed by looking at stock movements as a function of supply and demand. When the stock increases, the price of CPO will decrease and vice versa. Through Figure 1 it can be identified when the influence of ICP on CPO prices begins to occur. In 2006 when the mandatory limited subsidy (MST) policy was implemented, the increase in stock was not associated with a decrease in the CPO price. In that period, CPO and ICP were strongly correlated (0.77) as shown in Figure 1.



**Figure 1.** Correlation of CPO FOB Dumai and ICP with CPO stock movements

Source: Author’s calculation

The increase in CPO stock, which was followed by a decrease in the price of CPO occurred again during the biodiesel mandatory period which combined incentives and a fixed CPO export levy tariff. During this period, the correlation between CPO and ICP became very weak (-0.24). When the biodiesel mandatory combined with incentives and progressive CPO export levy tariff is implemented in 2020, the correlation between CPO and ICP is stronger than previous period (0.95). This is because the CPO export levy tariff scheme is based on the need for biodiesel incentives. It reconnected CPO and ICP prices again.

### 3.2. Empirical Analysis

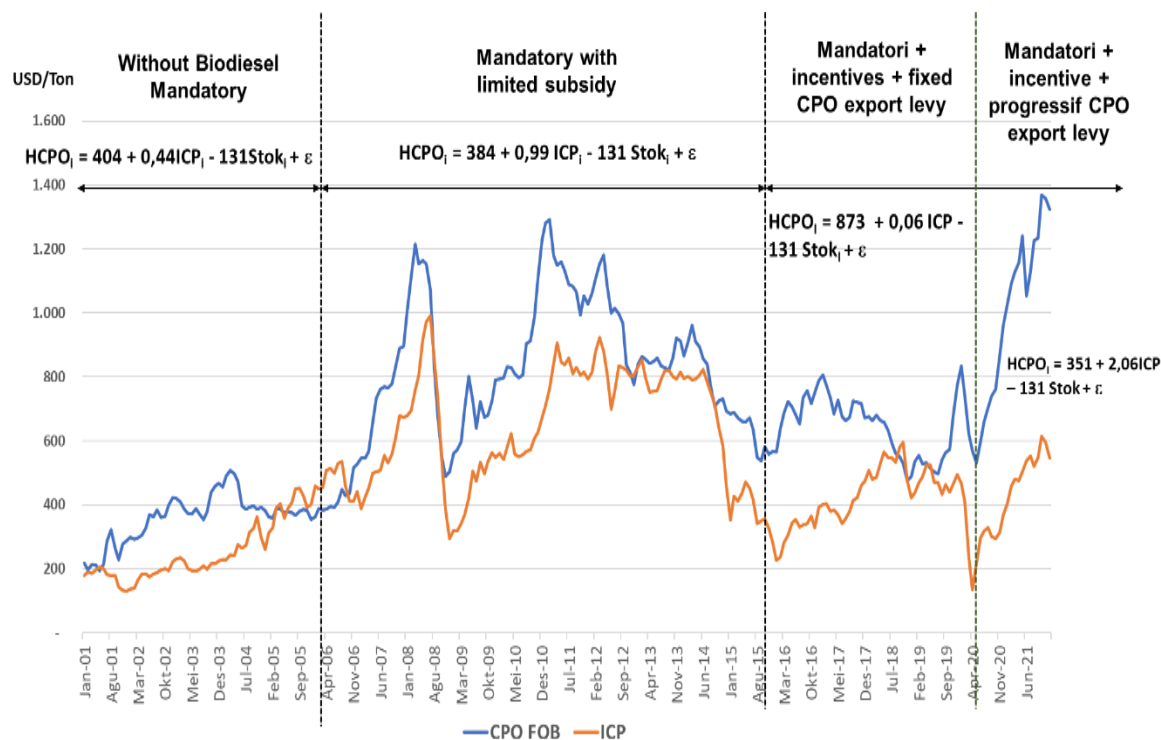
In line with the correlation analysis, the regression results using models (1), (2) and (3) also show that ICP has a positive and significant effect on all mandatory periods. The CPO and ICP price link are shown in Table 2. Based on the results of the regression conducted on 252 observational data on CPO prices and ICP from January 2001 to December 2021 without including the policy dummy variable, ICP is positively and significantly related to the CPO price with a coefficient value of 0.90. After the model was added to the policy dummy variable and the interaction of the policy dummy variable with ICP, the relationship between ICP and CPO prices FOB Dumai remains consistently positive and significant, with the ICP coefficient value decreasing to 0.27. After the control variable in the form of CPO stock is added to the model, the relationship between ICP and CPO prices FOB Dumai remains consistently positive and significant with the ICP coefficient value of 0.44.

**Table 2.** The result of model estimation

Dependent Variable: Pcpo (Price of CPO FOB Dumai)				
Variable	Descriptions	Model (1)	Model (2)	Model (3)
ICP	Indonesian Crude Oil Price	0,90*** (0,039)	0,27*** (0,069)	0,44*** (0,068)
D1	Dummy variabel 1 Mandatory with limited subsidy = 1, Others = 0		-111,72*** (43,234)	-19,72 (45,808)
D2	Dummy variabel 2 Mandatory + incentive + fixed levy = 1, Others = 0		413,51*** (54,855)	469,61*** (35,141)
D3	Dummy variabel 3 Mandatory with incentive+progressive levy = 1, Others = 0		-163,43*** (62,243)	-53,35 (59,670)
D1 x ICP	Dummy interaction		0,67*** (0,089)	0,55*** (0,086)
D2 x ICP	Dummy interaction		-0,51*** (0,139)	-0,39*** (0,097)
D3 x ICP	Dummy interaction		1,82*** (0,149)	1,61*** (0,149)
Stock	Stock of CPO			-131,13*** (19,868)
Constant	Intercept	232,40*** (20,259)	290,64*** (23,417)	435,71*** (25,24)
Summary				
Obs.		252	252	252
Adj. R <sup>2</sup>		0,537	0,824	0,873

Note: \*, \*\* and \*\*\* represent significance at 1%, 5% and 10% levels respectively

Source: Author's calculations



**Figure 2.** OLS result of CPO prices and ICP at various periods of the biodiesel mandatory policy

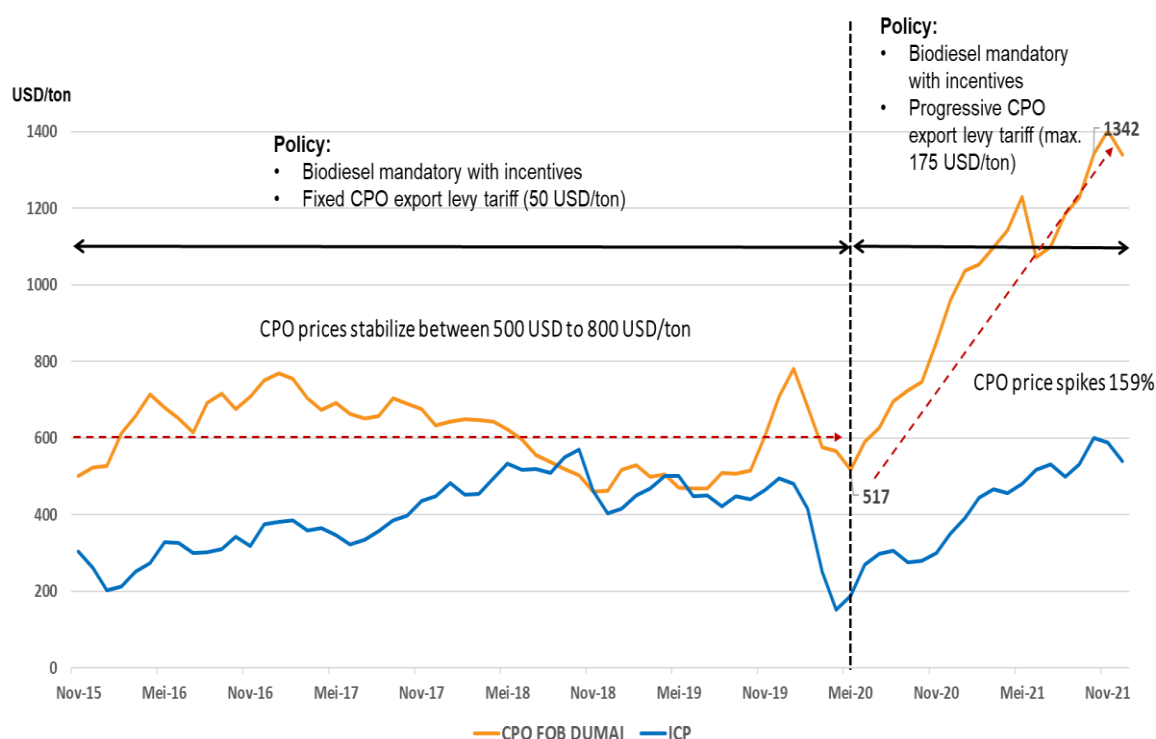
Source: Author's calculation



Figure 2 shows the result of OLS on CPO prices and ICP at Various Periods of the Biodiesel Mandatory Policy, 2001-2021. Based on Figure 2, the relationship between ICP and CPO is varied in each mandatory biodiesel policy in Indonesia. In the mandatory period of limited subsidized biodiesel, ICP is positively and significantly correlated. Assuming other variables are constant, for every increase in ICP by 1 USD/ton, CPO price increases by 1 USD/ton. In the biodiesel mandatory period with an incentive that combined of fixed CPO export levy tariff, ICP and CPO prices were not correlated is show a very low coefficient value (0.06). Meanwhile, in the biodiesel mandatory period with incentives that are combined with progressive CPO export levy tariff, ICP has a positive and significant correlation. For every 1 USD/ton increase in ICP, CPO price increases by 2 USD/ton, assuming other variables are constant.

### 3.3. Discussions

During the mandatory fixed CPO export levy tariff, the volume of biodiesel that can be given incentives is flexible following the availability of export levy funds. When the price difference between biodiesel and diesel is low, the amount of biodiesel that is given incentives is large. As a result, the stock of CPOs decreases and the CPO price rises. When the price of CPO rises, the difference between biodiesel and diesel fuel becomes high, so the volume of biodiesel that is given incentives is reduced. Then CPO stocks rise again making the CPO price falls again. In this scheme, CPO price stabilization was achieved as shown in Figure 3.

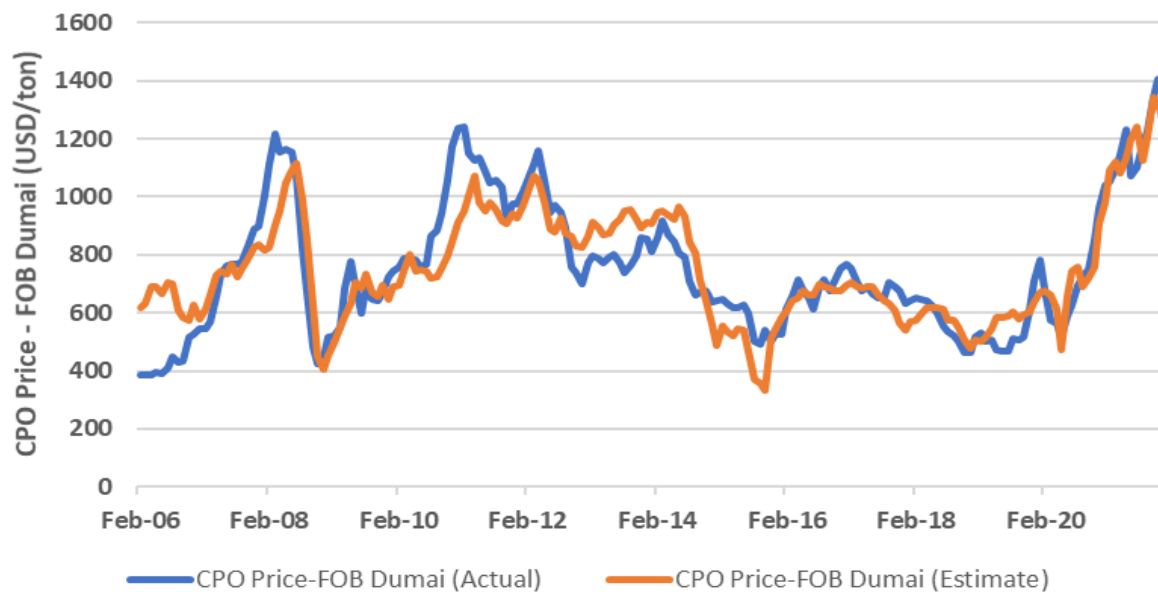


**Figure 3.** CPO and ICP price during biodiesel mandatory policy with incentives period

Source: Oil World and Ministry of Energy and Mineral Resources (MEMR)

However, these conditions become different in the biodiesel mandatory period with progressive export levy tariffs. In deciding the amount of biodiesel to be produced, biodiesel producers do not consider CPO stocks. As long as there is an incentive to cover the price difference between diesel and biodiesel, biodiesel demand will be very good for biodiesel producers. The ever-increasing volume of biodiesel will reduce the stock, but at the same time, the price of CPO is also tied to the ICP. When the mandatory volume of biodiesel was increased without considering the price and stock levels, the price of CPO FOB Dumai boost dramatically as shown in Figure 3. This condition can only be created through government policies. Referring to De Gorter et al. (2015) biofuel mandatory policy “likely contributed” to the edible oil price increase. Edible oil

prices are locked onto crude oil prices through the tax (this is the lowest edible oil prices can go unless there is blending capacity constraints). Otherwise, edible oil prices float up and away when mandates are binding.



**Figure 4.** CPO Price-FOB Dumai (Actual and Estimated), 2006-2021

Source: Author's calculation

Based on the regression results of equation (3), Figure 4 presents the actual CPO price and the estimated regression results. When the estimated price is higher than the actual price, it indicates the excess profit either due to the blending rate or production capacity. Excess profit will disappear along with the increase in mandatory volume and increase in production capacity so that producers can again maximize profits. When the biodiesel blending target set by the Government is 20% or the equivalent of 6.4 million kilolitres, the available production capacity reaches 12 million kilolitres. The mandatory biodiesel volume was then increased to 30% or the equivalent of 8.4 million kilolitres in 2020 and increased again to 9.3 million kilolitres in 2021. The progressive mandatory volume was followed by new investment in the biodiesel industry. The installed capacity of the biodiesel industry will increase by 70% from 10 million kilolitres in 2016 to 17 million kilolitres in 2021. According to the result of this study, we note that ICP and CPO prices can be the indicators in determining the target for CPO price stabilization. When ICP and CPO prices are not correlated, then CPO price stabilization has been achieved so that the biodiesel blending rate does not need to be increased. Since this study only uses CPO FOB Dumai data, further research can add Malaysia's CPO price which together with Indonesia controls 85% of the world CPO market.

#### 4. CONCLUSIONS

The relationship between CPO and ICP prices varies depending on the biodiesel policy. CPO and ICP prices are positively and significantly correlated in the period of biodiesel mandatory with limited subsidized and biodiesel mandatory combined with progressive CPO export levy tariffs. When CPO and ICP prices are correlated, the changes in CPO prices are more determined by ICP, rather than CPO stock. However, CPO and ICP prices are not correlated in the biodiesel mandatory period that is combined with fixed CPO export levy tariff. During that period, CPO price was relatively stable. The correlation between CPO and ICP prices can be used as an indicator in determining CPO price stabilization policy strategy.

This empirical research is expected to be useful for the Government of Indonesia, especially Ministry of Energy and Mineral Resources in the framework of assessing the current mandatory



biodiesel policy. When ICP and CPO prices are not correlated, then CPO price stabilization has been achieved so that the mandatory biodiesel blending level does not need to be increased. Since this study only uses CPO price of FOB Dumai data as the dependent variable, hopefully, further research can add the price of CPO FOB Malaysia which together with Indonesia controls 85% of the world CPO market to estimate price outlook.

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**Conflicts of Interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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