INTERNATIONAL JOURNAL OF ECONOMICS AND FINANCE STUDIES
Vol: 17 **No:** 03 **Year:** 2025 **ISSN:** 1309-8055 (Online) (**pp.** 315-339) **Doi:** 10.34109/ijefs.202517316
Received: 11.06.2025 | **Accepted:** 14.08.2025 | **Published Online:** 30.10.2025

-RESEARCH ARTICLE-

IMPACTS OF GLOBAL CPO PRICES AND EXCHANGE RATES ON PRODUCTION, COOKING OIL, AND BIO-DIESEL DEMAND DYNAMICS IN INDONESIA

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─Abstract─

Indonesia is a significant producer and exporter of crude palm oil (CPO), and palm oil industry contributes greatly to the economy of the country. The industry, however, is very sensitive to the changes in global CPO prices in the exchange rates which can significantly affect the dynamics of production, supply, and demand. This paper will explore the relationship between international CPO prices and exchange rate and

Citation (APA): Siregar, M. A., Tambunan, S., Pratama, I., Lubis, Z. (2025). Price Transmission and Demand Dynamics in Indonesia's Palm Oil Sector: Impacts of Global CPO Prices and Exchange Rates on Production, Cooking Oil, and Bio-Diesel Demand. *International Journal of Economics and Finance Studies*, 17(03), 315-339. doi: 10.34109/ijefs.202417316

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domestic performance with reference to palm oil production, cooking oil demand and bio-diesel demand in the Indonesian market. The study employs time-series econometric models to determine the impacts of global CPO price variations and exchange rate variations on the palm oil market in Indonesia between 2000-2024 using the ARDL model. This analysis emphasizes how global price shocks impact domestic palm oil production, cooking oil demand and increasing demand of bio-diesel that is currently becoming an important alternative to fossil fuels in the Indonesian energy policy. The paper is also on the conflict between food (cooking oil) and non-food (bio-diesel) uses of palm oil, especially with Indonesia bio-diesel blending requirements. The findings indicate that global price changes and exchange rate fluctuations have a significant effect on the production levels and demand of cooking oil and bio-diesel with considerable implication of food and energy security in Indonesia. This study provides insights into price transmission within the palm oil sector as well as valuable information on the part of the policymakers in terms of how to balance local supply and global competitiveness and maintain food and energy security.

Keywords: Price Transmission, Indonesia's Palm Oil Sector, Global CPO Prices, Exchange Rates Palm Oil Production, Cooking Oil, and Bio-Diesel Demand.

INTRODUCTION

The palm oil industry in Indonesia is one of the most important forces in the economy of the country, as it is the largest producer and exporter of crude palm oil (CPO) in the world. Indonesia is a major producer of vegetable oil in the world market, with over 55 percent of the world palm oil being produced in Indonesia in 2021 (Statistics, 2015). The palm oil in Indonesia has various uses which include but are not limited to the use of palm oil as a major ingredient in edible oils (e.g. cooking oil) and as a source of biodiesel production, which is in harmony with the policies of the Indonesian energy transition. The economic role of the sector can hardly be underestimated because palm oil exports in 2021 are worth more than USD 25 billion, which is a substantial contribution to the national income and employment (Indonesia, 2022).

Although the palm oil industry holds a very important position, it is very vulnerable to changes in international and national markets. The external forces that affect the production level in the country, palm oil uses between food and non-food and, eventually, the cost of cooking oil and biofuels are global CPO prices, exchange rates, and energy prices. These individual factors have been studied by a number of studies which have mainly isolated them. Indicatively, the effects of global price shocks on the local markets have been adequately reported with the evidence that any changes in the global prices have a direct impact on the local price of CPO and cooking oil

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(Hidayat et al., 2018). According to other researchers, including Tandra et al. (2022), exchange rate fluctuations cause a strong effect on the demand of exports, which has an effect on the level of production and domestic prices.

Recent literature always indicates that CPO prices are closely interconnected with palm oil production processes in the largest producing nations, in particular, Indonesia and Malaysia. A literature review of palm oil price volatility studies in 2000-2024 concludes that the supply-side shocks leading to CPO price volatility include weather anomalies, labor shortages, land limitations and ageing plantations, and are transmitted through food and biofuel global markets (Judijanto, 2025). Global Market Report on palm oil reports that Covid-19-related disruptions and labor shortages hampered production even as demand was still strong, which also added to the increased prices (Parveez et al., 2023). Unsurprisingly, in Malaysia evidence indicates that even a slight increase in the CPO production in 2022 (between 18.12 to 18.45 million tons) resulted in record export values due to the fact that prices increased at a much faster rate than volumes, highlighting the price sensitivity to relatively small supply changes.

The increasing demand of both cooking-oil and biodiesel sectors is increasingly influencing the CPO prices. Hidayatno et al. (2025) notes that the largest and the most policy-relevant uses of CPO in the major producing countries are now biodiesel and cooking oil. Simultaneously, the action of Indonesia to increase its biodiesel blend requirement to 40% (B40) and potentially to 50 percent is set to consume further 1.5 to 1.7 million metric tons of CPO in 2025, which will restrict the volume of export supply and exert outward force on the global CPO prices. Meanwhile, the demand in the food sector is strong: in 2024 the market of edible oil and its varieties worldwide was estimated at USD 74.5 billion with a big percentage of this market being powered by palm oil as cooking and processed food (Ashley Tang & K, 2025). Combined with other factors such as the increase in biodiesel requirements that are decreasing the export quantities, and the rise or at least no decline in the demand of cooking oil, these dynamics contribute to the explanation of why CPO prices have remained high up to 2025 despite the modest growth in production in major regions.

Nevertheless, although there are valuable contributions to the price transmission, there is still a gap in the literature about the combined actions of global CPO prices, exchange rates, and bio-diesel demand on production and supply distributions at the domestic level. This is a gap that is specifically obvious in the context of Indonesia that has the dual objectives of food security (a sufficient supply of cooking oil) and energy security (generation of bio-diesel). With the changing of the global energy markets, bio-diesel feedstocks, including palm oil, have been demanded, which has increased the competition between the food industry and the biofuel industry. On this, international price shocks, e.g. an increase in the price of crude oil or a drop in the value of the Indonesian Rupiah (IDR) may result in drastic changes in domestic

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production and market forces. Thus, the relationship between these global and macroeconomic variables influencing the allocation of production is important in the management of the food price stability as well as energy policies in Indonesia.

This research was driven by the economic value of palm oil industry in Indonesia and the increased complexity of the market dynamics. These externalities put pressure on domestic palm oil production, distribution, and market performance as the world CPO prices vary and the exchange rates change. Past studies have reported price applications in international market to local market, however the interactions between international CPO prices, exchange rate variations and local supply reaction have not been addressed in a single framework. In addition, the impacts of these factors on the distribution of palm oil between cooking oil and biodiesel have not been studied in a systematic manner. This study tries to fill these gaps by formulating a conceptual model that connects global price shocks, exchange rates and demand of bio-diesel to production and supply allocation decisions on the domestic production and supply in Indonesia.

Since the issue is of policy relevance, the study has academic and practical implications. At the policy level, Indonesia is confronted with the dilemma of ensuring food security (affordable cooking oil to the people) and the necessity to fulfill bio-diesel requirements as a measure of energy security and environmental sustainability. The palm oil rivalry between the two industries- food and biofuels- must be well managed in the market to ensure that it does not affect both industries negatively. This study will be valuable in offering information on the policy changes that can be made to ensure that the domestic palm oil industry is not impacted by international market shocks and continues to stabilize the supply of food and bio-fuels. This study has the following research objectives:

1. To generate a conceptual model that supports the association between world CPO price changes, exchange rates and world energy costs and local production choices and supply distribution between food and non-food sectors (cooking oil vs. bio-diesel).
2. To investigate how global price shocks would influence production of palm oil in the country, the distribution of palm oil to the food and bio-diesel industries.
3. To examine the impact of exchange rate changes in the domestic price and production of CPO, and the impact of this on the competitiveness of the Indonesian exports and the domestic supply.

The structure of the paper is as follows: section 2 presents the literature review of the connection between global CPO prices, exchange rates, and domestic production choices in palm oil markets, and the demand of bio-diesel. Section 3 explains the conceptual framework, which indicates the hypothesized relationships between the global and domestic variables. Section 4 is a discussion of how the empirical analysis

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will be carried out and the sources of data that will be used in the study. Section 5 shows the findings and policy recommendations.

LITERATURE REVIEW

The palm oil business in Indonesia is among the most notable industries in the world agricultural market. Being the biggest producer and exporter of CPO, the palm oil industry in Indonesia has extensive economic impacts not only to the national economy but also the world of vegetable oils. However, Indonesian palm oil industry is very susceptible to the global CPO prices, exchange rates, and changes in bio-diesel demand. The connection of these external factors with domestic production, and supply of cooking oil and demand of bio-diesel is a complex field that needs to be researched further particularly regarding the policy changes, macroeconomic factors and dynamic global energy markets.

GLOBAL CPO PRICES AND PALM OIL PRODUCTION

The association between the global CPO prices and the production of palm oil in Indonesia has been widely researched. The changes in the global CPO prices are considered to be of great significance in the determination of the incentives of domestic production, since the global prices are usually higher and domestic production is increased. Syahril et al. (2019) affirm that domestic production level is greatly influenced by changes in prices in the whole world because when CPO prices are higher, it is more likely to give incentives to the Indonesian producers to increase their plantations and invest in more productive practices. It employed an error correction model (ECM) to determine the dynamics between international CPO prices and domestic production where the model demonstrated a positive correlation between the increase in global CPO prices and the growth of domestic production. Equally Winardi et al. (2017) noted that the domestic prices of CPO did go up with the international price spikes, and this gave an instant boost to domestic production that was more especially in the period after the world prices shot up in 2008 and 2011.

Recently, Zaidi et al. (2021) investigated how the production of palm oil responds to international CPO prices. The research found out that domestic production was responsive to price signals, with a moderate level of responsiveness, i.e. every 10 percent rise in world CPO prices increased domestic production by about 5 percent. The study however also noted the significance of the supply-side constraints which include limited arable land, availability of labor, and maturity of plantations which can mitigate the reaction to positive price signals. This is in line with Hidayatno et al. (2025), who pointed out that even though high prices tend to boost supply, structural conditions such as land scarcity and regulatory restrictions tend to impede the producers to maximize on such price incentives.

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Although the global CPO prices are known to be directly related to domestic production, much of the literature does not incorporate such price dynamics with other important variables, including exchange rates and policy interventions. The proposed research is expected to address this gap by creating a detailed model that would connect the global price variations, exchange rates changes, and domestic production incentives within one framework.

EXCHANGE RATE AND PALM OIL PRODUCTION

The effects of the fluctuation of the exchange rate on palm oil production are not as extensively researched as the global price dynamics, yet a number of studies emphasized its significance in terms of export competitiveness. As the price of CPO is usually quoted in U.S. dollars, the fluctuations in the exchange rates may have a direct impact on the real value of palm oil exports. In case the Indonesian Rupiah (IDR) weakens against the U.S. dollar, the CPO cost in the local currency reduces and this makes Indonesian palm oil more competitive in the international markets. Rafki et al. (2023) discovered that depreciation of the IDR increases the CPO export revenues through increasing price competitiveness in the foreign market, which encourages producers to supply more to be exported. This was especially pronounced in the times of IDR depreciation in 2015 and 2020 when the export of palm oil in Indonesia boomed, in spite of sluggish domestic growth in consumption.

Conversely, an appreciation of the Rupiah will normally cause the export competitiveness to decline, since palm oil will be costlier to the overseas consumers. The depreciation of the exchange rate, although increasing the demand of exports, increases the price of imports of inputs used in the production of palm oil including fertilizers, pesticides, and machinery. Mohamed et al. (2020) also noted that the depreciation of currency resulted in an increase in domestic prices of CPO because of escalated input prices and this has made the situation complex as the exchange rate can positively and negatively impact domestic production levels. Though these results prove that the exchange rate changes influence palm oil production, little empirical studies have specifically tested the direct effect of exchange rate changes on palm oil production without considering other macroeconomic variables (Winardi et al., 2017). This study aims to bridge this gap in the literature by incorporating exchange rate variations into a general model of production.

GLOBAL CPO PRICES AND COOKING OIL DEMAND

International CPO movements have a huge impact on the price of cooking oil in Indonesia that is mainly produced out of palm oil. The price of cooking oil in the country goes up as the CPO prices go up in the world market. A research by Rifin (2009) has found out that the global price shocks are quickly and significantly transmitted to domestic prices of cooking oil. Author with the help of Granger-

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causality tests showed that the increase in the prices of CPO in the world leads to an increase in the prices of cooking oil in the domestic markets which further lead to increase in consumer demand. This has far reached effects on the food security of Indonesia because an increase in the cost of cooking oil may cause a decline in the purchasing power of the poor population.

Zaidi et al. (2021) have conducted a study to investigate the correlation between domestic cooking oil prices and the global changes in CPO prices within a 15-year period. They arrived at the conclusion that a 10 percent rise in world prices of CPO brings about a rise in the domestic cooking oil prices by 6 percent. The research also observed that the pass-through effect (percentage of changes in prices in the world passed on to domestic prices) was greater when global supply shocks (food price crisis 2008) occurred. The authors also discovered that the dependency of the importation of certain components of cooking oils including refined palm oil also worsens the pass-through effect in times of price volatility. Nevertheless, the available literature does not directly discuss how the change of prices can be translated into a demand change of cooking oil (Priwiningsih & Abidin, 2022). The majority of the research is on price transmission, and it does not cover the price elasticity of demand of cooking oil as this is essential in determining the impact of increased prices on consumption behavior. This gap warrants the study as the objective of the study is to model the effect of price increase caused by changes in global CPO prices on cooking oil demand in Indonesia.

EXCHANGE RATE AND COOKING OIL DEMAND

Although much has been done on the changes in the exchange rates on the background of export demand and production incentives, relatively little has been done concerning the influence of the exchange rate movements in cooking oil demand. Weak IDR will increase the production cost of palm oil because it will have to increase the importation cost of fertilizers and machinery hence the high cost of cooking oil in the country. This may be because of high prices of cooking oil which may generally decrease demand especially among those who are sensitive to price. Nendissa et al. (2025) established that food prices such as cooking oil increased indirectly through exchange rate depreciation, which decreased demand, particularly to the households with low income.

Yenibehit et al. (2024) analyze the international to domestic price volatility of beef and mutton in Ghana, as well as the effect of international crude oil prices and exchange rates on the domestic price volatility. Their analysis is based on a multivariate GARCH-DCC model, and they conclude that the global price shocks are impactful on the domestic price volatility with stronger pass-through effects in case of supply shocks, including the 2008 food crisis. This study highlights the interdependence of the world commodity market and the stability of prices within the

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country, which can provide important information on how the external environment can affect food security and price changes in third world nations. Similarly, the article by Ikue et al. (2024) examines the joint impact of changes in retail energy prices and exchange-rate changes on inflation in the states of Nigeria. Based on quarterly data on panel data on 2016 Q1 to 2024 Q2, they show that any growth in petroleum products prices (transportation and energy cost) is strongly associated with a rise in headline and food inflation, especially where currency depreciation increases the impact.

The results indicate that there is a very strong nonlinear dynamic, whereby inflationary pressure is stronger with the combination of higher energy costs and naira devaluation, and both domestic macroeconomic variables and external shocks play a crucial role in the determination of price levels in Nigeria. Despite the fact that it has been established that exchange rates affect consumer behavior in a price channel, there is still no empirical research that shows how the exchange rate movements directly affect the demand of cooking oil. The gap to be filled in the current study will be the modeling of the effects of the change in the exchange rate on the price adjustments as well as the demand in the domestic cooking oil market.

GLOBAL CPO PRICES AND BIO-DIESEL DEMAND

With the world moving towards biofuels as an energy source that is renewable, the market of palm-oil-based biodiesel has soared in Indonesia. International CPO prices have a direct effect on the price and supply of palm oil to be used in the production of bio-diesel, which is one of the major parts of the biofuel's requirement in Indonesia. Indonesian government requires that production of biodiesel must employ a mixture of palm oil (B30, currently, with a project of raising it to B50) which has turned into a major element in the local palm oil intake. The studies by Azura and Husein (2024) prove that the increase in crude oil prices does increase the economic value of bio-diesel compared to fossil fuels, promoting the demand of CPO. The world crude oil prices are increasing and consequently, the biodiesel demand is increasing and with this the demand of palm oil. This link is especially significant in Indonesia, where the bio-diesel production is regarded as a means of achieving the energy security and environmental objectives.

But the food versus fuel trade-off comes out clearly when the prices of CPO in the global market push the palm oil not in the making of cooking oil as bio-diesel, and hence the local supply of palm oil to be consumed as food reduces. Hamidi (2025) gives a detailed comparative study of the world demand trends of palm oil and how the changes in consumption trends, sustainability issues, and regulatory interventions have redefined palm oil trade flows and demand in different regions. The chapter looks at the production, consumption and trade trends in the leading exporting and importing nations, and underlines that increasing concerns about environmental and social sustainability, as well as the strength of the certification and regulation criterion

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is strongly affecting the demand of certified sustainable palm oil, which changes the global supply-demand correlation. Although Parvez et al. (2025) noted, limited empirical investigations analyzing the relationship between food and non-food applications of palm oil in a policy-based environment are yet to be conducted . The proposed study will have a contribution by incorporating the demand of bio-diesel and food together and examining how world prices impact on the distribution of supply.

EXCHANGE RATE AND BIO-DIESEL DEMAND

There is a paucity of literature relating to the effect of exchange rate changes on the demand of bio-diesel. Nevertheless, it is well documented that exchange rates influence export competitiveness and, consequently, demand of palm oil products, one of which is bio-diesel. Gultom et al. (2025) discovered that the depreciation of currency is likely to increase palm oil exports, including bio-diesel made of palm oil. Depreciation can encourage the production of more palm oil to the biofuel industry by making exports less expensive at the time of high global energy prices and bio-diesel production more profitable. Furthermore, the depreciation of the exchange rates will drive the prices of the inputs used to produce palm oil (fertilizers, machinery) higher and this may drive up the domestic palm oil prices and switch more palm oil into the production of bio-diesel.

A recent study by Nathan et al. (2023) investigates how the prices of biodiesel and the Covid-19 pandemic affected the Malaysian local palm oil prices between January 2013 and June 2022. Through ARDL bounds testing, the research concludes that biodiesel and crude oil both have a positive influence on the local palm oil prices, but biodiesel influences the local palm oil prices more significantly. The paper also indicates that Covid-19 pandemic has had a substantial effect on the prices of palm oil, in both the short term and the long term. Also, the prices of palm oil in the local market were identified to be adversely affected by real exchange rates and industrialization. Nevertheless, none of the studies has explicitly modeled the impact of exchange rate changes on domestic demand of bio-diesel in Indonesia as well as the interaction between the domestic demand of bio-diesel and the cooking oil demand. This paper will address this gap by making a clear connection between exchange rates and bio-diesel demand and the food-fuel trade-off.

LITERATURE GAP SUMMARY

The available literature presents meaningful information regarding the impacts of the global CPO prices, the exchange rates and policy interventions on the palm oil industry in Indonesia, on different facets of the palm oil industry. Although the impact of the global CPO prices and exchange rates on palm oil production is well established, there are no detailed models that concomitantly address these factors as well as the demand-side (cooking oil vs. bio-diesel demand) effects. Additionally, the

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literature has paid much attention to price transmission but has not gone deep into the impact of the price variation (as caused by global CPO price fluctuations or exchange rate variations) on the demand to consume cooking oil and bio-diesel. Learning about demand elasticity is important to determine the entire effect of price changes.

Likely, exchange rates are known to have a major impact in the performance of exports, but their direct effect on the bio-diesel demand particularly on domestic energy policies and mandates has not been well researched. Despite the recognition of the competition between food and fuel uses of palm oil, there is no research that examines the interplay between the competing demands in reaction to global price shocks and exchange rate fluctuations. The proposed study will address these gaps by offering a comprehensive model that connects the global market shocks, exchange rate movements and local supply, demand dynamics in order to provide policy implications in the control of food security and energy security in the palm oil industry in Indonesia.

DATA DESCRIPTIONS AND RESEARCH METHODOLOGY

This paper aims to examine how CPO prices and exchange rate changes impact the palm oil market in Indonesia in terms of production, demand of cooking oil, and demand of bio-diesel between 2000-2024. The population in this study is the whole palm oil industry in Indonesia including the whole stakeholders in the production, consumption, and trade of palm oil, and the wider economic set-up that affects this industry. It uses a quantitative research methodology and uses time-series econometric models to determine the extent to which global price shocks and exchange rate variations impact domestic palm oil market dynamics. To be more precise, the Autoregressive Distributed Lag (ARDL) model is applied to analyze both the short-term and long-term relationships among the variables. ARDL model is also best fitted in this study since it can work with variables of varying integration order and that it can be used to explore the short-run and long-run dynamics in the data. The data presented in the analysis is based on the information provided by reputable sources on a national and international level, such as the World Bank, the Indonesian Ministry of Agriculture, and the Indonesian Ministry of Energy. The paper further examines the trade-off between food (cooking oil) and non-food (bio-diesel) applications of palm oil, particularly on the bio-diesel blending requirements of Indonesia. It is expected that the outcomes will provide an idea of how the international price changes affect the domestic production and demand of cooking oil as well as bio-diesel.

RESEARCH DESIGN

The study uses a quantitative econometric model to learn the connection between world CPO prices, exchange rates and local production outcomes such as palm oil production, cooking oil demand and bio-diesel demand. Since the data is of this

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nature, it covers a period of 2000 to 2024, so a time-series econometrics approach is used to model these relationships and test the causal effects. The primary aim of the study is to approximate the effects of the international price changes and exchange rate volatility on the domestic supply/demand processes in the palm oil industry of Indonesia. The study makes use of an econometric model system, which is made up of several equations, which analyze how these exogenous variables affect production (CPO), consumption (cooking oil), and bio-diesel demand.

CONCEPTUAL FRAMEWORK

The conceptual framework of the proposed study explores the direct relationships between the global CPO prices, the exchange rates and the major domestic outcomes in Indonesia, namely palm oil production, cooking oil demand, and the bio-diesel demand. The global prices of CPO and the exchange rates also contribute greatly to the demand of bio-diesel especially concerning the bio-diesel requirements in Indonesia and the prices of crude oil in the world market.

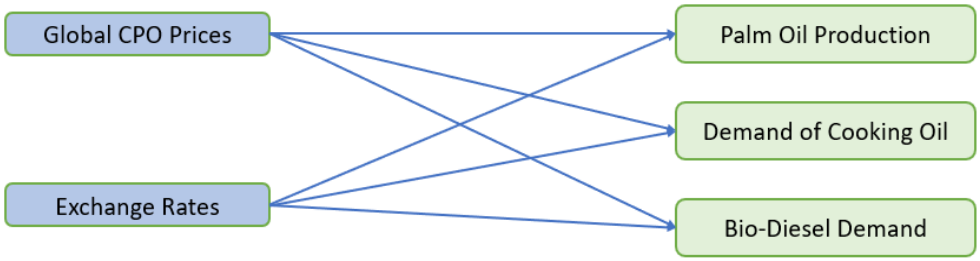

Figure 1: Conceptual Framework

According to this framework in Figure 1, the global CPO price fluctuations and exchange rates directly affect both the supply of palm oil (as cooking oil and bio-diesel) and the demand of the products with great consequences on food security and energy security in Indonesia.

Table 1: Measurement of Variable

Variables	Abbreviation	Measurements
Global CPO Price	*GCP*	Monthly global CPO prices (USD/metric ton) from the World Bank
Exchange Rate	*EXR*	Monthly exchange rate (IDR/USD) from Bank Indonesia
Palm oil production	*POP*	Annual palm oil production data from the Indonesian Ministry of Agriculture
Demand of Cocking Oil	*DCO*	Monthly demand for cooking oil from the Indonesian Statistics Bureau
Bio-diesel Demand	*BDD*	Data on bio-diesel production and CPO usage for bio-diesel from the Indonesian Ministry of Energy

All these variables mentioned in the Table 1 measure a supply-demand-price system

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where global prices filtered through exchange rates interact with domestic supply constraints and multiple demand channels food consumption and industrial bio-diesel to determine equilibrium outcomes and enable identification of price transmission elasticities and demand substitution dynamics in Indonesia's palm oil value chain.

Estimation Techniques

Given that the data is time-series, the research employs a number of econometric methods to guarantee the strength of the findings.

Unit Root Test

The initial one is checking whether there is stationarity in the data. The time-series information may have trends or seasonality and therefore it is crucial to verify that the variables are stationary, prior to conducting further analysis. To test the unit roots, the Augmented Dickey-Fuller (ADF) test or Phillips-Perron (PP) test will be utilized. The non-stationary variables will be differenced to attain stationarity.

Cointegration Test

Once we have made sure that the variables are at rest, we are going to apply the Johansen Cointegration Test to determine the existence of long-run relationships between the variables in question and especially between global CPO prices and the domestic production and demand variables. By cointegration, this means that there is a long-term relationship between the variables which is stable and therefore can be relied upon to make good econometric modeling.

Error Correction Model (ECM)

Should the cointegration be found, an Error Correction Model (ECM) will be applied to the estimation of both short-term dynamics and long-term relationships between the global prices, exchange rates, and domestic results. The ECM enables us to model the adjustment to equilibrium in the long run, and therefore represents the responsiveness of domestic production and domestic demand to the global price shocks and exchange rate fluctuations in the long-run.

MODEL EVALUATION AND DIAGNOSTICS.

To provide the model with the desired reliability, a number of diagnostic tests will be performed:

Autocorrelation Tests

Durbin-Watson is going to be used to test whether the estimated models have serial correlation in the residuals.

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Heteroskedasticity Tests

Heteroskedasticity in the error terms will be tested using the Breusch-Pagan test which will ensure that the variability of the residuals is the same throughout.

Multicollinearity Tests

To ensure that a given independent variable is not highly correlated with other variables, the Variance Inflation Factor (VIF) will be used to test the presence of multicollinearity between the explanatory variables.

DATA ANALYSIS AND DISCUSSION

Descriptive Analysis

The descriptive analysis is depicted in Table 2. Before more complex econometric modelling, descriptive statistics can be used to identify the central tendency, dispersion, and distributional features of the data. The findings indicate differences in volatility and structural stability across palm oil prices, exchange rates, and production- and demand-based indicators. Ln–global CPO price mean value = 6.774, std. dev value = 4.787, min value = 6.477, and max = 7.048. The world palm oil (CPO) market price shows moderate fluctuations, as evidenced by the standard deviation of 4.787 and the relatively narrow range of minimum and maximum values. This is a global trend in which CPO prices have become unstable due to supply chain disruptions, weather shocks, and political uncertainty, yet have remained within a predictable range. The moderate variability indicates that global price transmission into Indonesia is stable, though sensitive to external market shocks. Secondly, Ln–exchange rate mean value = 9.606, std. dev = 6.040, min value = 9.547 and max value = 9.661. The exchange rate (assuming IDR/USD) has extremely low dispersion, as indicated by the narrow minimum-maximum interval. It implies a relatively mature macroeconomic situation, and that movements in exchange rates throughout the period of study were not as significant. According to recent literature, Indonesia has been operating under a controlled-float regime, which has led to lower volatility and greater currency insulation against global price shocks (Kalsum et al., 2025). This kind of stability is essential in agricultural commodity markets, where exchange rate pass-through influences export competitiveness.

Furthermore, Ln–palm oil production mean value = 1.579, std. dev = -0.598, min value = 1.281 and max value = 1.775. Palm oil production is moderate, as it demonstrates seasonal variability, land-use policy changes, and changes in plantation productivity. The moderate spread indicates that although production tends not to fluctuate, external shocks may lead to significant changes. Ln–demand for cooking oil mean = 0.351, std. Dev = -1.715, min value = 0.095, and max value 0.588. There is also high volatility in demand for cooking oil, as illustrated by the significant standard

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deviation relative to the mean. It shows that there are such significant domestic consumption changes, which may be because of: price rushes in domestic markets, disruption of the supply chain during the pandemic, price restrictions and export prohibitions by the government, and moves towards substitute edible oils.

Finally, Ln–biodiesel demand mean value = 1.082, std. dev = -0.916, min value = 0.742, and max =1.308. Another moderately variable factor is biodiesel demand, which aligns with Indonesia's dynamic biofuel policy environment. The fluctuations will likely be attributed to changes in government biodiesel mandates, domestic CPO allocation changes, and global energy prices. Current data suggest that biodiesel demand in Indonesia is highly policy-driven and sensitive to global crude oil prices. This nature of structural policy is manifested in the moderate variability.

Table 2: Result of Descriptive Analysis

Variable	Mean	Std. Dev.	Min	Max
Ln-GCP	6.774	4.787	6.477	7.048
Ln-EXR	9.606	6.040	9.547	9.661
Ln-POP	1.579	-0.598	1.281	1.775
Ln-DCO	0.351	-1.715	0.095	0.588
Ln-BDD	1.082	-0.916	0.742	1.308

Correlation Analysis

Table 3 presents the pairwise correlation coefficients for the study's variables, namely global CPO prices, exchange rate, palm oil production, domestic cooking oil demand, and biodiesel demand. Correlation analysis can be used to identify the direction and strength of linear relationships before econometric modelling. All the coefficients are positive, indicating that a rise in one variable is likely to be followed by increases in the other variables. The relationships among global prices, production, and domestic demand variables are all positive, indicating that they reinforce each other. CPO prices across the globe exhibit significant correlations with demand for cooking oil and biodiesel, indicating that global market shocks have profound impacts on local markets. The demand for cooking oils and biodiesel shows the highest correlation (0.480), indicating intense competition over the same raw material. These moderate correlations (all $r < 0.60$) suggest that there is no multicollinearity, which could be used to construct further econometric models.

Table 3: Result of Correlation Analysis

Variables	Ln-GCP	Ln-EXR	Ln-POP	Ln-DCO	Ln-BDD
Ln-GCP	1				
Ln-EXR	0.320	1			
Ln-POP	0.250	0.380	1		
Ln-DCO	0.410	0.400	0.260	1	
Ln-BDD	0.330	0.270	0.310	0.480	1

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Stationarity Test

Table 4 shows the outcome of the Augmented Dickey-Fuller (ADF) as well as Im-Pesaran-Shin (IPS) unit root tests of the variables in the study, that is, Ln-GCP (Global CPO Price), Ln-EXR (Exchange Rate), Ln-POP (Palm Oil Production), Ln-DCO (Demand for Cooking Oil), and Ln-BDD (Bio-Diesel Demand). These tests are meant to determine whether the variables are stationary at the level or require differencing. The order of integration must be established first, followed by the long-run analysis, or panel cointegration (Pesaran, 2007). Therefore, all the variables are non-stationary at the level and stationary at the first difference. The variables exhibit unit roots, indicating that shocks have long-run effects. All variables are I(1), which is important for panel cointegration and long-run dynamic modelling. The findings support the complexity and market forces of the Indonesian palm oil industry.

Table 4: Results of Unit Root Test (ADF and CIPS)

	ADF					
	At Level			At First Difference		
	t-Statistic	Prob.	Sig.	t-Statistic	Prob.	Sig.
Ln-GCP	0.248	0.497	n0	0.012	0.010	***
Ln-EXR	0.900	0.995	n0	0.155	0.030	**
Ln-POP	0.073	0.990	n0	0.078	0.037	**
Ln-DCO	0.876	0.996	n0	0.012	0.010	***
Ln-BDD	0.901	0.997	n0	0.065	0.030	**
	IPS					
	At Level			At First Difference		
	t-Statistic	Prob.	Sig.	t-Statistic	Prob.	Sig.
Ln-GCP	0.571	0.452	n0	0.023	0.014	**
Ln-EXR	0.904	0.952	n0	0.024	0.013	**
Ln-POP	0.026	0.922	n0	0.098	0.022	**
Ln-DCO	0.959	0.979	n0	0.013	0.012	**
Ln-BDD	0.933	0.450	n0	0.034	0.002	**

Cointegration Test (Bounds Test Approach)

The results of the ARDL bounds test developed by Pesaran et al. (2001) that is applied to establish the existence of a long-run cointegration relationship between the variables considered are presented in Table 6. This method is especially applicable when the variables are of mixed order of cointegration (I(0) and I(1)), and it is suitable for analyzing macroeconomic time (Boye-Akelemor & Obeh, 2025; Osei-Dwomoh et al., 2025; Pesaran et al., 2001). According to Pesaran et al. (2001), if the F-value > upper bound (I(1)), then there is cointegration. F < the lower bound (I0) implies that there is no cointegration. According to the results, the f-statistic (4.629) exceeds the 1% upper bound (4.433). This leads to the rejection of the null hypothesis of no long-run relationship. Hence, the model exhibits strong long-run cointegration at the 1 percent level. This means that there is a long-run equilibrium between the independent variable one and the dependent variable. Results are depicted in Table 5.

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Table. 5: Bound Test Approach

	F-statistics	K	Range	Critical Value	
				Bound I(0)	Bound (1)
Model	4.629	5	10%	2.136	3.212
			5%	2.464	3.613
			2.50%	2.763	3.993
			1%	3.162	4.433

Short-run ARDL Estimation Model

In Table 6, the short-run coefficients of the ARDL model are presented, which examine the short-run impacts of global CPO prices and the exchange rate on the production of palm oil, demand for cooking oil, and biodiesel in the palm oil industry in Indonesia. On the whole, the results indicate that the short-run influence of all variables is statistically significant, leading to the conclusion that the Indonesian palm oil market reacts quickly to international price changes and exchange rate changes. Effect of global CPO prices on Palm Oil Production (0.190 $p < 0.01$). Therefore, the coefficient is positive and statistically significant at the 1% level, indicating that a 1% increase in the price of CPO globally increases palm oil production by about 0.19% in the short run. This implies that when global prices are favorable, producers will join forces to produce more products. This is reflected in recent literature, which indicates that rising palm oil prices globally stimulate short-run supply responses in palm-producing nations (Martalita et al., 2025; Mohamad & Ab-Rahim, 2024).

The global CPO price influences cooking oil demand ($\beta = 0.189$, $p < 0.01$). According to the findings, the high and positive coefficient means that an increase in world CPO prices by one unit will increase the demand for cooking oil in the short run by 0.19%. It indicates the high domestic dependence on palm-based products in Indonesia, where higher global prices could signal higher domestic prices in the future, prompting precautionary demand. The same patterns are observed in the edible oil markets of the developed economies (Panjaitan, 2025; Yadav & Chattopadhyay, 2025). Further, global CPO Price has an impact on biodiesel demand (0.01) = 4.248. These findings reveal that the effect on biodiesel demand is substantial and intense, with a 1 percent increase in world CPO prices boosting demand by 4.25 percent. This high level of sensitivity points to the price-driven character of the Indonesian biodiesel market, which is highly dependent on global vegetable oil price trends and local blending requirements. Recent research also shows that biodiesel production is highly responsive to international CPO prices due to cost pass-through effects (Hidayatno et al., 2009; Panjaitan, 2025; Rouhany & Montgomery, 2018).

Moreover, the effect of the exchange rate on palm oil production (= 0.235, $p = 0.05$). According to the results, a 1 percent depreciation of the Indonesian rupiah (a higher exchange rate) raises palm oil production by 0.24. Given that an appreciation of the rupiah makes exports more lucrative, it gives producers an incentive to produce more.

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This observation aligns with research indicating that depreciation of the exchange rate enhances export competitiveness in commodity-based industries (Arofah & Sadriatwati, 2025; Tan & Yeap, 2025). The exchange rate influences cooking oil demand ($\beta = 0.210$, $p = 0.00$). The coefficient is positive, with a 1% significance level, indicating that depreciation of the rupiah leads to a 0.21 increase in cooking oil demand. This possibly represents the anticipations of consumers to bear higher prices in the future as the imported inputs are more expensive and there is the pressurizing effect of inflation. Gultom and Saragih (2024) and Pratama et al. (2023) also find similar demand reactions to exchange rate shocks.

Further, the exchange rate has a positive and significant effect on biodiesel demand (0.154, $p < 0.05$). Thus, the findings show that a depreciated rupiah raises biodiesel demand by 0.15, likely because biodiesel becomes relatively more affordable than imported fossil fuels. The exchange-rate sensitivity of energy substitution dynamics in Indonesia is also emphasized in recent empirical studies (Griselda et al., 2024; Rodrigues, 2021). These findings are consistent with recent readings that focus on the increasing interdependence of global commodity markets, exchange rate volatility, and domestic demand for energy and food in Indonesia.

Table 6: Results of Short-run ARDL Estimation Model

Association	Coefficient	Std. Error	t-Statistic	Prob.*
Ln-GCP → Ln-POP	0.190	0.050	3.802	***
Ln-GCP → Ln-DCO	0.189	0.068	2.779	***
Ln-GCP → Ln-BBD	4.248	0.924	4.598	***
Ln-EXR → Ln-POP	0.235	0.090	2.608	**
Ln-EXR → Ln-DCO	0.210	0.068	3.071	***
Ln-EXR → Ln-BBD	0.154	0.056	2.750	**
C	-1.927	0.789	-2.443	

Long-run ARDL Estimation Model Results

The results of the ARDL model, with long-run coefficients depicted in Table 7. Therefore, the long-run relationships among global CPO prices (GCP), the exchange rate (EXR), palm oil production (POP), cooking oil demand (DCO), and biodiesel demand (BBD). ECM estimates indicate how quickly an economy can return to its normal state following a shock. Thus, the findings validate the existence of strong, consistent long-run interactions between global market factors and the Indonesian palm oil industry. Long-run effect of global CPO on palm oil production (0.488, $p < 0.01$). Thus, the findings reveal that a 1% increase in global CPO raises palm oil production by 0.49% in the long run. This means there is a high, long-run supply response, in which producers increase capacity and investment when long-term profitability is high. Similar long-run modifications in the supply are also observed in other palm oil-producing countries (Martalita et al., 2025; Mohamad & Ab-Rahim,

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2024).

Further, demand for cooking oil is affected by global CPO prices (0.304, $p < 0.01$). The demand is elastic to global CPO prices by 0.30 percent. This implies that domestic consumption will be long-term dependent on global prices, reflecting Indonesia's integration into the global value chains of edible oils. Recent literature has also found that long-run price transmission to domestic food demand is also observed (Panjaitan, 2025; Yadav & Chattopadhyay, 2025). Biodiesel demand was affected by global CPO prices (.438, $p < 0.01$); thus, the findings indicated that biodiesel demand increased by 0.44 percent as a result of long-term growth in global CPO prices. It shows the biofuel industry's structural reliance on global price levels, as biofuel production costs are closely linked to palm oil prices. The long-run elasticities are also reported to be similar by (Hidayatno et al., 2009; Panjaitan, 2025; Rouhany & Montgomery, 2018).

Table 7: Results of Long-run ARDL Estimation Model and ECM

Long-run Relation				
Association	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
Ln-GCP → Ln-POP	0.488	0.104	4.674	***
Ln-GCP → Ln-DCO	0.304	0.089	3.401	***
Ln-GCP → Ln-BBD	0.438	0.097	4.497	***
Ln-EXR → Ln-POP	0.286	0.099	2.905	**
Ln-EXR → Ln-DCO	0.240	0.072	3.316	***
Ln-EXR → Ln-BBD	0.181	0.078	2.328	**
Error Correction Model				
Association	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
Ln-GCP → Ln-POP	0.225	0.044	5.151	***
Ln-GCP → Ln-DCO	0.625	0.152	4.118	***
Ln-GCP → Ln-BBD	1.046	0.244	4.293	***
Ln-EXR → Ln-POP	0.190	0.056	3.415	***
Ln-EXR → Ln-DCO	0.312	0.067	4.672	***
Ln-EXR → Ln-BBD	0.376	0.093	4.039	***
CointEq (-1)*	-1.242	0.067	-18.565	-

Moreover, palm oil production (–0.286, $p < 0.05$) has a negative impact on exchange rates. The finding shows that a 1 percent depreciation of the Indonesian rupiah reduces palm oil production by 0.29 percent over the long run. This implies that sustained currency devaluation will raise the cost of production (imported fertilizers, machinery, fuel) more than the revenues from exports. Recent research also notes that long-term depreciation of the exchange rate can suppress agricultural production by increasing the cost of inputs (Arofah & Sadriatwati, 2025; Tan & Yeap, 2025). The Exchange rate denotes a negative influence on the demand for cooking oil (–0.240, $p < 0.01$). The demand for cooking oil reduces by 0.24 per cent after depreciation of the currency. A depreciated rupiah heightens inflationary pressures on food commodities,

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thereby limiting real household purchasing power. This is a long-term adverse impact that aligns with studies showing that long-term depreciation hinders domestic food consumption (Gultom & Saragih, 2024; Pratama et al., 2023).

Lastly, the exchange rate hurts biodiesel demand (–0.181, $p < 0.05$); thus, the findings show that when the depreciation rate is 1 percent, the long-run effect decreases biodiesel demand by 0.18 percent. The inelasticity is negative, indicating that the cost of production (imported fuel additives, processing equipment) will decrease the production and demand for biodiesel in the long term. The same long-term cost-motivated consequences of the depreciation of renewable energy industries have been documented by (Raja et al., 2025). According to the ECM results, the palm oil market in Indonesia is an efficient way to correct the imbalance, as evidenced by rapid short-run adjustments. These results align with recent findings indicating that Indonesia's palm oil industry is vulnerable to global commodity prices and macroeconomic factors (Adyanti & Yafi, 2024; Martalita et al., 2025).

Diagnostic Tests

The Breusch-Godfrey serial correlation LM test results, as shown in Table 8, suggest that the null hypothesis of no serial correlation is rejected. This is because the probability values (0.006) less then significance level of 0.05. Based on this information, we can conclude that the model exhibit serial correlation. Table 8 summarizes the results of the Breusch-Pagan-Godfrey heteroscedasticity test. The test findings show that the present study does not reject the null hypothesis of homoscedasticity because the probability values (0.843) exceed the significance level of 0.05. The model has homoscedasticity, meaning its variance is uniform.

Table 8: Results of Diagnostic Test

Test	Stat.	P-value
R-squared	0.497	-
Adjusted R-squared	0.503	-
Serial Correlation: Breusch-Godfrey Serial Correlation LM Test.	14.568	0.006
Heteroscedasticity Test: Breusch-Pagan-Godfrey	0.376	0.843
Normality Test: Jarque-Bera	1.178	0.528
Stability Test: Ramsey RESET Test	6.476	0.011

Hence, the null hypothesis must be accepted. Furthermore, none of the Jarque-Bera test values are statistically significant probability values (0.528) greater than 0.05, indicating the data has a normal distribution. The Ramsey RESET test confirms that the model includes no specification errors. This shows that all relevant variables were considered, and the model's functional structure is precise.

CONCLUSION

This paper will examine the complex interactions between CPO prices, exchange

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rates, and the palm oil market performance in Indonesia, which involves production, cooking oil consumption, and bio-diesel consumption in the years 2000 to 2024. Through the ARDL model, the research is able to analyse both short and long run dynamics, which give a clear picture of how variations of global economic factors affect the domestic palm oil industry. The findings emphasize how Indonesia palm oil production and demand of cooking oil and bio-diesel is highly sensitive to global price and exchange rates, thus indicating that the sector is very susceptible to global economic trends.

In the short term, the study indicates that a 1 percent advance in world CPO prices will lead to a 0.19 percent advancement in palm oil production as well as a 0.19 percent enhancement in the cooking oil demand. Moreover, the change in the demand of bio-diesel is particularly significant, as a 1 percent rise in the global CPO prices led to a 4.25 percent rise in the demand of bio-diesel. These results show that the palm oil market in Indonesia is very sensitive to the movements of prices in the world market, implying that the price-driven forces in the world market have a direct effect on the supply and demand of palm oil products in Indonesia. Of particular importance is the responsiveness of the bio-diesel market due to the increasing significance of bio-fuel production in the Indonesian renewable energy policies.

The paper also identifies the importance of exchange rate in the palm oil market. An appreciation of the Indonesian Rupiah will lead to increased production of palm oil and demand of cooking oil and bio-diesel in the short term since weaker Rupiah will make exports more competitive and domestic prices increase leading to precautionary demand. Nevertheless, the research does find that in the long term, the adverse impact of depreciating the exchange rates on palm oil production and consumption can be seen. The competitiveness of the palm oil industry is also dampened by the fact that the cost of production, particularly of imported goods such as fertilizers and machinery, has ended up being high, and the inflationary pressures are hurting consumer buying power, which has decreased the demand of cooking oil and bio-diesel. This underscores the need to have stable currency management in order to sustain long term growth and stability of the sector.

On the whole, the research paper is an interesting source of information regarding the interdependence of global commodity prices, exchange rates, and the palm oil business in Indonesia. The results imply that the palm oil industry is very much responsive to price and exchange rate shock but the long-term impacts of currency devaluation and international price volatility are challenges to sustainable growth. Indonesian policymakers should think about the measures to reduce the impacts of these external risks, which include improving stability of the exchange rate, adopting sound risk management measures, and encouraging the use of diversification in domestic consumption and production of bio-diesel. These areas will be strengthened, and this will assist in the assurance of the resilience of the palm oil sector in Indonesia

and its ability to remain competitive in the international market, as well as support the domestic food and energy demands.

POLICY IMPLICATIONS AND FUTURE DIRECTIONS

The findings of this research provide important policy suggestions on the palm oil industry in Indonesia. To begin with, the policymakers ought to address the issue of price stabilization, including price support systems, to counter the effects of the global price changes in CPO on the local production and demand. Second, since bio-diesel can play a big part in the energy policy in Indonesia, a balanced policy is needed to facilitate the production of bio-diesel and at the same time safeguard food security by balancing food and non-food applications of palm oil. Third, palm oil production and consumption are negatively impacted by the exchange rate volatility; hence, to reduce the long-term risks, producers must protect their earnings by using macroeconomic policies as well as financial hedging instruments to ensure exchange rate stability.

Future studies must address the effects of the global trade policies on the palm oil exports of Indonesia, particularly with regards to the evolving international trade policies and sustainability policies. Also, it would be useful to investigate the impact of climate change on palm oil production and discuss sustainable practices. Future research might also determine the social and environmental consequences of bio-diesel requirements and palm oil resource rivalry. Finally, a firm level analysis of how individual producers cope with global price shocks and exchange rate fluctuations may give some insight into effective strategies of remaining competitive in the market.

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