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Analysis of Indonesia's Palm Oil (CPO) Export Volume Moderated by Inflation

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A B S T R A C T

This study examines the effects of exchange rates, GDP, commodity prices, and inflation on Indonesia's CPO export volume. A quantitative approach was employed using secondary time-series data from January 2018 to December 2024, comprising 84 observations. Data were analyzed using PLS-SEM with SmartPLS 4.1.1. The results indicate that exchange rates and GDP positively and significantly affect CPO export volume. Conversely, commodity prices exert a negative and significant effect, whereas inflation has no direct significant influence. Furthermore, inflation strengthens the exchange rate–export relationship but weakens the effects of GDP and commodity prices on Indonesia's CPO exports

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INTRODUCTION

Natural resources owned by each country are different from one another. With the differences in natural resources owned by a country, an exchange of natural resources must be carried out in order to meet the needs of each country (Rini Silaban & Nurlina, 2022). One of the countries that has an advantage in natural resources is Indonesia. The abundant natural resources make Indonesia have a great opportunity to gain substantial profits as well. One way to achieve this is by conducting international trade to meet the needs of people in various parts of the country (Hakiki & Asnawi, 2019). International Trade is a country's access to expand its market share (Devi & Murtala, 2019). International trade is divided into two parts, namely imports and exports. Importing involves purchasing goods or services from foreign countries, whereas exporting involves selling goods or services to international markets (Wahyuni et al., 2021). Exporting goods from regions with superior commodities is one of the key factors driving the economic progress of those regions (Chen et al., 2023)

Indonesia's export earnings are substantially supported by the agricultural sector, especially the plantation subsector, in which palm oil constitutes a leading commodity. As a key plantation product, palm oil is processed into various derivatives, including crude palm oil (CPO), one of the country's most important export commodities. Based on available data, Direktorat Jenderal Perkebunan (2025), Palm oil (CPO) in 2024 is a plantation commodity that ranks first with the highest production reaching more than 47 million tons, contributing 82.23% of Indonesia's total plantation production. Data from the Council of Palm Oil Producing Countries (2025) show that among several major palm oil producing countries, in 2024 Indonesia ranked first as the largest producer of CPO commodities in the world with a production of 47,474,604 tons. Meanwhile, Trademap data (2025) recorded Indonesia as a major global exporter of CPO along with Malaysia. This condition confirms that CPO plays a strategic role as a source of foreign exchange and a support for Indonesia's economic growth.

Nevertheless, although Indonesia has production advantages and a large market share, the volume of CPO exports does not always show a stable trend. According to data from the Central Statistics Agency (2025), the volume of CPO exports throughout 2024 experienced fluctuations. This phenomenon shows that the performance of CPO exports is not only determined by production capacity but is also influenced by various macroeconomic factors. One of the factors suspected to influence exports is the rupiah exchange rate. Theoretically, changes in the exchange rate can affect the price competitiveness of commodities in the international market. When the rupiah depreciates, the price of export products becomes relatively cheaper for foreign buyers, potentially increasing export volume (Advent et al., 2021). However, previous research results show inconsistent findings. Trisakti et al (2022) stated that the exchange rate has a positive and significant effect on exports. Conversely, Ogbona & Ichokua (2022) found that the exchange rate has a negative and significant effect, while Blecker (2023) concluded that the exchange rate has a negative and insignificant effect on exports.

In addition to the exchange rate, Gross Domestic Product (GDP) also plays a role in determining a country's ability to produce goods and services (Nguyen & Poczta-Wajda, 2024). Theoretically, an increase in GDP reflects an increased production capacity that can encourage higher exports. Ali et al (2023) concluded that GDP has a positive and significant effect on exports. However, different results were found by Nopiana et al (2022) who stated that GDP has a negative and insignificant effect on Indonesia's exports.

THEORETICAL REVIEW

Another factor that also influences exports is the international price of CPO. According to Glauben et al (2022) international prices are closely related to export volume because competitive prices will increase demand in the global market. Wu et al (2025) found that international prices have a positive and significant effect on exports. Conversely, Umar Djalo et al (2023) concluded that international prices have a negative and insignificant effect on exports. In addition, inflation as an indicator of macroeconomic stability also has the potential to affect exports. Inflation is the general and sustained increase in the prices of goods and services (Girdzijauskas et al., 2022). High inflation can increase production costs and reduce the competitiveness of domestic products in the international market (Vîrjan et al., 2023). Fitri (2022) previous studies have reported inconsistent findings regarding the role of inflation in export performance. Some studies concluded that inflation has a negative and significant effect on exports, whereas others found that inflation exerts a positive but non-significant influence on export activities. These inconsistencies indicate the existence of a research gap and suggest that the relationships among macroeconomic variables and export performance remain inconclusive.

Therefore, this study aims to examine the effects of the rupiah exchange rate, gross domestic product (GDP), commodity prices, and inflation on Indonesia’s crude palm oil (CPO) export volume. In addition, this study investigates the moderating role of inflation in the relationships between the rupiah exchange rate, GDP, commodity prices, and Indonesia’s CPO export volume.

METHODOLOGY

This study employed a quantitative descriptive design using a secondary data analysis approach. The quantitative approach was selected because it enables the examination of relationships among variables through numerical data obtained from official statistical sources. Specifically, this study analyzed the effects of the rupiah exchange rate, gross domestic product (GDP), commodity prices, and inflation on Indonesia’s crude palm oil (CPO) export volume, as well as the moderating role of inflation in the relationships between the exchange rate, GDP, commodity prices, and CPO export volume during the 2018–2024 period. The study was conducted in Indonesia using monthly time-series data covering seven years, from January 2018 to December 2024, resulting in 84 observations. The data analyzed were secondary, quantitative, and time-series in nature. Data were collected from several official and reliable sources, including the Central Bureau of Statistics (BPS), the Directorate General of

Plantations, Bank Indonesia, the World Bank, and other relevant publications and databases. The variables examined in this study consisted of CPO export volume, exchange rates, GDP, commodity prices, and inflation.

Data analysis was performed using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach with SmartPLS version 4.1.1. PLS-SEM is a component-based and variance-based structural equation modeling technique designed to evaluate predictive relationships among constructs and determine the magnitude and significance of direct and moderating effects between variables. The analytical procedure comprised three stages: (1) evaluation of the measurement model (outer model) to assess the validity and reliability of the constructs, (2) evaluation of the structural model (inner model) to examine the relationships among variables, and (3) hypothesis testing to determine the significance of the proposed direct and moderating effects

RESULTS

Partial Least Square (PLS) Analysis

1. Measurement Model Testing (Outer Model)

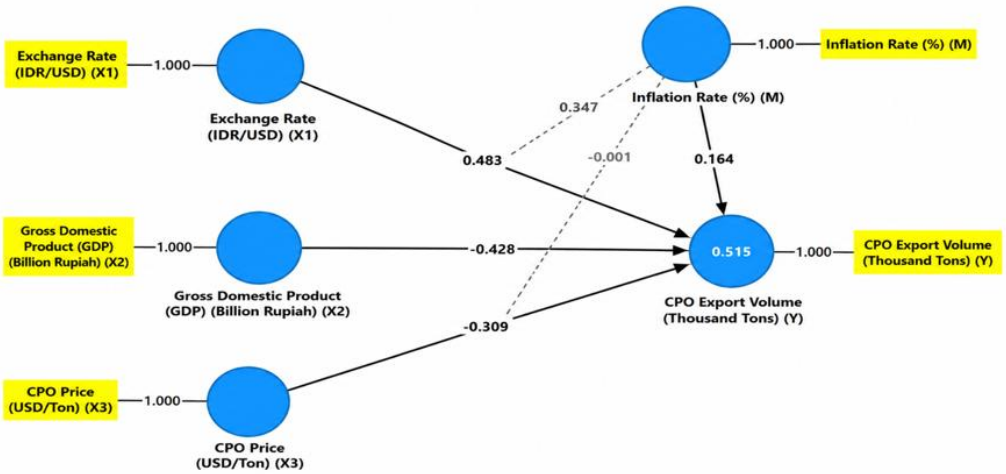

Figure 1. Outer Model

In formative measurement models, the outer model evaluation using SmartPLS is based on two primary criteria, namely convergent validity and collinearity among indicators, to ensure that the indicators appropriately represent the constructs and are free from problematic multicollinearity.

a. Convergent Validity

The convergent validity of a formative measurement model is evaluated based on the correlation between indicator scores and latent construct scores estimated through the Partial Least Squares (PLS) procedure. A strong correlation demonstrates that the indicators sufficiently capture the underlying construct being measured. Individual formative indicators are considered valid and ideal if the loading factor > 0.70.

Table 1. Outer weight

Construct Relationship	Outer weights
CPO Price (X3) → CPO Price (X3)	1.000
Inflation (M) → Inflation (M)	1.000
Exchange Rate (X1) → Exchange Rate (X1)	1.000
GDP (X2) → GDP (X2)	1.000
Export Volume (Y) → Export Volume (Y)	1.000
Inflation (M) × CPO Price (X3) → Inflation (M) × CPO Price (X3)	1.000
Inflation (M) × Exchange Rate (X1) → Inflation (M) × Exchange Rate (X1)	1.000
Inflation (M) × GDP (X2) → Inflation (M) × GDP (X2)	1.000

Table 1 presents the factor loading values used to assess convergent validity. All indicators for the rupiah exchange rate, GDP, commodity prices, inflation, and CPO export volume have factor loadings greater than 0.70, exceeding the recommended threshold. This indicates that the indicators adequately represent their respective constructs and possess satisfactory convergent validity. Consequently, all indicators were deemed valid and included in further analyses.

b. Multicollinearity Test

The multicollinearity test was conducted to verify that no excessive linear relationships exist among the independent variables. In PLS-SEM, multicollinearity is assessed using the Variance Inflation Factor (VIF), where values exceeding 5 indicate problematic multicollinearity. In contrast, VIF values below this threshold demonstrate that the predictor variables are not highly intercorrelated. The results of the multicollinearity test are presented in Table 2.

Table 2. Multicollinearity Test Results

Variables	VIF
CPO Price (X3)	1.000
Inflation Rate (M)	1.000
Exchange Rate (X1)	1.000
Gross Domestic Product (GDP) (X2)	1.000
CPO Export Volume (Y)	1.000
Inflation Rate × CPO Price	1.000
Inflation Rate × Exchange Rate	1.000
Inflation Rate × GDP	1.000

Inflation Rate × GDP 1.000

Table 2 presents the results of the multicollinearity test based on the Variance Inflation Factor (VIF). Since all indicators exhibit VIF values below the threshold of 5, no multicollinearity problems were detected among the variables. These findings indicate that the predictor variables are not excessively correlated and meet the assumptions required for further PLS-SEM analysis.

2. Structural Model Evaluation (Inner Model)

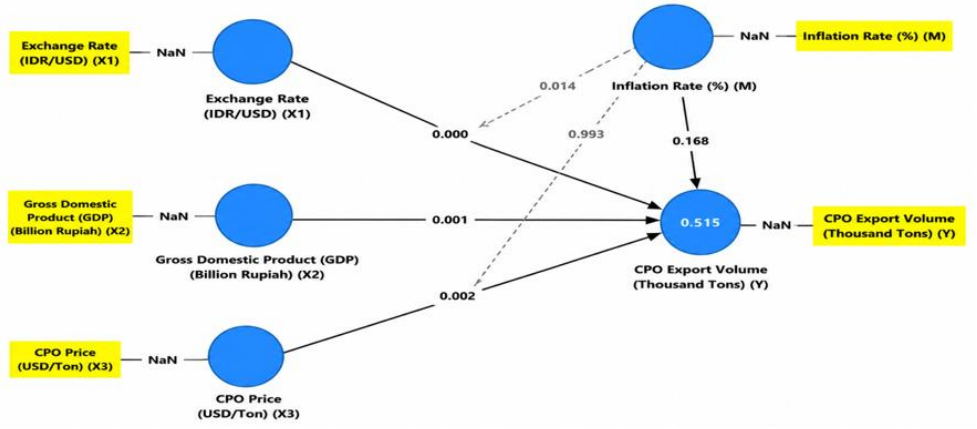

Figure 2. Structural Model (Inner Model)

The structural model assessment was conducted by evaluating the coefficient of determination (R^2), t-statistics, and the significance of the structural path coefficients. The R^2 value indicates the proportion of variance in the endogenous construct explained by the exogenous variables and reflects the model's explanatory capability. R^2 values above 0.67 are considered substantial, values between 0.33 and 0.67 are regarded as moderate, and values between 0.19 and 0.33 are classified as weak (Ghozali & Latan, 2015).

Table 3. R-Square Value

Variable	R-square	R-square adjusted
CPO Export Volume	0.515	0.470

An R^2 value of 0.515 indicates that 51.5% of the variance in CPO export volume is explained by the exchange rate, GDP, commodity prices, inflation, and their interaction effects, demonstrating moderate explanatory power. The adjusted R^2 value of 0.470 further indicates that, after accounting for the number of predictors, the model explains 47.0% of the variation in CPO export volume. Consequently, the remaining 53.0% of the variance is influenced by other factors beyond the scope of the present model.

b. Predictive Relevance (Q2)

The predictive relevance of the structural model was evaluated using the Stone–Geisser Q^2 statistic. Predictive relevance assesses the model's ability to accurately reconstruct observed values and generate reliable parameter estimates. The Q^2 value ranges from 0 to 1, with values closer to 1 indicating greater predictive capability and higher model relevance. A Q^2 value greater than zero demonstrates that the model possesses predictive relevance for the endogenous construct, whereas values equal to or below zero indicate a lack of predictive capability. In PLS-SEM, the Q^2 statistic serves as an indicator of the model's predictive performance and is conceptually comparable to the total coefficient of determination in path analysis. The results of the predictive relevance calculation are presented in Table 3.

Q2 value = 1 – (1 – R2)

Q2 value = 1 – (1 – 0.515)

= 0.515

Explanation:

Q2: Predictive Relevance value

R2: R-Square value of the export volume variable

The obtained Q^2 value of 0.515 indicates that the structural model possesses adequate predictive relevance. Specifically, the model is capable of explaining and predicting 51.5% of the variation in the observed data, whereas the remaining 48.5% is explained by other factors outside the proposed model. Therefore, the model exhibits satisfactory predictive capability for the endogenous construct under investigation.

3. Hypothesis Testing

Hypothesis testing was performed by assessing the significance of the estimated parameters to determine the relationships among the study variables. In PLS-SEM, each hypothesized relationship is statistically evaluated using path coefficients, t-statistics, and p-values generated through the bootstrapping procedure. Hypotheses with significant parameter estimates are considered empirically supported. relationship is conducted using simulation. In this case, the bootstrap method is applied to the sample. The results of testing with bootstrapping from the PLS analysis are as follows:

Table 4. Results of Hypothesis Testing

Path Relationship	**Original Sample (O)**	**P Values**
Exchange Rate (X1) → CPO Export Volume (Y)	0.483	0.000
Gross Domestic Product (GDP) (X2) → CPO Export Volume (Y)	-0.428	0.001
CPO Price (X3) → CPO Export Volume (Y)	-0.309	0.002
Inflation Rate (M) → CPO Export Volume (Y)	0.164	0.168
Inflation Rate (M) × Exchange Rate (X1) → CPO Export Volume (Y)	0.347	0.014
Inflation Rate (M) × Gross Domestic Product (GDP) (X2) → CPO Export Volume (Y)	-0.001	0.993
Inflation Rate (M) × CPO Price (X3) → CPO Export Volume (Y)	-0.323	0.104

DISCUSSION

The exchange rate variable exerts a positive and significant influence on Indonesia's CPO export volume, as reflected by an original sample coefficient of 0.483 and a p-value of 0.000, which is below the 0.05 significance threshold. Therefore, the first hypothesis is accepted. Therefore, the first hypothesis is supported. This result is in line with the findings of previous studies conducted by Gold & Yusuf, (2025); Pradina & Adhitya, (2023); Pratama et al (2024), which reported that exchange rates significantly influence CPO export volumes.

The GDP variable exhibits a negative and statistically significant effect on Indonesia's CPO export volume, as evidenced by an original sample coefficient

of –0.428 and a p-value of 0.001, which is below the 0.05 significance threshold. Accordingly, the second hypothesis is supported. However, this finding contrasts with the results of previous studies conducted by Nuryanto et al (2023) the negative coefficient suggests that increases in GDP are associated with reductions in Indonesia's CPO export volume. This phenomenon may be attributed to the tendency of economic growth to stimulate domestic consumption, thereby decreasing the exportable surplus of crude palm oil. These findings are consistent with the study conducted by Gultom & Sinaga (2023) which reported a negative and significant relationship between GDP and Indonesia's CPO export volume.

The CPO price variable likewise demonstrates a negative and statistically significant effect on Indonesia's CPO export volume, as indicated by an original sample coefficient of –0.309 and a p-value of 0.002, which is below the 0.05 significance threshold. Accordingly, the third hypothesis is supported. This finding is consistent with the results reported by Rahmadani Afhari et al. (2020). The negative coefficient implies that increases in global CPO prices are associated with declines in Indonesia's CPO export volume. A plausible explanation is that rising prices reduce demand in international markets and encourage importing countries to substitute CPO with alternative vegetable oils, such as soybean, sunflower, or rapeseed oils. These findings are further corroborated by the study conducted by Gultom et al (2024) which found that CPO prices significantly and negatively affect Indonesia's CPO export volume.

The inflation variable does not have a significant direct effect on Indonesia's CPO export volume, as indicated by an original sample value of 0.164 and a p-value of 0.168, which exceeds 0.05. Consequently, the fourth hypothesis is rejected. This finding differs from studies by Umar Djalo et al (2023) which reported a significant influence of inflation on export volumes. The absence of a significant effect may be attributed to the fact that inflation levels during the observation period were relatively stable and did not substantially alter the production and export costs of CPO.

Inflation affects the magnitude of the relationship between exchange rate fluctuations and Indonesia's crude palm oil export performance, with an original sample value of 0.347 and a p-value of 0.014, which is below 0.05. Therefore, the fifth hypothesis is accepted. The positive coefficient indicates that inflation strengthens the influence of exchange rates on CPO export volume. When inflation rises, exchange rate fluctuations tend to have a stronger impact on export performance.

In contrast, inflation does not significantly moderate the relationship between GDP and Indonesia's CPO export volume, as evidenced by an original sample value of –0.001 and a p-value of 0.993, which is greater than 0.05. Thus, the sixth hypothesis is rejected. This result suggests that inflation does not strengthen or weaken the effect of GDP on CPO export volume.

In a similar vein, inflation failed to exert a significant moderating effect on the relationship between CPO prices and Indonesia's crude palm oil export volume. The interaction term yielded an original sample value of –0.323 and a p-value of 0.104, exceeding the 0.05 significance criterion. Accordingly, the seventh

hypothesis was rejected, indicating that variations in inflation do not meaningfully alter the extent to which changes in CPO prices influence Indonesia's CPO export volume.

CONCLUSION AND RECOMMENDATION

The exchange rate has a positive and significant effect on Indonesia's CPO export volume. Gross Domestic Product (GDP) has a negative and significant effect on Indonesia's CPO export volume. Meanwhile, inflation has a positive but insignificant effect on Indonesia's CPO export volume. Inflation significantly strengthens exchange rate dynamics and their impact on indonesia's crude palm oil export volume. However, inflation does not significantly moderate the effect of Gross Domestic Product (GDP) on Furthermore, inflation was not found to significantly moderate the relationship between CPO prices and the volume of Indonesia's crude palm oil exports.

FURTHER STUDY

Future studies are recommended to include additional macroeconomic variables, such as international demand, export taxes, production costs, trade policies, and global vegetable oil prices, to provide a more comprehensive explanation of Indonesia's CPO export volume. Further research may also use a longer observation period and compare Indonesia with other major CPO-exporting countries, such as Malaysia. In addition, future studies can apply different analytical methods, such as ARDL, VECM, or panel data regression, to obtain deeper insights into the short-term and long-term relationships among exchange rates, GDP, CPO prices, inflation, and CPO export performance.

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