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Analysis of the Effect of Productive Land Area, Production Volume, Exchange Rates, and International Prices on the Volume of Indonesian Dry Natural Rubber Exports for the Period 2015-2024

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Abstract: This research investigates the impact of productive land area, production volume, the rupiah exchange rate against the US dollar, and international prices on Indonesia's dry natural rubber export volume from 2015 to 2024. Secondary data were sourced from the Central Statistics Agency, the Ministry of Agriculture, and Bank Indonesia. The analytical approach employed multiple linear regression, incorporating classical assumption tests and hypothesis testing to validate the model. Partial results reveal that productive land area, exchange rate, and international prices exert a negative yet insignificant influence on export volume. In contrast, production volume demonstrates a positive and significant effect, underscoring that higher output can substantially boost exports. Simultaneously results the four independent variables significantly affect export volume, as evidenced by an F_{value} of 97,446 exceeding the F_{table} value of 5,19 and a significance level of 0,000 below 0,05. The R^2 value of 0,987 suggests that 98,7% of the variation in export volume is accounted for by these factors. These findings highlight the critical role of enhancing production efficiency and implementing economic stabilization measures to improve the global competitiveness of Indonesia's rubber exports.

Keywords: Productive Land Area, Production Volume, Exchange Rate, International Prices, Export Volume.

INTRODUCTION

The agricultural sector serves as a vital cornerstone of Indonesia's economy, contributing significantly to job creation, supplying raw materials for industry, and generating foreign exchange via exports. Plantations are part of the agricultural sub-sector that has a major contribution, apart from mineral commodities, namely dried natural rubber. Indonesia is one of the world's three largest natural rubber producers, along with Thailand and Vietnam. Indonesia's rubber exports are widely used in the global automotive industry, particularly for vehicle tires, as well as various rubber-based products (Ismail & Ahmad, 2021).

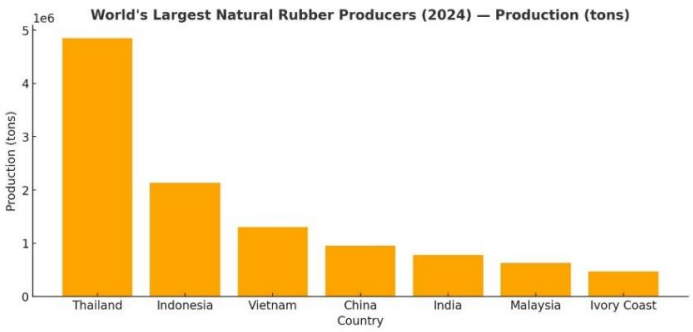


Figure 1. The World's Largest Rubber Producer in 2024
Source: Badan Pusat Statistik, 2025

According to the information presented in Figure 1, Thailand leads the world as the top producer of natural rubber, with an output of 4.850.000 tons significantly ahead of Indonesia, which ranks second with a production of 2.132.088 tons. In terms of production in 2024, Vietnam ranks third with a production of 1.300.000 tons, followed by China (950.000 tons), India (780.000 tons), Malaysia (630.000 tons), and Ivory Coast as the only representative from Africa with a production of 470.000 tons. This indicates that Southeast Asian countries dominate the global rubber market, including Indonesia (Badan Pusat Statistik, 2025).

As the world's second-largest producer of natural rubber, Indonesia exports various types of dry natural rubber such as Technically Specified Natural Rubber (TSNR), Smoked Sheets (RSS), Mixture Latex, Compounded Natural Gums, and Natural Rubber Latex, with competitiveness measured by the Revealed Comparative Advantage (RCA) index (Victor, 2023). TSNR is the main export commodity with the highest RCA (41,3), followed by RSS (9,12), Mixture Latex (3,05), Compounded Natural Gums (1,28), while Natural Latex has an RCA < 1 (Victor, 2023). Indonesia's rubber trade is based on the theory of comparative advantage, whereby the country exports products that have relatively higher efficiency and imports those that are less efficient (Victor, 2023). Global demand for natural rubber is influenced by developments in the automotive industry, world oil prices, and environmental policies in importing countries such as China, the United States, and the European Union (Putra et al., 2022).

Indonesia's rubber export performance in recent years has tended to be volatile and has even declined, raising concerns about the competitiveness of this commodity in the international market. Changes in rubber land area and production are important variables that determine the supply of rubber for the export market (Kementerian Pertanian, 2024).

Table 1. Development of Productive Land Area, Production Volume, and Export Volume of Dry Natural Rubber in Indonesia from 2015 to 2024

Year	Productive Land Area (ha)	Production Volume (tons/ha)	Export Volume (tons/ha)
2015	3.621.103	3.145.398	2.630.313
2016	3.639.049	3.357.951	2.578.791
2017	3.659.090	3.680.428	2.992.529
2018	3.671.387	3.630.357	2.812.105
2019	3.676.036	3.301.405	2.503.671
2020	3.726.173	3.037.348	2.279.915
2021	3.776.486	3.045.314	2.334.734
2022	3.557.091	2.717.081	2.035.902
2023	3.152.745	2.240.826	1.753.985

2024	3.149.277	2.132.088	1.619.334

Source: Badan Pusat Statistik, 2025; Kementerian Pertanian Republik Indonesia, 2025

According to the data in Table 1, Indonesia's productive rubber land area decreased from 3.621.103 million hectares in 2015 to around 3.149.277 million hectares in 2024, accompanied by a decline in production from 3.145.398 million tons per hectare to 2.132.088 million tons per hectare in the same period. This condition is directly proportional to the decline in rubber export volume, which only reached 1.619.334 million tons per hectare in 2024, a significant decrease compared to 2.630.313 million tons per hectare in 2015 (Badan Pusat Statistik, 2025).

Fluctuations in Indonesia's rubber export volume are not only influenced by domestic production factors, but also by external dynamics such as international rubber prices and the Indonesian rupiah exchange rate against the US dollar. International rubber prices, which are highly dependent on global demand, especially from the automotive industry, have experienced instability due to changes in the global economic cycle, climate, and economic slowdowns in major importing countries such as China. The rupiah exchange rate, which has tended to weaken against the US dollar in the period from 2015 to 2024, is also an important factor, because rupiah depreciation generally increases the competitiveness of export prices, while appreciation has the potential to weaken exports (Saputri et al., 2025).

Table 2. Development of Exchange Rate, International Price, and Export Volume of Dry Natural Rubber in Indonesia from 2015 to 2024

Year	Exchange Rate (IDR/US$)	International Price (US$/kg)	Export Volume (tons/ha)
2015	13.392	11.780	2.630.313
2016	13.307	19.030	2.578.791
2017	13.384	14.690	2.992.529
2018	14.246	14.050	2.812.105
2019	14.146	14.470	2.503.671
2020	14.572	15.030	2.279.915
2021	14.312	17.830	2.334.734
2022	14.871	13.020	2.035.902
2023	15.255	15.610	1.753.985
2024	15.847	18.760	1.619.334

Source: Central Statistics Agency, 2025; Bank Indonesia, 2025

According to Table 2, the Indonesian rupiah exchange rate against the US dollar, international rubber prices, and Indonesia's rubber export volume exhibited fluctuations over the period from 2015 to 2024. At the beginning of the period, the rupiah exchange rate was recorded at IDR 13,392 per US$, the rubber price was US$ 11.780 per kg, and the export volume was 2.630.313 million tons. However, over time, the rupiah exchange rate continued to weaken to IDR 15.847 per US$ in 2024. The global price of rubber rose in 2016 to US$ 19.030 per kg, but then fluctuated and fell back to US$ 18.760 per kg in 2024. These conditions have impacted export performance, which, despite increasing in 2017 to nearly 3 million tons per hectare, has overall declined significantly to only 1.619.334 million tons per hectare in 2024. This indicates that the depreciation of the rupiah and the volatility of global rubber prices have significantly undermined the competitiveness of Indonesian rubber exports in the international market (Badan Pusat Statistik, 2025; Bank Indonesia, 2025).

Rubber plays an important role in the Indonesian economy, and the significant decline in exports makes this study highly relevant and important. This study specifically focuses on the

period 2015 to 2024, during which there was a significant decline in natural rubber exports. Based on the background, which includes a decline in productive land area, production volume, and the rupiah exchange rate and international rubber prices that are not always in line with demand theory, identifying the factors that drive and hinder Indonesian rubber exports is very important. Therefore, the title of this study is formulated as follows: "Analysis of the Effect of Productive Land Area, Production Volume, Exchange Rate, and International Prices on the Volume of Indonesian Natural Rubber Exports for the Period 2015–2024," with the aim of analyzing the impact of these variables, both simultaneously and partially, on the volume of Indonesian dry natural rubber exports.

METHOD

This study employs a quantitative approach with explanatory research to examine the influence of productive land area, production volume, the rupiah exchange rate against the US dollar, and international prices on Indonesia's dry natural rubber export volume over the 2015 to 2024 period. Conducted in Serang using purposive sampling from 2025 to 2026, the study relies on secondary time-series data sourced from the Central Statistics Agency, the Ministry of Agriculture of the Republic of Indonesia, and Bank Indonesia. Data analysis was performed using multiple linear regression in IBM SPSS 22, incorporating classical assumption tests normality, multicollinearity, heteroscedasticity, and autocorrelation to validate the regression model. Hypothesis testing included F tests, t tests, and the coefficient of determination (R^2) to assess the significance and extent of the independent variables' impact on the dependent variable.

RESULTS AND DISCUSSION

Classical Assumption Test

Normality Test Results

A normality test was performed on the regression model for Indonesia's dry natural rubber export volume to assess whether the independent and dependent variables were normally distributed. This test is essential for confirming the data distribution in the regression analysis. According to the Kolmogorov-Smirnov test, if the significance value is less than 0,05; the data is deemed non-normally distributed; if greater than 0,05; the data is considered normally distributed.

Table 3. Results of the Kolmogorov-Smirnov One-Sample Normality Test

One-Sample Kolmogorov-Smirnov Test	
Kolmogorov-Smirnov Z	0,189
Asymp. Sig. (2-tailed)	0,200

Source: The author processed the data using IBM SPSS 22

According to the One-Sample Kolmogorov-Smirnov Test results in Table 3, the Asymptotic Significance (2-tailed) is 0,189; which exceeds 0,05; and the Kolmogorov-Smirnov statistic is 0,200; also above 0,05. Based on the test's decision rule where an Asymp. Sig. value greater than 0,05 indicates normal distribution it is concluded that the data in this study are normally distributed.

Multicollinearity Test Results

Multicollinearity testing is conducted to detect excessively high correlations among independent variables within a regression model. Such high correlations can cause regression coefficient estimates to become unstable. A common measurement is done through the Variance Inflation Factor (VIF). The model is considered free of multicollinearity if VIF < 10

or Tolerance > 0,10. Conversely, there is an indication of multicollinearity if VIF > 10 or Tolerance < 0,10.

Table 4. Multicollinearity Test Results

Variable	Tolerance	VIF	Criteria
Area of Productive Dry Natural Rubber Plantations (X_1)	0,301	3,319	No Multicollinearity
Production Volume of Dry Natural Rubber (X_2)	0,168	5,965	No Multicollinearity
Rupiah Exchange Rate Against the Dollar (X_3)	0,267	3,743	No Multicollinearity
International Price of Dry Natural Rubber (X_4)	0,921	1,085	No Multicollinearity

Source: The author processed the data using IBM SPSS 22

According on the results shown in Table 4, a regression model is considered free of multicollinearity if both tolerance and VIF values exceed 0,10. The findings indicate that tolerance and VIF values for all independent variables (X) are above 0,10 and below 10. Accordingly, the regression model is confirmed to be free from multicollinearity. Tolerance values greater than 0,01 further demonstrate that the independent variables are not excessively correlated, ensuring each contributes meaningfully without redundancy that could distort model estimation.

Heteroscedasticity Test Results

The heteroscedasticity test assesses whether the variance of residuals remains constant or exhibits inequality across observations. It involves correlating independent variables with unstandardized residuals. Common statistical methods include the Park test, Glejser test, White test, Spearman's rank correlation test, Goldfeld-Quandt test, and Breusch Pagan Godfrey test. This study applies the Glejser test. The decision criterion is as follows: heteroscedasticity is absent if the significance value exceeds 0,05; and present if it is below 0,05.

Table 5. Results of Glejser Heteroscedasticity Testing

Variable	Significance	Criteria
(Constant)	0,331	
Area of Productive Dry Natural Rubber Plantations (X_1)	0,542	No Heteroscedasticity
Production Volume of Dry Natural Rubber (X_2)	0,270	No Heteroscedasticity
Rupiah Exchange Rate Against the Dollar (X_3)	0,154	No Heteroscedasticity
International Price of Dry Natural Rubber (X_4)	0,328	No Heteroscedasticity

Source: The author processed the data using IBM SPSS 22

According on the results shown in Table 5, the Glejser test was performed by regressing the absolute residual values (AbsUi) against the independent variables. Heteroscedasticity is absent if the significance value between the absolute residuals and each independent variable exceeds 0,05. The SPSS results show significance values for productive land area (X_1) at 0,542; production volume (X_2) at 0,270; rupiah exchange rate against the dollar (X_3) at 0,154; and international price (X_4) at 0,328 all greater than 0,05. This leads to the conclusion that the model used does not exhibit heteroscedasticity.

Autocorrelation Test Results

The autocorrelation test aims to detect correlations between regression errors in periods t and t-1, which indicate the presence of autocorrelation due to sequential data relationships. This study uses a non-parametric Runs Test to test whether the residuals are random or systematic. If the Asymp. Sig. (2-tailed) value is > 0,05; then there is no significant autocorrelation and the regression model is optimal.

Table 6. Results of the Autocorrelation Runs Test

Runs Test

Asymp. Sig. (2-tailed)
0,737

Source: The author processed the data using IBM SPSS 22

According on the results shown in Table 6, the Asymp. Sig. (2-tailed) score of 0,737 > 0,05. Linear regression analysis can be continued because this finding suggests that the regression model does not show signs of autocorrelation.

Multiple Linear Regression Analysis

The influence of the independent variables productive land area (X_1), production volume (X_2), rupiah exchange rate against the US dollar (X_3), and international prices (X_4) on the dependent variable, natural rubber export volume (Y), was assessed through multiple linear regression. This method models the linear relationship between multiple independent variables and a single dependent variable, aiming to determine the direction of their associations, whether positive or negative. The outcomes of the multiple regression analysis, processed using SPSS 22, are presented in the table below:

Table 7. Multiple Linear Regression Test Results

Variable	Coefficient			
	B	T	Significance	VIF
(Constant)	3005398,045	2,774	0,039	
Area of Productive Dry Natural Rubber Plantations (X_1)	-0,308	-1,699	0,150	3,319
Production Volume of Dry Natural Rubber (X_2)	0,761	7,357	0,001	5,965
Rupiah Exchange Rate Against the Dollar (X_3)	-114,982	-2,238	0,075	3,743
International Price of Dry Natural Rubber (X_4)	-13,711	-1,423	0,214	1,085

Source: The author processed the data using IBM SPSS 22

According on the results shown in Table 7, the regression coefficient values for each variable, derived from the multiple linear regression analysis performed using SPSS, are presented. The resulting regression equation model is stated as follows:

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

$$Y = 3005398{,}045 - 0{,}308\ X_1 + 0{,}761\ X_2 - 114{,}982\ X_3 - 13{,}711\ X_4 + \varepsilon$$

The equation indicates that the regression coefficient of variable X1 exerts a negative influence. In other words, each 1-unit increase in X_1 will cause a decrease of 0,308 in Indonesia's natural rubber export volume (Y). In this analysis, it is assumed that variables X_2, X_3, and X_4 remain constant. A positive effect is given by the regression coefficient of variable X_2. This implies that a 1-unit increase in X_2 will result in an increase of 0,761 in Indonesia's natural rubber export volume (Y). In this analysis, it is assumed that variables X_1, X_3, and X_4 remain constant. The regression coefficient associated with variable X_3 shows a negative impact. Specifically, a 1-unit increase in X_3 results in a decrease of 114,982 in Indonesia's natural rubber export volume (Y). In this analysis, it is assumed that variables X_1, X_2, and X_4 remain constant. The regression coefficient of variable X_4 has a negative effect. In other words, each 1-unit increase in X_4 will cause a decrease of 13,711 in Indonesia's natural rubber export volume (Y). In this analysis, it is assumed that variables X_1, X_2, and X_3 remain constant. The constant of 3005398,045 demonstrates that if the values of all independent variables (X_1, X_2, X_3, and X_4) are zero, then Indonesia's natural rubber export volume (Y) is estimated to reach 3005398,045 units.

Hypothesis Testing

Results of the Coefficient of Determination Test (R^2)

The autocorrelation test aims to detect correlations between regression errors in periods t and t-1, which indicate the presence of autocorrelation due to sequential data relationships. This study uses a non-parametric Runs Test to test whether the residuals are random or systematic. If the Asymp. Sig. (2-tailed) value is > 0,05; then there is no significant autocorrelation and the regression model is optimal.

Table 8. Results of the Coefficient of Determination (R^2) Test

R	R Square
0,994	0,987

Source: The author processed the data using IBM SPSS 22

According on the results shown in Table 8, the correlation values obtained from the relationship between the four variables show that R indicates a multiple linear correlation/Pearson correlation between productive land area (X_1), production volume (X_2), the rupiah exchange rate against the US dollar (X_3), international prices (X_4), and natural rubber export volume (Y) is 0,994. A correlation coefficient of 0,994 signifies a very strong positive relationship, demonstrating that productive land area, production volume, the rupiah exchange rate against the US dollar, and international prices collectively have a substantial impact on the volume of natural rubber exports in Indonesia.

The R^2 value (coefficient of determination) is 0,987; as shown in Table 8. This shows that the independent factors, particularly productive land area (X_1), production volume (X_2), the rupiah exchange rate against the US dollar (X_3), and international prices (X_4), can explain the dependent variable, namely natural rubber export volume (Y), by around 98,7%. The remaining 1,3% is attributable to other factors not examined in this study. A coefficient of determination of 0,987; which is close to 1, indicates that the regression model is highly accurate and that the independent variables strongly account for the variation in the dependent variable.

Simultaneous Test Results (F Test)

The F test is employed to assess whether the independent variables collectively exert a significant effect on the dependent variable. Also referred to as the simultaneous significance test, it evaluates whether the combined influence of all independent variables in the model on the dependent variable is statistically meaningful. When the test yields highly significant results, the null hypothesis (H_0) is rejected in favor of the alternative hypothesis (H_1). The opposite occurs when the results are not significant; in such cases, (H_0) is accepted while (H_1) is rejected. From this context, it is clear that (H_0) is rejected when the F_{value} score exceeds F_{table}, and accepted when the F_{value} does not reach F_{table}. Furthermore, an F_{value} score that exceeds the critical score of F_{table} or a significance score > 0,05 indicates that the independent factors jointly influence the dependent factor.

Table 9. Simultaneous Test Results (F test)

Model	Df	F_{value}	F_{table}	Significance
Regression	4	97,446	5,19	0,000
Residual	5			
Total	9			

Source: The author processed the data using IBM SPSS 22

According on the results shown in Table 9, The significance value is 0,000; confirming that the test result is less than the significance level of 0,05 (0,000 < 0,05). In addition to looking at the significance value, it is also proven by the Fcount test result obtained of 97,446 and the F_{table} value determined to be 5,19 when df 1 (number of independent variables) is equal to 4 and df 2 (n-k-1) is equal to 5. It is known that F_{value} (97,446) > F_{table} (5,19); this shows that

together, the four independent variables of productive land area (X_1), production volume (X_2), rupiah exchange rate against the US dollar (X_3), and international prices (X_4) have a significant simultaneous effect on the dependent variable of natural rubber export volume (Y).

Partial Test Results (t test)

The partial t test is a statistical technique employed to evaluate whether the coefficients of the four independent variables collectively influence the dependent variable, or whether each independent variable exerts a partial (individually significant) effect on the dependent variable. If the t test yields a t_{value} that surpasses the critical t_{table} value or a significance level below 0,05; it indicates a significant partial influence on the dependent variable.

Table 10. Partial Test Results (t test)

Model	t_{value}	t_{table}	Significance
Area of Productive Dry Natural Rubber Land (X_1)	-1,699	2,571	0,150
Production Volume of Dry Natural Rubber (X_2)	7,357	2,571	0,001
Rupiah Exchange Rate Against the Dollar (X_3)	-2,238	2,571	0,075
International Price of Dry Natural Rubber (X_4)	-1,423	2,571	0,214
Volume of Natural Dry Rubber Exports (Y) = Variabel Dependent			
Constant = 3005398,045			

Source: The author processed the data using IBM SPSS 22

According on the results shown in Table 10, the obtained t_{value} is -1,699; while the t_{table} value is 2,571; thus, $t_{value} < t_{table}$. The significance level for the productive natural rubber land area variable is 0,150 > 0,05; therefore, there is no statistically significant partial effect between the independent variable of area of productive dry natural rubber land (X_1) and the dependent variable of volume of natural dry rubber exports (Y).

The obtained t_{value} is 7,357; while the t_{table} value is 2,571; thus, t_{value} (7,357) > t_{table} (2,571). The significance level for the natural rubber production volume variable is 0,001 < 0,05; therefore, there is a statistically significant partial effect between the independent variable of production volume of dry natural rubber (X_2) and the dependent variable of volume of natural dry rubber exports (Y).

Additionally, the t_{value} is -2,238 and the t_{table} is 2,571; thus, t_{value} (-2,238) < t_{table} (2,571). The significance level for the rupiah exchange rate against the US dollar is 0,075 > 0,05; therefore, there is no statistically significant partial effect between the independent variable of the rupiah exchange rate against the dollar (X_3) and the dependent variable of volume of natural dry rubber exports (Y).

Furthermore, the t_{value} is -1,423 and the t_{table} is 2,571; thus, t_{value} (-1,423) < t_{table} (2,571). The significance level for the international price of natural rubber is 0,214 > 0,05; therefore, there is no statistically significant partial effect between the independent variable of the international price of dry natural rubber (X_4) and the dependent variable of volume of natural dry rubber exports (Y).

Relationship between Productive Land Area and Dry Natural Rubber Export Volume

The hypothesis testing results indicate that productive land area has no statistically significant impact on Indonesia's dry natural rubber export volume. Specifically, it exerts a negative influence, whereby an expansion in productive land area may paradoxically reduce export volume, though this effect lacks significance. This phenomenon arises from issues like declining land productivity stemming from inadequate management practices or land expansion unaccompanied by corresponding improvements in production quality, thereby failing to boost exportable supply (Cahyaningtyas et al., 2022). As theorized by Santoso & Wibowo (2023), land area contributes to achieving economies of scale in agriculture, yet its influence on exports is not invariably positive without sufficient technological support in

cultivation and supportive government policies. Absent productivity gains, larger land areas can lead to stagnant or declining export volumes due to operational inefficiencies. Putra & Sari (2022) further note that land area influences production indirectly, but in export contexts, extraneous variables such as weather conditions and land management practices can invert this relationship from positive to negative. These findings align with prior studies, including Silaban et al. (2020), who observed that land area does not consistently yield positive effects on Indonesia's natural rubber exports to the United States, and Ngatemini et al. (2022), who reported a negative and insignificant relationship with export volumes attributable to fluctuating land productivity.

Relationship between Production Volume and Export Volume of Dry Natural Rubber

The hypothesis testing results indicate that production volume exerts a significant influence on the volume of dry natural rubber exports in Indonesia. Specifically, production volume positively impacts export volumes, meaning that an annual rise in production will boost exports by providing a greater supply of rubber to satisfy international demand (Wijaya & Hartono, 2021). As outlined in the theory by Prasetyo et al. (2023), rubber production embodies the efficiency of inputs and outputs within the plantation industry; advancements via agronomic technologies enhance exports, leveraging Indonesia's comparative advantage. Higher production levels thus lead to expanded export volumes through improved domestic supply capacity. Sari & Nugroho (2024) further explain that contemporary rubber production employs an integrated system linking input elements to export markets, rendering this positive effect crucial for maintaining global competitiveness. These findings align with earlier studies, including Izzah & Bujana (2024), which confirmed a positive impact of production volume on Indonesia's rubber exports from 2019 to 2023, and Putra et al. (2022), who identified a significant positive correlation between production and export demand for natural rubber.

Relationship between Exchange Rates and the Volume of Dry Natural Rubber Exports

The hypothesis testing outcomes reveal that the rupiah to US dollar exchange rate does not significantly influence the volume of dry natural rubber exports from Indonesia. This exchange rate exhibits a negative impact on export volumes, such that a depreciation of the rupiah (reflected in a higher exchange rate against the dollar) may lead to reduced exports, albeit insignificantly, likely due to elevated costs of imported inputs like fertilizers and technology, which erode export competitiveness (Salim & Soelistyo, 2024). As theorized by Astuti & Ardila (2019), exchange rate volatility influences export pricing via connections to financial markets, yet this impact is not invariably beneficial without accompanying domestic economic stability. A weakening exchange rate can thus diminish export volumes owing to reliance on costlier imported inputs. Safitri et al. (2025) note that exchange rates, as a key macroeconomic variable, shape exports through international trade dynamics, but for rubber, elements like inflation and global demand overshadow the exchange rate's role. These results corroborate prior research, such as Rezandy & Yasin (2021), which found no significant exchange rate effect on Indonesia's non-oil and gas exports, and Tiara Annisa et al. (2024), who reported a negative and insignificant relationship between the exchange rate and international rubber trade volumes.

Relationship between Prices and the Volume of Dry Natural Rubber Exports

The hypothesis testing results demonstrate that international prices do not exert a significant influence on the volume of dry natural rubber exports from Indonesia. International prices display a negative impact on these export volumes, meaning that annual increases in global prices may paradoxically lead to reduced exports, though the effect is not statistically significant. This phenomenon could stem from elevated prices prompting importing nations to

shift toward synthetic rubber or alternative substitutes, thereby diminishing demand for Indonesian exports (Yuningtyas et al., 2019). As theorized by Putra et al. (2022), global rubber prices are shaped by demand fluctuations in the automotive sector, yet sharp price volatility can curtail export volumes unless countered by enhancements in product quality. Rising international prices might thus suppress exports amid erratic demand and rivalry from synthetic alternatives. Johnson & Lee (2019) highlight that worldwide natural rubber demand is affected by environmental considerations, but steep prices frequently constrain short-term export volumes. These findings are consistent with earlier research, including Ngatemini et al. (2022), which identified a negative and insignificant relationship between international prices and Indonesian natural rubber exports, as well as Syofya & Dwisefianto (2024), who observed comparable effects on exports of plantation products like coffee and rubber.

CONCLUSION

From the research findings spanning 2015 to 2024, it was determined that productive land area, production volume, exchange rates, and international prices simultaneously have a significant effect on the volume of Indonesia's dry natural rubber exports. This is supported by an F_{value} of 97,446, which exceeds the F_{table} value of 5,19; a significance level of 0,000 below 0,05; and an R^2 of 0,987; indicating that these four variables explain 98,7% of the variation in export volume. Therefore, these factors collectively play a crucial role in shaping Indonesia's rubber export performance in the international market, although other variables not modeled have a minor influence.

Partial analysis reveals that production volume is the sole variable exerting a positive and significant impact on Indonesia's dry natural rubber export volume, supported by a t_{value} of 7,357, which exceeds the t_{table} value of 2,571; a significance level of 0,001 below 0,05; while productive land area, currency exchange rates, and international prices have a negative but insignificant impact. An increase in production volume has been proven to increase exports because it increases domestic supply to meet global demand. Conversely, land expansion without increased productivity, depreciation of the rupiah exchange rate, and increases in international prices have no real impact on exports and may even reduce competitiveness.

This study offers a thorough examination of the relationships among variables influencing Indonesia's natural rubber exports. Further in depth research is needed to explore other factors that could potentially affect export volumes and refine the model to provide more accurate predictions. Based on these results, it is advised that the government prioritize policies aimed at boosting productivity by adopting modern agronomic technologies including high quality seeds, fertilizers, and efficient irrigation systems instead of focusing exclusively on expanding land area. The government is also expected to maintain the stability of the rupiah exchange rate with appropriate monetary policies to reduce the negative impact of exchange rate fluctuations on production costs. For farmers and rubber industry players, the implementation of sustainable cultivation practices is important to increase efficiency and export competitiveness. Future researchers are advised to add variables such as trade policies, climate conditions, and demand from export destination countries to enrich the analysis, while comparing rubber management strategies with major producing countries such as Thailand and Vietnam as a reference for improving the competitiveness of the national rubber agribusiness.

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