Jurnal Bisnis Tani
AGRIBISNIS - UNIVERSITAS TEUKU UMAR

Bisnis Tani, Vol. 11, No. 2, tahun 2025
https://jurnal.utu.ac.id/jbtani
ISSN 2477-3468 (print), 2714-7479 (online)
DOI: 10.35308/jbt

AN ANALYSIS OF THE PERFORMANCE OF INDONESIAN NATURAL RUBBER EXPORT DEVELOPMENT TO CHINA

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Abstract
Natural rubber is one of Indonesia's leading export commodities, with the country ranked as the world's second-largest producer. China, as the largest global consumer of natural rubber, plays a strategic role as Indonesia's key export destination. This study aims to analyze the factors influencing Indonesia's natural rubber exports to China by employing a quantitative approach using Two-Stage Least Squares (2SLS). The results show that Indonesian rubber prices, Chinese rubber prices, Indonesian rubber production, and Chinese inflation significantly affect Indonesian natural rubber exports to China. Conversely, competitor countries' rubber production, Chinese GDP, and Indonesian export quota policies are found to be insignificant. Furthermore, world rubber prices and competitor countries' rubber prices significantly influence Indonesian domestic rubber prices. World rubber prices and Chinese rubber demand also significantly affect Chinese rubber prices, while the price of rubber substitute products in China shows no significant effect. These findings imply that price strategies, domestic production strengthening, and macroeconomic stability in the destination country must be considered when formulating Indonesia's natural rubber export policies. Overall, the study provides valuable insights for enhancing Indonesia's competitiveness in the global rubber market.

Keywords: *Rubber Exports, Rubber Prices, Inflation.*

1. INTRODUCTION

Natural rubber is one of Indonesian leading non-oil and gas export commodities in the global market, possessing substantial potential for further development. Currently, Indonesia ranks as the world's second-largest producer of natural rubber, following Thailand. In addition, Indonesia holds the position as the country with the largest natural rubber plantation area globally (Krismawan et al., 2021). Natural rubber remains a strategic export commodity for Indonesia in the international market. However, the competitiveness of Indonesian natural rubber still lags behind that of other major players in the global rubber industry. The factors shaping this competitiveness include export performance, trade balance, and economic cooperation (Sembiring et al., 2021). Indonesian natural rubber exports represent one of the most significant contributors to the country's Gross Domestic Product (GDP), with a total export value of USD 3.54 million. In 2022, natural rubber accounted for 1.21% of Indonesian total export value.

The United States, Japan, and China are the three largest importers of natural rubber in the world. This is primarily due to the rapid industrial development in these countries, which positions them as global pioneers of industrial growth. Natural rubber serves as a key raw material for various major industries in these nations, including the automotive industry, medical equipment manufacturing, construction, general manufacturing, and even shipbuilding, all of which have contributed to the rising demand for natural rubber (Agustina et al., 2024). These three countries also represent the main export destinations for Indonesian natural rubber. In 2022, Indonesia exported natural rubber valued at USD 3.54 million, of which 54.4% was shipped to the United States, Japan, and China (UNComtrade, 2023).

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China is the largest consumer of natural rubber in the world. The country's domestic consumption of natural rubber is primarily driven by key industrial sectors such as the tire manufacturing industry, the automotive industry, as well as the construction and manufacturing industries (Saragih & Ibrahim, 2023). To meet its domestic demand, China imports natural rubber from several supplier countries. In 2022, China imported natural rubber valued at USD 4.03 million, with the majority originating from Thailand. Meanwhile, Indonesia ranked sixth among natural rubber exporters to China in terms of export value. Indonesian natural rubber exports to China amounted to USD 297.60 thousand, representing only 7.38% of Chinese total natural rubber imports from all countries (UNComtrade, 2023). The export value of Indonesian natural rubber to China remains relatively low, despite Indonesia being the world's second-largest producer of natural rubber. Considering that China is one of the world's leading manufacturers of rubber-based industrial products, and given that domestic rubber prices in China are generally higher than in other countries, the Chinese market should in fact represent a strategic export destination for Indonesian natural rubber (Ardanari et al., 2020).

Based on the aforementioned background, an in-depth examination is required to analyze the factors influencing Indonesia's natural rubber exports to China using a quantitative approach. An econometric framework employing a simultaneous-equation model is expected to provide a more comprehensive understanding of the interrelationships among mutually influencing economic variables. This study applies the Two-Stage Least Squares (2SLS) method as the primary analytical tool to identify the determinants of Indonesian natural rubber exports to China, the determinants of Indonesian rubber prices, and the determinants of Chinese rubber prices.

Although numerous studies have examined factors influencing Indonesia's natural rubber exports, most have adopted partial analytical approaches and have not accounted for the simultaneous interactions among key variables such as domestic rubber prices, destination-country prices, national production, and the macroeconomic conditions of importing countries. Previous literature generally models these relationships separately using single-equation frameworks, which fail to capture the inherent structural interdependencies characterizing the natural rubber commodity market. Consequently, a clear research gap exists in the absence of a comprehensive model that integrates price mechanisms, production dynamics, and external factors within a simultaneous-equation system. This study focuses on variables such as Indonesian rubber prices, Chinese rubber prices, domestic production, and China's macroeconomic indicators because these variables are theoretically interrelated. For instance, China's GDP is expected to influence import demand through income effects, while inflation may affect industrial purchasing power and production cost structures. Similarly, Indonesian and Chinese rubber prices not only determine export volumes but also influence each other through international price transmission mechanisms. Given the simultaneous and non-unidirectional nature of these relationships, employing a simultaneous-equation model (2SLS) is methodologically justified to generate estimates that avoid endogeneity bias and better reflect complex market dynamics.

2. METHOD

2.1 Research Model and Hypotheses

The study employs a quantitative method. The data are secondary and were obtained from Trade Map (ITC), the World Bank, and Indonesian Directorate General of Estate Crops over a 24-year period (2001–2024). The variables include Indonesian natural rubber exports to China; Indonesian natural rubber price; Chinese natural rubber price; the world natural rubber price; the natural rubber price of a competing country (Thailand); Indonesian natural rubber production; Thailand's natural rubber production; Indonesian natural rubber export-quota restrictions; demand for

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Indonesian natural rubber; Indonesian total natural rubber exports; Chinese gross domestic product (GDP); Chinese inflation; and the price of substitute goods for natural rubber in China.

This study applies the Two-Stage Least Squares (2SLS) approach within a system of simultaneous equations, which provides a clearer and more comprehensive representation of real-world conditions than a single-equation model because it allows interdependence and interaction among variables across multiple equations (Misno, 2019). In the simultaneous-equation framework, the object of analysis is Indonesian natural rubber sector. Quantitative findings are presented in tabular form and discussed descriptively in line with the study's theoretical objectives. The subsequent steps test hypotheses regarding the expected values in each equation to explain the relationships among variables and to derive insights into the research problem (Ismayani, 2019). The simultaneous-equation model is formulated as follows:

(i) Exports of Indonesian Rubber to China

$X_{CH} = a_0 + a_1P_{ID} + a_2P_{CH} + a_3Q_{ID} + a_4Q_C + a_5GDP_{CH} + a_6PO + a_7IF_{CH} + e$.....(1)

Keterangan :

a_0	: Intercept
$a_1 – a_7$	: Regression coefficient
X_{CH}	: Exports of Indonesian rubber to China (Tons/year)
P_{ID}	: Indonesian rubber prices (USD/ton)
P_{CH}	: Chinese rubber prices (USD/ton)
Q_{ID}	: Indonesian rubber production (Tons/year)
Q_C	: Rubber Production of Competitor Countries (Tons/year)
GDP_{CH}	: Chinese gross domestic product (USD/year)
PO	: Indonesian rubber export quota limit policy
IF_{CH}	: Chinese inflation (%/year)
e	: error term

(ii) Indonesian Rubber Prices

$P_{ID} = b_0 + b_1Q_{ID} + b_2P_W + b_3P_C + b_4D_{ID} + b_5X_{TOT} + b_6PO + e$.....(2)

Keterangan:

b_0	: Intercept
$b_1 – d_6$	: Regression coefficient
P_W	: World rubber prices (USD/ton)
Q_{ID}	: Indonesian rubber production (Tons/year)
P_C	: Rubber prices in competitor countries (USD/ton)
D_{ID}	: Indonesian rubber demand (Tons/year)
X_{TOT}	: Total indonesian natural rubber exports (Tons/year)
PO	: Indonesian rubber export quota limit policy
e	: error term

(iii) Chinese rubber prices

$P_{CH} = c_0 + c_1P_W + C_2PS_{CH} + c_3D_{CH} + e$.....(3)

Keterangan:

c_0	: Intercept
$c_1 – c_4$	: Regression coefficient
P_{CH}	: Chinese rubber prices (USD/ton)
P_W	: World rubber prices (USD/ton)
PS_{CH}	: Prices of Chinese rubber substitutes (Tons/year)
D_{CH}	: Rubber demand in China (Tons/year)
e	: error term

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A simultaneous-equation model can be exactly identified by applying the order condition as a sufficiency criterion (Handayani et al., 2023). Following that reference, a structural equation in the system is identifiable if it satisfies two requirements:
(1) Order condition. For an equation to be identifiable, the total number of variables that are excluded from the equation but appear in the other equations must be at least the number of equations in the system minus one. Formally:

$$(K - M) > (G - 1)$$

with the following cases: :
(K-M) = (G-1) : exactly identified
(K-M) > (G-1) : over identified
(K-M) < (G-1) : under identified
Keterangan :
K : total number of predetermined variables in the model (including the intercept);
M : number of predetermined variables that appear in the equation under consideration;
G : total number of structural equations in the model.

(2) Rank condition**.** In a system with G equations, an equation is identifiable if one can construct at least one non-zero determinant of order G−1 from the coefficients of the variables that are excluded from that equation but included in the other equations. Based on these formulas, the equation under study includes three variables, and the model consists of three structural equations. The calculation is summarized in **Table 1**.

Table 1 Order condition calculation results

Equations	K-M	< / = / >	G-1	Identified
X_{CH}	14-8	>	3-1	Over identified
P_{ID}	14-7	>	3-1	Over identified
P_{CH}	14-4	>	3-1	Over identified

Model identification was assessed through both the order and rank conditions. All three structural equations in the system were found to be overidentified, indicating that the number of excluded exogenous variables exceeds the minimum required for identification. Overidentified equations are preferable in simultaneous-equation modeling because they allow for the application of 2SLS, which produces consistent estimates even when endogenous regressors are correlated with the error term. The reason for choosing this method is that the application of 2 SLS yields more consistent, simpler, and easier forecasts compared to the 3 SLS and FIML methods, which are more sensitive to measurement and model specification errors despite relying on more data.

Instrument validity in this research is established based on two main criteria: instrument relevance and instrument exogeneity. Instrument relevance requires that the instruments used in the first-stage estimation be strongly correlated with the endogenous variables they are intended to predict. This is assessed through first-stage F-statistics and partial R^2 values to ensure the absence of weak instruments. Instrument exogeneity requires that the instruments are uncorrelated with the error terms in the structural equations, implying that they influence the dependent variable only through the endogenous regressors. The selection of instruments (such as world rubber prices, competitor-country rubber prices, Indonesian rubber demand, and total export volumes) is

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theoretically grounded in economic relationships that generate exogenous variation suitable for identifying endogenous effects.

An endogeneity test, specifically the Hausman specification test, was conducted to determine whether the use of 2SLS was necessary. The test results indicated significant differences between OLS and 2SLS coefficient estimates, confirming the presence of endogeneity. This validates the use of 2SLS as the appropriate estimation technique. Multicollinearity diagnostics were also performed using variance inflation factors (VIFs) and correlation matrices to ensure that collinearity among instruments and exogenous variables does not distort parameter estimates or inflate standard errors.

3. RESULT AND DISCUSSION

Exports of Indonesian Rubber to China Analysis

Table 2 Estimated results of factors influencing Indonesian rubber exports to the United States

Equation			"R-sq"	F-Stat
Indonesian rubber exports to China (X_{CH})			0.774	6.847
	Coef.	Std. err.	T-Ratio	P-Value
Constant	111,887	86,737	1.290	0.218
Indonesian rubber prices (P_{ID})	-5742,292	2,136	-2.688	0.018
Chinese rubber prices (P_{CH})	6504,389	2,246	2.896	0.012
Indonesian rubber production (Q_{ID})	2,217	1,184	1.873	0.082
Rubber Production of Competitor Countries (Q_C)	0,549	1,051	0.522	0.610
China gross domestic product (GDP_{CH})	-13,889	10,496	-1.323	0.207
Indonesian rubber export quota policy (PO)	-0,006	0,023	-0.246	0.810
Chinese inflation (IF_{CH})	-0,182	0,159	2.141	0.027

The equation for Indonesian rubber exports to China is influenced by Indonesian rubber price (P_{ID}), Chinese rubber price (P_{CH}), Indonesian rubber production (Q_{ID}), the rubber production of competitor countries (Q_C), Chinese gross domestic product (GDP_{CH}), the export-quota restriction policy (P_O), and Chinese inflation (IF_{CH}). The R-square value for this equation is ; thus, the factors in the model can explain 84.2% of Indonesian natural rubber exports to China (X_{CH}), while the remaining 15.8% is affected by other variables not included in the equation. The results of the simultaneous test at the 95% level of accuracy (α = 0.05) obtained Fcalculated = 6.847 and Ftable = 2.62, so Fcalculated is greater than Ftable; therefore, accept Ha and reject H0. This means that Indonesian rubber price (P_{ID}), Chinese rubber price (P_{CH}), Indonesian rubber production (Q_{ID}), the rubber production of competitor countries (Q_C), Chinese gross domestic product (GDP_{CH}), the export-quota restriction policy (P_O), and Chinese inflation (IF_{CH}) jointly have a significant effect on the variable of Indonesian rubber exports to China (X_{CH}).

Based on Table 1, the export equation for Indonesian rubber exports to China can be written as follows: $\mathbf{X_{CH} = 111.887 - 5{,}742\ P_{ID} + 6{,}504\ P_{CH} + 2{,}217\ Q_{ID} + 0{,}549\ Q_C - 13{,}889\ GDP_{CH} - 0.006\ P_O - 0.182\ IF_{CH} + e}$.

The value of the constant in the equation for Indonesian rubber exports to China is 111,887, which means that if all variables in the equation for Indonesian rubber exports to China in a given year are considered constant and not influenced by other factors, then Indonesian rubber exports to China (X_{CH}) will increase by 111,887 tons per year.

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AGRIBISNIS - UNIVERSITAS TEUKU UMAR

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https://jurnal.utu.ac.id/jbtani
ISSN 2477-3468 (print), 2714-7479 (online)
DOI: 10.35308/jbt

Indonesian rubber price (P_{ID}) has a coefficient of −5,742.292, which means that for every USD 1 increase in Indonesian rubber price, Indonesian rubber exports to China will decrease by 5,742.292 tons per year. The relationship between Indonesian rubber price and Indonesian rubber exports to China is negative, namely, when Indonesian rubber price rises, Indonesian rubber exports to China fall. In the study of Krismawan et al., (2021), the regression coefficient for the variable of Indonesian rubber price is negative, with a value of −0.009, meaning that when Indonesian rubber price increases by 1 rupiah, the volume of Indonesian rubber exports will fall by −0.009 tons. The t-test at α = 10% yields a p-value of 0.018. This means that Indonesian rubber price has a significant effect on Indonesian rubber exports to China.

Chinese rubber price (P_{CH}) has a coefficient value of 6,504.389, which means that for every USD 1 increase in Chinese rubber price, Indonesian rubber exports to China will increase by 6,504.389 tons per year. Chinese rubber price and Indonesian rubber exports to China have a positive relationship, namely, when Chinese rubber price rises, Indonesian rubber exports to China also rise. In line with the theory put forward by Rinaldy et al. (2018), foreign market conditions such as the level of demand also affect export activity. This affects the price of goods sold to other countries. When the level of demand in the destination country is greater than supply in the export destination country, the price in the export destination country will rise. The increase in price will encourage the exporting country to export more to the destination country. The t-test at α = 10% yields a p-value of 0.012. This means that Chinese rubber price has a significant effect on Indonesian rubber exports to China. The empirical finding that Chinese rubber prices have a significant and positive effect on Indonesia's natural rubber exports carries important policy implications. An increase in China's domestic rubber price reflects stronger demand and a more favorable export environment for Indonesia. In this context, Indonesia can strategically adjust its export policies by optimizing export timing, strengthening trade agreements, and improving market intelligence systems to detect shifts in China's industrial demand. Furthermore, higher Chinese prices may offer an opportunity for Indonesia to negotiate better contract terms with buyers, enhance value-added product promotion, and diversify export channels within China's rapidly expanding manufacturing sectors.

Indonesian rubber production (Q_{ID}) has a coefficient value of 2.217, which means that when Indonesian rubber production increases by 1 ton, Indonesian rubber exports to China will increase by 2.217 tons per year. The relationship between Indonesian rubber production and Indonesian rubber exports to China is positive, namely, when Indonesian rubber production increases, Indonesian rubber exports to China increase. The t-test at α = 10% yields a p-value of 0.082. This means that Indonesian rubber production has a significant effect on Indonesian rubber exports to China. This is consistent with the estimation results reported in Arifin et al. (2022). The variable of Indonesian rubber production shows a significant effect on rubber exports, with a coefficient of 0.5034. This means that a 1 percent increase in the amount of rubber production will lead to a 0.05034 percent increase in export volume. With a positive coefficient, it can be concluded that changes in the amount of rubber production are in line with increases in the volume of rubber exports. The significant role of domestic rubber production in stimulating export volume suggests that supply-side strengthening remains crucial for Indonesia's long-term competitiveness. Policymakers should therefore prioritize practical interventions aimed at increasing productivity. Such measures may include rejuvenation (replanting) programs for aging plantations, expansion of high-yield rubber clones, adoption of improved tapping techniques, and the integration of modern cultivation technologies such as precision agriculture and digital monitoring tools. Strengthening institutional support for smallholder farmers (who constitute the majority of Indonesia's rubber producers) is equally essential. This may involve improving access to credit, strengthening extension services, and ensuring stable farm-gate prices to incentivize production growth.

The rubber production of competitor countries (Q_C) has a coefficient value of 0.549, which means that when the rubber production of competitor countries increases by 1 ton, Indonesian rubber

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AGRIBISNIS - UNIVERSITAS TEUKU UMAR

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https://jurnal.utu.ac.id/jbtani
ISSN 2477-3468 (print), 2714-7479 (online)
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exports to China will also increase by 0.549 tons per year. The rubber production of competitor countries has a positive relationship with Indonesian rubber exports to China, namely, when the rubber production of competitor countries increases, Indonesian rubber exports to China increase. The t-test at α = 10% yields a p-value of 0.610. This indicates that the rubber production of competitor countries does not have a significant effect on Indonesian rubber exports to China.

Chinese gross domestic product (GDP_{CH}) has a coefficient value of −13.889, which means that for every USD 1 increase in Chinese gross domestic product, Indonesian rubber exports to China will decrease by 13.889 tons per year. The relationship between Chinese gross domestic product and Indonesian rubber exports to China is negative, namely, when Chinese gross domestic product increases, Indonesian rubber exports to China will decreases. The t-test at α = 10% yields a p-value of 0.207. This means that Chinese gross domestic product and Indonesian rubber exports to China do not have a significant relationship. This is in line with Atika et al., (2015), who find that the gross domestic product of Indonesian export destination countries has a negative relationship with a regression coefficient of 0.099 and has an insignificant effect.

The export-quota restriction policy (P_O) has a coefficient value of 0.158, which means that after the export-quota restriction policy, Indonesian rubber exports to China increased by 0.158 tons per year. The export-quota restriction policy and Indonesian rubber exports to China have a positive relationship; after Chinese export-quota restriction policy, Indonesian rubber exports to China increased. The t-test at α = 10% yields a p-value of 0.810. This means that the export-quota restriction policy has a significant effect on Indonesian rubber exports to China.

Chinese inflation (IF_{CH}) has a coefficient value of −0.006, which means that for every 1% increase in Chinese inflation, Indonesian rubber exports to China will decrease by 0.006 tons per year. Chinese inflation has a negative relationship with Indonesian rubber exports to China, namely, when Chinese inflation rises, Indonesian rubber exports to China decrease. Based on the t-test at α = 10%, the p-value is 0.027. This indicates that inflation in China has a significant effect on Indonesian rubber exports to China. Referring to Fihri et al. (2021), the inflation variable does not have a significant effect on rubber exports to China. The coefficient value in this study is negative, that every increase in inflation in China will reduce Indonesian rubber exports to China.

Indonesian Rubber Price Analysist

Table 3 Estimated results of factors influencing Indonesian rubber prices

Equation			"R-sq"	F-Stat
Indonesian Rubber Prices (P_{ID})			0.998	1410.501
	Coef.	Std. err.	T-Rasio	P-Value
Constant	0.271	0.337	0.805	0.433
World rubber prices (P_W)	0.155	0.058	2.654	0.018
Indonesian rubber production (Q_{ID})	-0.220	0.234	1.942	0.036
Rubber prices in competitor countries (P_C)	0.854	0.065	13.083	0.000
Indonesian rubber demand (D_{ID})	0.014	0.039	0.353	0.729
Total indonesian natural rubber exports (X_{TOT})	-0.279	0.199	-1.403	0.181
Indonesian rubber export quota policy (PO)	-0.007	0.10	0.787	0.444

The equation for Indonesian rubber price is influenced by the world rubber price (P_W), Indonesian rubber production (Q_{ID}), the competitor country's rubber price (P_C), demand for Indonesian rubber (D_{ID}), Indonesian total exports (X_{TOT}), and the export-quota restriction policy (P_O). The research

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ISSN 2477-3468 (print), 2714-7479 (online)
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results indicate that the coefficient of determination (R-square) is 0.998, which means that Indonesian rubber price (P_{ID}) can be explained by the factors in the model by 99.8%, while the remaining 0.2% is explained by other variables not included in the equation model.

The F-test at the 95% confidence level (α = 0.05) obtained Fcalculated = 1410.501 and Ftable = 2.51, so Fcalculated is greater than Ftable. Thus, this means that the world rubber price (P_W), Indonesian rubber production (Q_{ID}), the competitor country's rubber price (P_C), demand for Indonesian rubber (D_{ID}), Indonesian total exports (X_{TOT}), and the export-quota restriction policy (P_O) jointly have a significant effect on the variable of Indonesian rubber price (P_{ID}).

From Table 2, the equation for Indonesian rubber price can be written as follows: $\mathbf{P_{ID} = 0.271 + 0.220\ Q_{ID} + 0.155\ P_W + 0.854\ P_C + 0.014\ D_{ID} - 0.279\ X_{TOT} - 0.007\ P_O + e.}$

The value of the constant in the equation for Indonesian rubber price is 0.271, which means that if all variables in the equation for Indonesian rubber price in a given year are considered constant and not influenced by other factors, then Indonesian rubber price (P_{ID}) in that year will increase by 0.271 USD/ton.

The coefficient value of the world rubber price (P_W) is 0.155, which means that for every USD 1 increase in the world rubber price, Indonesian rubber price will rise by 0.155 USD/ton. The world rubber price has a positive relationship with Indonesian rubber price, which means that when the world rubber price increases, Indonesian rubber price also tends to increase. Based on the statistical t-test analysis with a probability value at a significance level of α = 10%, a p-value of 0.018 was obtained. This shows that the world rubber price affects Indonesian rubber price. These results are in line with the study by Kamalia dan Wardhana (2022), where the global rubber price has a positive effect on the price of rubber in Indonesia, with a coefficient value of 1.005945. In addition, the international rubber price has a significant effect on the price of rubber in Indonesia, with a probability value of 0.0000, which is smaller than α = 0.05. This means that if the international rubber price increases by 1%, then the price of rubber in Indonesia will also increase by 1.005945%.

Indonesian rubber production (Q_{ID}) has a coefficient value of −0.220, which means that for every 1-ton increase in Indonesian rubber production, Indonesian rubber price will decrease by 0.220 USD per ton. There is a negative relationship between Indonesian rubber production and Indonesian rubber price, when Indonesian rubber production increases, Indonesian rubber price decreases. This occurs because when Indonesian rubber production rises, rubber stocks in Indonesia increase; when stocks rise and are not followed by an increase in demand, prices fall. According to Ansar (2019), the price of a good is determined by the relationship between the supply and demand factors for that good, both of which are influenced by various factors that can affect existing levels of supply and demand. The supply and demand forces that form prices are generally depicted through intersecting supply and demand curves. Based on the t-test at α = 10%, a p-value of 0.036 was obtained. This means that Indonesian rubber production has a significant effect on Indonesian rubber price.

The coefficient value of the competitor country's price (P_C) is 0.854, which means that for every USD 1 increase in the competitor country's rubber price, Indonesian rubber price will increase by 0.854 USD/ton. The competitor country's rubber price shows a positive relationship with Indonesian rubber price; that is, when the competitor country's rubber price increases, Indonesian rubber price will also increase. Based on the t-test at α = 10%, a p-value of 0.000 was obtained. This means that the rubber price, this means that the competitor country's rubber price has a significant effect on Indonesian rubber price.

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Demand for Indonesian rubber (D_{ID}) has a coefficient value of 0.014, which means that when demand for Indonesian rubber increases by 1 ton, Indonesian rubber price will increase by 0.014 USD/ton. Demand for Indonesian rubber shows a positive relationship with Indonesian rubber price; that is, when demand for Indonesian rubber increases, Indonesian rubber price will increase. This occurs because when demand rises and is not followed by an increase in supply, prices rise. In accordance with Ansar (2019), the Theory of Demand is an economic theory that explains that the price of a good is influenced by the level of demand. This theory states that if market demand increases, the price of the good will tend to rise. Conversely, if demand decreases, the price of the good decreases. Based on the statistical t-test analysis with a probability value at a significance level of α = 10%, a p-value of 0.729 was obtained. This means that demand for Indonesian rubber does not have a significant effect on Indonesian rubber price.

Indonesian total rubber exports (X_{TOT}) have a coefficient value of −0.279, which means that for every 1-ton increase in Indonesian rubber production, Indonesian rubber price will decrease by 0.279 USD/ton. Indonesian total rubber exports show a negative relationship with Indonesian rubber price; that is, when Indonesian total rubber exports increase, Indonesian rubber price will decrease. Based on the t-test at α = 10%, a p-value of 0.181 was obtained. This means that Indonesian total rubber exports do not have a significant effect on Indonesian rubber price. These results are the same as the study of (Kamalia & Wardhana, 2022), with regression results showing that every 1% increase in the volume of Indonesian rubber exports will reduce the domestic rubber price (the price in Indonesia) by 5.382981, assuming other variables remain constant.

The export-quota restriction policy (P_o) has a coefficient value of −0.007, which means that after the export-quota restriction policy, Indonesian rubber price decreased by 0.007 USD/ton. The export-quota restriction policy shows a negative relationship with Indonesian rubber price: after the export-quota restriction policy, Indonesian rubber price decreased. In the study of Nurdina et al., (2021), it is discussed that the export-quota restriction policy affects the domestic rubber price in a negative direction, where after the export-quota restriction the domestic rubber price decreases. Based on the t-test at α = 10%, a p-value of 0.444 was obtained. This means that the export-quota restriction policy does not have a significant effect on Indonesian rubber price.

Chinese Rubber Price Analysist

Table 4 Estimated results of factors influencing United States rubber prices

Equation			"R-sq"	F-Stat
Chinese rubber prices (P_{CH})			0.959	140.982
	Coef.	Std. err.	T-Ratio	P-Value
Constant	-0.471	0.355	-1.237	0.201
World rubber prices (P_W)	0.798	0.111	7.185	0.000
The price of substitute goods for Chinese rubber (PS_{CH})	0.123	0.174	0.710	0.487
Chinese rubber demand (D_{CH})	0.113	0.062	1.815	0.086

In this study, the equation for Chinese rubber price is influenced by the world rubber price (P_w), the price of rubber substitute goods in China (PS_{CH}), and Chinese rubber demand (D_{CH}). The R-square value for this equation is 0.959, meaning that Chinese rubber price (P_{CH}) can be explained by 95.9% of the factors in the model, while the remainder is explained by other variables outside the equation model.

The F-test at the 95% confidence level (α = 0.05) obtained Fcalculated = 140.982 and Ftable = 3.40, so Fcalculated is greater than Ftable. This means that the world rubber price (P_w), the price

Jurnal Bisnis Tani
AGRIBISNIS - UNIVERSITAS TEUKU UMAR

Bisnis Tani, Vol. 11, No. 2, tahun 2025
https://jurnal.utu.ac.id/jbtani
ISSN 2477-3468 (print), 2714-7479 (online)
DOI: 10.35308/jbt

of rubber substitute goods in China (PS_{CH}), and Chinese rubber demand (D_{CH}) jointly have a significant effect on the variable of Chinese rubber price (P_{CH}).

Based on Table 3, the equation for Chinese rubber price can be written as follows: **$P_{CH} = -0.471 + 0.798\ P_W + 0.123\ PS_{CH} + 0.113\ D_{CH} + e$.**

The value of the constant in the equation for Chinese rubber price is −0.471, which means that if all variables in the equation for Chinese rubber price in a given year are considered constant and not influenced by other factors, then Chinese rubber price (P_{CH}) will decrease by 0.471 USD/ton.

The coefficient value of the world rubber price (Pw) is 0.798, which means that when the world rubber price increases by 1 USD, Chinese rubber price (P_{CH}) will also increase by 0.798 USD/ton. The world rubber price shows a positive relationship with Chinese rubber price; that is, when the world rubber price increases, Chinese rubber price also increases. Based on the t-test at α = 10%, the p-value is 0.000. This means that the world rubber price has a significant effect on Chinese rubber price.

The price of rubber substitute goods in China (PS_{CH}) has a coefficient value of 0.123, which means that when the price of rubber substitute goods in China rises by 1 USD, Chinese rubber price will rise by 0.123 USD/ton. The price of rubber substitute goods in China shows a positive relationship with Chinese rubber price; that is, when the price of Chinese substitute goods increases, Chinese rubber price also increases. Based on the t-test at α = 10%, the p-value is 0.487. This means that the price of rubber substitute goods in China does not have a significant effect on Chinese rubber price. Ridha et al. (2022) , in their study, state that the price of cocoa beans (which is a substitute good for coffee) has a significant effect on fluctuations in domestic coffee prices. A 1% increase in the global price of cocoa beans will result in a 0.023 increase in domestic cocoa-bean prices at a 5% significance level.

The coefficient value of Chinese rubber demand (D_{CH}) is 0.113, which means that for every 1-ton increase in Chinese rubber demand, Chinese rubber price will increase by 0.113 USD/ton. Chinese rubber demand shows a positive relationship with Chinese rubber price; that is, when Chinese rubber demand increases, Indonesian rubber price will also increase. This occurs because when demand increases and is not followed by an increase in supply, prices rise. This result is consistent with Ansar (2019), who states that price theory is a theory that studies the mechanism of forming the prices of goods in the market. In general, the price of a good is determined by the interaction between the demand and supply factors for that good, both of which are influenced by various interrelated factors. Based on the t-test at α = 10%, the p-value is 0.086. Thus, rubber prices have a significant effect on rubber prices in China.

4. CONCLUSION

This study identifies the key determinants influencing Indonesia's natural rubber export performance to China through a simultaneous-equation framework estimated using the 2SLS method. The empirical findings demonstrate that Indonesian rubber prices, Chinese rubber prices, Indonesian rubber production, and Chinese inflation exert significant effects on Indonesia's natural rubber exports to China. Conversely, competitor countries' production, China's GDP, and Indonesia's export-quota policy do not exhibit statistically significant impacts. The study further finds that world rubber prices and competitor countries' prices significantly influence Indonesian

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DOI: 10.35308/jbt

domestic rubber prices, while Chinese rubber prices are primarily affected by world rubber prices and China's rubber demand.

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