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Analysis of the Disparity between Rice Import, Production, and Consumption in Indonesia

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Abstract: Indonesian people's rice consumption can be met by domestic production. However, the government continues to import rice to maintain rice reserves and the stability of rice prices in the domestic market. However, the volume of imported rice is relatively high, where in 2023 rice imports reached 3,062,858, making Indonesia one of the largest rice importers in the world. This study aims to determine factors influencing rice imports, production, and consumption in Indonesia using secondary data from 2004 to 2023. The data analysis method uses a simultaneous equation model estimated by the Two Stage Least Squares (2SLS) method; this study includes three equations: rice import volume, domestic rice production, and public rice consumption. The study results show that the price of imported rice and the exchange rate significantly influence the volume of rice imports. In contrast, rice production significantly influences domestic rice production, and public rice consumption is influenced by population and per capita income. (*Abstract*)

Keywords: *Rice, Import, Production, Consumption, Two Stage Last Square*

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I. INTRODUCTION

Rice is a staple food for most Indonesians, so its availability significantly affects national food security and impacts the country's stability. Indonesia can meet its domestic rice demand with domestic rice production. Based on BPS data, the Indonesian people's rice consumption from 2014 to 2023 can still be met by domestic rice production, and there is a rice surplus every year, with the lowest in 2023.

Although Indonesia can meet domestic rice needs, the government imports rice. This policy is based on considerations for the supply of rice reserves in the community and maintaining the stability of rice prices in the domestic market (Pamungkas et al., 2017 and Susanti, 2017). However, the volume of rice imports fluctuates immensely, it tends to be high, where in 2023 there was a very high increase in rice imports, namely around 3,062,858 tons of rice with an import value reaching US$ 1,789,024,000, making Indonesia the second largest rice importer in the world with the highest import value globally (Trade Map, 2024). In contrast, Indonesia is one of the largest rice producers in the world, contributing around 6% of total global rice production.

Therefore, this study will examine various factors influencing the volume of imports, production, and rice consumption in Indonesia.

II. RESEARCH METHODE

This study uses secondary data in a time series (annual data) for 20 years from 2004 to 2023. The data sources are obtained from several sources, such as statistical data from BPS and online databases such as Trade Map, WTO International trade, Bank Sentral Republika Indonesia, and others that support this research. Data collection, data analysis, writing, and preparation of research results were carried out in March 2025.

This study uses a simultaneous equation model approach, and the statistical analysis used is Two-Stage Least Squares (2SLS). The simultaneous equation model models several equations with simultaneous or interrelated relationships, where the independent variable (exogenous) in one or more equations is also a dependent variable (endogenous) in other equations. The simultaneous equation model in each equation has endogenous variables, namely variables whose values are determined in the equation model, and exogenous variables whose values are determined outside the model (Rahmadeni & Feronika, 2020). In this study, there are three equation models with the following equation specifications;

Equation 1:

$$r_{Mv} = \beta_0 + \beta_1 D_{rPd} + \beta_2 T_{rc} + \beta_3 M_{rp} + \beta_4 E_g + e$$

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Equation 2:

$$T_{rc} = \partial_0 + \partial_1 T_o + \partial_2 D_{rp} + \partial_3 I_C + e$$

Equation 3:

$$D_{rPd} = D_{uPd} \times GKG\ \%$$

The first equation is the volume of Indonesian rice imports, which is influenced by four exogenous variables: domestic rice production, public rice consumption, imported rice prices, and exchange rates. The second equation is that public rice consumption is influenced by three exogenous variables: population, average domestic rice price, and income per capita. Finally, the third equation is that domestic rice production is influenced by domestic unhulled rice production and the percentage of dry milled grain (GKG) conversion into rice.

III. RESULT AND DISCUSSION

A. *Dynamics of Rice Production, Consumption, and Imports*

Rice is one of the strategic food commodities in Indonesia that plays an important role in maintaining the country's stability. Its production depends on the rice harvest or Dry Milled Grain (GKG). Over the past 20 years, the development of rice production has fluctuated dramatically. The highest rice production occurred in 2017 amounting to 81,382,451 tons, the high rice production in that year was influenced by an increase in the harvested land area of around 4.15% from the previous year to 15,790,000 Ha, which is the largest harvested land area in the last 20 years and is also supported by high land productivity. While the lowest rice production occurred in 2023, amounting to 53,980,993 tons, the low rice production in that year was influenced by a decrease in the harvested land area of around 0.23% from the previous year to 10,213,705 Ha, which is the smallest harvested land area in the last 20 years (BPS, accessed September 10, 2024).

Based on the level of rice consumption, Indonesia is in fourth place as the largest rice-consuming country in the world, with an average rice consumption per capita of around 93-100 kg/year, because rice is the primary source of carbohydrates in the community's diet. Total rice consumption continues to increase along with the increasing population. Meanwhile, domestic rice production has decreased every year due to the conversion of agricultural land to non-agricultural land. Therefore, the increase in consumption is inversely proportional to rice production, which directly impacts government policy in maintaining food security by importing rice.

Although Indonesia is one of the largest rice producers in the world, this does not make Indonesia classified as a self-sufficient rice country and the largest rice exporter in the international market; on the contrary, Indonesia is one of the largest rice-importing countries in the world. Rice imports are not new to Indonesia, because this practice has been carried out for a long time. According to several sources, Indonesia first imported rice during the Dutch colonial era around 1910. Although Indonesia was once self-sufficient in rice, it did not last long, as in 1990 Indonesia imported rice again; this continues until now (CNBC Indonesia, accessed July 22, 2024), which means that Indonesia is dependent on rice imports.

B. *Classical Assumption Test Results*

➢ *Multicollinearity Test*

A multicollinearity test is conducted to detect whether there is a powerful relationship between exogenous variables in an equation. One method commonly used is to calculate the Variance Inflation Factor (VIF) value, where a VIF value greater than 10 indicates high multicollinearity and vice versa. If the VIF value is less than 10, there is no multicollinearity. The following are the results of the multicollinearity test for each equation model in this study.

Table 1 The results of Calculating the VIF value in the Equation model (R_{Mv})

Variables	VIF Value Decision	Multicollinearity Description
Domestic rice production (D_{rPd})	1,838 ≤ 10	No multicollinearity
Rice consumption (T_{rc})	5,596 ≤ 10	No multicollinearity
Imported rice prices (M_{rp})	1,885 ≤ 10	No multicollinearity
Exchange rate (E_g)	7,447 ≤ 10	No multicollinearity

Based on the results of the multicollinearity test, it is known that the Indonesian rice import volume equation model does not experience multicollinearity problems. This can be seen based on the Variance Inflation Factor (VIF) value for each exogenous variable, which is less than 10 (≤ 10). Thus, it can be concluded that there is no multicollinearity between the exogenous variables in this equation model.

Table 2 The Results of Calculating the VIF value in the Equation model (T_{rc})

Variables	VIF Value Decision	Multicollinearity Description
Total population (T_o)	8,994 ≤ 10	No multicollinearity
Average domestic rice price (D_{rp})	4,564 ≤ 10	No multicollinearity
Income per capita (I_C)	3,283 ≤ 10	No multicollinearity

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Based on the results of the multicollinearity test, it is known that the equation model of community rice consumption with exogenous variables consisting of population, average domestic rice price, and per capita income shows a VIF value of less ≤ 10. Thus, this equation model does not experience multicollinearity problems between exogenous variables.

➢ *Autocorrelation Test*

In the context of time series or regression data analysis, autocorrelation tests are conducted to detect the extent to which the values of a variable are related to the values of the same variable at a previous time. The results of the autocorrelation test based on the Durbin-Watson calculation values are as follows:

Table 3 Autocorrelation test based on Durbin-Watson value Calculation

Persamaan	DW Score	Decision	Information
Rice import volume (r_{Mv})	2,065	1,828 < 2,065 < 2,172	No autocorrelation
Rice consumption (T_{rc})	1,717	1,676 < 1,717 < 2,324	No autocorrelation
Domestic rice production (D_{rPd})	1,823	1,410 < 1,823 < 2,590	No autocorrelation

In the equation of Indonesia's rice import volume (from the international market, the Durbin-Watson value is 2,065, which is between 1,828 and 2,172 (du value and 4- du value). This result shows that the Durbin-Watson value is in the acceptance area, which means there are no symptoms of autocorrelation.

Furthermore, the Durbin-Watson value in the community rice consumption (T_{rc}) equation is 1,717, between 1,676 (du) and 2,324 (4-du). This shows that the Durbin-Watson value is in the acceptance area, so the model estimate does not experience autocorrelation.

Finally, the domestic rice production equation has a DW value of around 1,823, which is also between the du (1,410) and 4-du (2,590) values. The DW value is in the acceptance area, which shows that the model estimate in the equation also does not experience autocorrelation.

C. Simultaneous Equation Model Analysis Results

➢ *Indonesia's Rice Import Volume Equation*

Table 4 Estimation Results of Factors Influencing Rice Import Volume

Equation		R-Sq	F-Stat	Sig
Rice import volume (r_{Mv})		0.9621	74.479	0.001
	Est. Coef	Stan. Error	T-Ratio	P-Value
Constanta	-296	0.723	-0.410	0.967
Domestic rice production (D_{rPd})	-0.266	0.663	-0.402	0.688
Rice consumption (T_{rc})	0.457	0.433	1.055	0.291
Imported rice prices (M_{rp})	1.878	0.690	27.22	0.001
Exchange rate (E_g)	118	38.40	3.082	0.002

The model equation for the volume of Indonesian rice imports from the international market is as follows:

$$r_{Mv} = -296 - 0{,}266\, D_{rPd} + 0{,}457\, T_{rc} + 1{,}878\, M_{rp} + 118\, E_g + e$$

In the equation model, the volume of Indonesian rice imports from the international market is influenced by several factors, namely: domestic rice production, rice consumption, imported rice prices, and exchange rates. Based on the results of the analysis test, the coefficient of determination (R-square) value was obtained at 0.9621, which means that the volume of rice imports carried out by Indonesia from the international market can be explained by the four exogenous variables in the model by 96.21%, while other factors outside the equation model explain 3.79%. The results of simultaneous testing at a significance level of 95% (α = 0.05) obtained an F-count value of 74.479 and an F-table value of around 3.06 so that it can be concluded that the F-count value is greater than the F-table value (74.479> 3.06) which means that simultaneously the four variables affect the volume of rice imports carried out by Indonesia from the international market. If examined partially (t-test), two exogenous variables have a significant effect on the volume of rice imports, namely, variables of imported rice prices and exchange rates, and two exogenous variables do not have a significant effect, namely, domestic rice production and total rice consumption.

The domestic rice production variable has a P-value of 0.688, so it does not have a significant effect on the volume of rice imports, both at the significance level of α= 5% (0.688 > 0.05) and at the significance level of α = 10% (0.688 > 0.1). The estimated coefficient value of the variable is -0.266; it can be concluded that an increase in domestic rice production by 1% can reduce the volume of rice imports by 0.266 tons/year. Increasing domestic rice production is believed to reduce the volume of rice imports because the increasing availability of rice domestically reduces the need for rice from abroad. This is also in line with self-sufficiency or food independence, where the country tries to meet its food needs from domestic production. However, based on the results of the analysis, domestic rice production does not significantly affect the volume of rice imports because Indonesia always imports rice, even though domestic rice production is increasing.

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Furthermore, the rice consumption variable of the Indonesian people has a P-Value of 0.294, so that this variable does not have a significant effect on the endogenous variables in this equation, either at the significance level of α = 5% (0.291> 0.05), or at the significance level of α = 10% (0.291> 0.1). The estimated coefficient value of this variable is 0.457; it can be concluded that an increase in the total rice consumption of the Indonesian people by 1% can increase the volume of rice imports carried out by the government by 0.457 tons/year. Let us look at rice production over the past 20 years. It has fluctuated dramatically, tending to decrease. At the same time, people's rice consumption has increased every year, such as in 2023, rice production reached around 33.72 million tons, which is the lowest rice production in the past 20 years, while the population in 2023 reached 278.69 million people, which is the highest population in the past 20 years. This shows that rice production does not align with the increasing population growth. To overcome this, the government imports rice to maintain domestic stock needs. This study's results align with research conducted by Wibawa et al. (2023), which states that the unstable rice production and rice consumption levels cause Indonesia to continue to import rice. However, based on the results of the analysis of the total rice consumption variable, it does not have a significant effect on the volume of Indonesian rice imports for several reasons, including the existence of an import restriction policy to protect local farmers where this policy will limit the volume of imports even though rice consumption increases (Ministry of Agriculture of the Republic of Indonesia, accessed April 30, 2025).

The imported rice price has an estimated coefficient value of 1.878, so a 1% increase in imported rice will increase the volume of rice imports by around 1.878 tons/year. Based on the t-test, the price of imported rice significantly affects the volume of rice imports at a significance level of α = 5% (0.001 <0.05). When the price of imported rice increases, the volume of rice imports also increases, which is not explained by the theory of supply and demand. However, this sometimes does not apply to necessities such as rice because rice can also experience inelastic demand caused by several factors, including an increase in public rice consumption that is not balanced by domestic rice production.

Finally, the estimated coefficient of the exchange rate variable is 118, so when the exchange rate rises (strengthens) by 1%, it will cause an increase in the volume of rice imports by 118 tons/Ha. Based on the t- test, the exchange rate variable significantly affects the volume of rice imports at a significance level of α = 5% (0.002 <0.05). The appreciation of the domestic currency against foreign currencies can increase the volume of rice imports. This is because when the exchange rate appreciates, the amount of domestic currency that needs to be exchanged into dollars decreases. After all, the cost of importing rice decreases, thus increasing import volume. Similar findings were also conveyed by Paipan and Abrar (2020), where exchange rate appreciation will cause the government to be able to import rice in larger quantities.

➢ *Indonesian People's Rice Consumption Equation*

Table 5 Estimation Results of Factors Influencing Rice Consumption

Equation		**R-Sq**	**F-Stat**	**Sig**
Rice consumption (T_{rc})		0.9037	14.132	0.001
	Est. Coef	**Stan. Error**	**T-Ratio**	**P-Value**
Constanta	0.302	0.101	2.991	0.003
Total population (T_o)	0.183	0.441	4.165	0.001
Average domestic rice price (D_{rp})	-26.147	144.4	-0.181	0.856
Income per capita (I_C)	-0.142	0.336	-4.244	0.001

- *The Equation for Total Rice Consumption by Indonesian People is as Follows:*

$$T_{rc} = 0{,}302 + 0{,}183\,T_o - 26{,}147\,D_{rp} - 0{,}142\,I_C + e$$

This equation has three exogenous variables: total population, average domestic rice price, and income per capita. Based on the test results of the analysis, the coefficient of determination (R-square) value is 0.9037, which means that the three factors explain the rice consumption variable of the Indonesian people by 90.37%. In contrast, 9.63% is explained by other factors outside the equation model. The results of simultaneous testing at a significance level of 95% (α = 0.05) obtained an F-count value of around 14.132 which is greater than the F-table value of around 3.24 (14.132> 3.24) and obtained a significance value below 0.05 (0.001 <0.05), it can be concluded that simultaneously all exogenous variables affect the total rice consumption of the Indonesian people. The partial analysis (t-test) results found two exogenous variables that significantly affected rice consumption: total population and income per capita. At the same time, the average domestic rice price variable did not have a significant effect.

The total population variable has an estimated coefficient of around 0.183, indicating that the effect of population on rice consumption of Indonesian people is in the same direction, so an increase in total population of around 1% can increase total rice consumption of the community by around 0.183 tons/year. The t-test results for the population variable significantly affect total rice consumption of the community at a significance level of α = 5% (0.001 <0.05). Total population growth in an area directly impacts the community's rice consumption. This is due to the role of rice as the main staple food in Indonesia, where around 97% of the population consumes it as the primary source of carbohydrates in everyday life (Wibawa et al., 2023).

The average domestic rice price variable has a P- value of around 0.856, so that the variable does not have a significant effect on the endogenous variable either at the

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significance level α = 5% (0.856 > 0.05), or at the significance level α = 10% (0.856 > 0.1). The estimated coefficient value of the variable is -26.147; it can be concluded that an increase in the average domestic rice price of around 1% can reduce the rice consumption of the Indonesian people by around 26.147 tons/year. An increase in the average domestic rice price can reduce the rice consumption of the Indonesian people, especially among low-income people. This is related to the concept of price elasticity of demand, which measures how sensitive the amount of goods demanded is to changes in price. Although most studies show that the demand for rice in Indonesia is inelastic, meaning that price increases do not significantly affect overall consumption, the increase in rice prices still affects the level of consumption, especially for low-income people. Meanwhile, the average domestic rice price variable does not significantly affect total rice consumption.

The majority of the Indonesian population consumes rice as a staple food, thus strengthening the inelastic nature of rice demand, which causes price changes not always to affect the amount of rice consumption, where people continue to buy rice even though the price increases, because rice is a staple food that is difficult to replace.

Furthermore, the income per capita variable has an estimated coefficient value of around -0.142, indicating that an increase in income per capita of around 1% can reduce the rice consumption of the Indonesian people by around 0.142 tons/year. The t-test results for this variable significantly affect the rice consumption of the community at a significance level of α = 5% (0.001<0.05). Along with increased income per capita, people's consumption patterns tend to diversify. Dependence on rice as the primary source of carbohydrates decreases and shifts to more varied foods, including meat and other highly nutritious products. In addition, people are paying more attention to nutritional balance by increasing their protein, vitamins, and mineral intake. This consumption diversification enriches the variety of nutrients and contributes to a decrease in total rice consumption per capita.

➢ *Domestic Rice Production Equation*

Table 6 Estimation Results of Factors Influencing Domestic Rice Production

Equation			**R-Sq**	
Domestic rice production (D_{rPd})			1.0000	
	Est. Coef	**Stan. Error**	**T-Ratio**	**P-Value**
Constanta	0.187	0.789	0.237	1.000
Domestic unhulled rice production (D_{uPd})	0.624	0.154	0.404	0.001

- *The Equation for Domestic Rice Production is as Follows:*

$$D_{rPd} = 0{,}187 + 0{,}624\, D_{uPd} + e$$

In the fifth equation model, one exogenous variable, namely unhulled rice production, affects domestic rice production. Based on the results of the analysis test, the coefficient of determination (R-square) value is 1.0000, which means that domestic rice production is influenced by the exogenous variables in the model by 100%, and there are no other exogenous variables outside the model that affect the endogenous variables.

The estimated coefficient value for the domestic unhulled rice production variable is around 0.624, which means an increase of around 1% can increase rice production by around 0.624 tons/year. Based on statistical tests, the exogenous variable significantly affects rice production at a significance level of α = 5% (0.001 <0.05). The increase in unhulled rice production directly contributes to the increase in rice production, taking into account the conversion value of dry milled grain (GKG) to rice. The percentage of GKG conversion to rice continues to increase along with improvements in milling technology. This increase in yield reflects the increasingly efficient milling process in producing rice from GKG. Although data on unhulled rice production developments over the past 20 years shows a downward trend due to reduced harvest areas, the increase in productivity still positively impacts increasing rice production.

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V. CONCLUSION

Based on the analysis results and discussion that have been carried out, external factors significantly influence the high rice import volume in Indonesia in the form of exchange rates and imported rice prices. Meanwhile, domestic rice production and consumption variables do not significantly affect the volume of rice imports. Thus, macroeconomic factors are more dominant in influencing Indonesia's rice import volume. Meanwhile, total population and income per capita significantly influence domestic rice consumption. In contrast, the average domestic rice price does not have a significant effect, considering that rice has an inelastic nature.

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