An Almost Ideal Demand System approach in analysing demand for Indonesian imported rice

Resti P. Destiarni¹, Nurul Arifyanti¹, and Ahmad S. Jamil²

¹Department of Agribusiness, Faculty of Agriculture, University of Trunojoyo, Bangkalan, Indonesia
²Faculty of Animal Science and Agriculture, Obihiro University of Agriculture and Veterinary Medicine, Japan

Abstract. Indonesia's rice imports throughout 2022 will increase by 5%. Indonesia plans to import again to anticipate production disruptions due to a potential El Nino. Indirectly, Indonesia depends on other countries for its rice needs, so this study's main objective is to analyse rice import performance and estimate the competitiveness and elasticity of demand for Indonesian rice imports. This research used annual import data of Indonesia from Thailand, Vietnam, and India, which came from the UN-Comtrade and will be analysed using the Almost Ideal Demand System (AIDS). The results showed that Thailand has the largest share and an inelastic own-price elasticity, so the consumption of imported rice from Thailand is unaffected by price changes. Based on income elasticity, it shows that imported rice is a normal good. Rice imports from Thailand and India are complementary, while others are substitutes for each other. Thailand is still the largest supplier of imported rice for Indonesia, and it will be a challenge for Indonesia if Thailand limits the amount of rice it exports to domestic needs. Imports are a short-term solution, so a long-term policy must deal with limited rice stocks caused by climate and weather uncertainties.

1 Introduction

Agriculture as an essential sector is challenging for Indonesia, which faces a food crisis. The enormous food consumption is still occupied by rice as the primary source in addition to maize, cassava, and sweet potatoes, with a percentage reaching 95% [1,2]. Indonesia's rice consumption in 2022 reached 93.9 kg/capita/year with a total demand of 35 million tons, while data shows that the availability of rice in domestic production only reached 32 million tons [3,4]. This shows a shortage of rice availability that the government must meet.

One of the obstacles to domestic food fulfilment is uncontrolled climate change, which has become a significant threat to farmers, leading to a food crisis. The El Nino phenomenon causes vulnerabilities experienced by farmers, such as limited water, high temperatures, floods, and pest attacks [5,6]. Another factor is that Indonesian people's interest in and consumption of carbohydrate food is still high and supported by increased income, which positively affects rice consumption [1]. Although the growth of consumption leads to a negative 0.58% and the availability of rice increases by 0.78%, it still cannot meet the total

* Corresponding author: resti.destiarni@trunojoyo.ac.id
demand [4]. This situation aligns with the different objectives on the producer and consumer sides, which show the continuous nature of rice consumption in consumers and cannot be stopped. In contrast, producers have a limited and discontinuous nature in fulfilling demand.

This condition impacts the policy that the government must issue by importing rice through the Ministry of Trade. Imports are one way to fulfill domestic rice demand [7]. The development of Indonesia’s rice imports in 2011–2020 fluctuated with an average value of 1.1 million tons per year, the highest in 2011 and 2018, reaching 2.7 million tons and 2.2 million tons, respectively [4,8]. The rice import policy is stipulated in the Regulation of the Minister of Trade of the Republic of Indonesia Number 1 of 2018, which states that there is an import duty as a support for the welfare of farmers, in addition to encouragement to improve the quality of production but also protect the competitiveness of rice, maintain price stability, and absorption of domestic products. The rice import policy in terms of needs and time period is prioritised for short-term implementation with the aim of balancing price stability, emergencies, the poor and the use of post-disaster food insecurity management. However, in the long term, the government should not do it and prioritise the consumption of domestic products [9].

Asian countries dominate rice import and export trade patterns. The enormous rice consumption in China, India, Bangladesh, Indonesia, and Vietnam is projected to increase except for Japan and South Korea, which are predicted to decrease. This is based on population assumptions. Indonesia claims that there will be an increase in production of 4.6%, which is also in line with the positive growth of domestic consumption [10]. The cluster of importing countries regarding average export value is divided into high, medium, and low. Countries included in the high group are Thailand and Vietnam. Thailand's export value in 2015–2020 was recorded to be high and stable. Countries in the medium cluster include India, Pakistan, and China. Finally, Indonesia, Singapore, Laos, the Philippines, Cambodia, Brunei, Myanmar, Japan, and Taiwan are in the low cluster.

In contrast, Malaysia is in the low-high cluster because it has a low export value but is surrounded by countries with high export values [11–14]. Export-import activities as an implementation of international trade show the integration between rice markets in the ASEAN region so that specific issues will affect each other if there is a shock. Thailand and Vietnam are the largest exporters, and Indonesia and the Philippines, the largest importing countries in ASEAN, show the dependence and relationship between countries in the food trade sector [12]. International trade activities are facilitated by cooperation between countries. They are starting from the ASEAN Economic Community (AEC), China and ASEAN Cooperation (CAFTA), and several Asian countries.

Indonesia imports most of its rice from India, Pakistan, Thailand, and Vietnam [8]. Based on BPS data, Indonesia's rice imports throughout 2022 increased by 5%, with the first place being India, with a value of 171 thousand tons. Indonesia again plans to import in 2023 with an increase in volume of two million tons to anticipate production disruptions due to the potential of El Nino [15]. The government aims to encourage increased production and reduce rice consumption to maintain price stability, reduce imports, and increase rice exports [12]. Although this is a conflict between the Ministry of Agriculture and the Ministry of Trade regarding rice imports, where the rise in pro-production policy of the Ministry of Agriculture is not in synergy with the steps of the Ministry of Trade, which states that excess stocks will cause prices to decline and reduce farmers’ income, in the short term imports are appropriate [16]. The realisation of the value of rice imports in 2022 decreased by 5.97%, but volume increased by 14.40%. The form of imports is still dominated by processed rice 98% (3,710 tons) and fresh unhulled rice 2% (43 tons) [17]. In cooperation, Indonesia established trade with Thailand and Vietnam through the AEC in 2015 and ASEAN with India in 2009. The World Trade Organization (WTO) policy on import quotas shows the expansion of the global market and bilateral relations with Thailand to import 1 million tons of rice [18].
The main objectives of this study are to analyse the performance of rice imports, estimate the noon power of three import source countries, and the elasticity of Indonesia's rice import demand. Thailand, Vietnam, and India are the largest sources of rice imports to Indonesia and have shown a positive trend in the volume of rice imports. The analysis used is the Almost Ideal Demand System (AIDS) model, specifically looking at consumer behavioural equilibrium preferences that can be considered in international rice trade activities [19–21]. This research is expected to help related parties formulate better policies and provide information on rice imports and exports with the approach of Indonesia's countries, namely Thailand, Vietnam, and India, as importers and exporters.

2 Methodology

The data used in this study are secondary in the volume and quantity of Indonesian rice imports from Thailand, Vietnam, and India obtained from the United Nations Commodity Trade (UN Comtrade) using the Harmonised System (HS) 1006 code. The data is annual data from 1994–2021. Meanwhile, the rest of world (ROW) data in this study is calculated by reducing the total volume of Indonesia's rice imports from the world by the total imports from the three countries of origin (Thailand, Vietnam, and India). In addition, the price used is a proxy calculated by dividing the import value by the import volume of rice from each country.

The data was analysed using a quantitative method in the Almost Ideal Demand System (AIDS) model, which Deaton and Muellbauer first introduced because it can analyse the import demand for a commodity [22,23]. The three countries of origin were selected based on the relatively stable and most significant market share values during the study period. The AIDS model used in this study is:

\[ w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln P_j + \beta_i \ln \left( \frac{x}{p} \right) \]  

(1)

where \( W \) is the market share of the country of origin of Indonesia's rice imports, \( P \) is the country of origin price of Indonesia's rice imports, \( x \) is the total import value of Indonesia, and \( p^* \) is the geometric stone price index \( \sum w_i p_i \).

There are three equations of the AIDS model in this study, which consist of the Thailand equation with the dependent variable importing market share and independent variables are the price of imported rice from Thailand, Vietnam, India, and ROW, Vietnam equation, and India equation with dependent and independent variables similar to Thailand equation. The three equations include:

\[ W_{\text{thai}} = \alpha_1 + \delta_1 \ln P_{\text{thai}} + \delta_2 \ln P_{\text{viet}} + \delta_3 \ln P_{\text{ind}} + \delta_4 \ln P_{\text{row}} + \beta_1 \ln \left( \frac{x}{p^*} \right) \]  

(2)

\[ W_{\text{viet}} = \alpha_2 + \delta_5 \ln P_{\text{thai}} + \delta_6 \ln P_{\text{viet}} + \delta_7 \ln P_{\text{ind}} + \delta_8 \ln P_{\text{row}} + \beta_2 \ln \left( \frac{x}{p^*} \right) \]  

(3)

\[ W_{\text{ind}} = \alpha_3 + \delta_9 \ln P_{\text{thai}} + \delta_{10} \ln P_{\text{viet}} + \delta_{11} \ln P_{\text{ind}} + \delta_{12} \ln P_{\text{row}} + \beta_3 \ln \left( \frac{x}{p^*} \right) \]  

(4)

where:

\( W_{\text{thai}} \) : share of imports from Thailand
\( W_{\text{viet}} \) : share of imports from Vietnam
\( W_{\text{ind}} \) : share of imports from India
\( \alpha_1, \alpha_2, \alpha_3 \) : intercept
\( \delta_1, \ldots, \delta_8, \beta_1, \beta_2, \beta_3 \) : coefficient
\( P_{\text{thai}} \) : rice price (import value per import volume) Thailand
\( P_{\text{viet}} \) : rice price (import value per import volume) Vietnam
The estimation of the AIDS model was estimated using the seemingly unrelated regression (SUR) method. SUR is a recursive method or model standard in economic or business modelling. This model consists of a set of variables considered as a group because they have a close conceptual relationship. The three equations in this study are restricted by using homogeneity and symmetry constraints, while the adding up restriction has been fulfilled in the model by itself as an advantage of the AIDS model. Such limitation is based on the primary form of the AIDS model itself. The AIDS model is a demand system consisting of several interrelated demand functions. Therefore, limitation is required as the primary property/condition of the demand function.

Homogeneity restriction:

\[
\sum_{i=1}^{n} \alpha_i = 1, \quad \sum_{i=1}^{n} y_{ij} = 1, \quad \sum_{i=1}^{n} \beta_i = 1
\]

Symmetry restriction:

\[
\sum_{i=1}^{n} y_{ij} = 0
\]

Adding up restriction:

\[
y_{ij} = y_{ji}
\]

Consumer theory is used in estimating the AIDS model of the level of competition for imported rice because import demand is part of domestic demand. According to Henneberry and Curry (1995) [24], import demand is the difference between domestic demand and domestic production when imported domestic goods are perfect substitutes. The import demand for a commodity is a function of domestic demand, which, when there is a shift in the domestic demand function, will cause a shift in the import demand function. This reflects that the explanatory variables of the import demand function are based on consumer theory emphasising utility maximisation. The explanation justifies this study in using the restriction of the main properties of the demand function as part of the application of consumer theory. From the estimated AIDS parameters, elasticity values were determined for Thailand, Vietnam, and India. The elasticity values are calculated to illustrate the level of competition among the three countries. The elasticity values are:

1. Own price elasticity (uncompensated),

\[
e_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{\hat{w}_i} \hat{\beta}_1 \left( \frac{\hat{w}_i}{\hat{w}_j} \right)
\]

(5)

2. Cross price elasticity (compensated),

\[
e^*_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{\hat{w}_i} + \hat{w}_j
\]

(6)

3. Indonesia's expenditure elasticity of rice imports

\[
\eta_i = 1 + \frac{\hat{\beta}_i}{\hat{w}_i}
\]

(7)
3 Result and discussion

3.1 Level of import competition among major rice import source countries

3.1.1 Estimation of demand model parameters (AIDS model)

The AIDS model is a demand system that describes the competition between Indonesia's three rice import source countries. Table 1 shows the AIDS model of imported rice demand in Indonesia, illustrating the competition level from the three import source countries. Based on Table 1, the R² value for each AIDS model is 43.14% for Thailand, 32.16% for Vietnam, and negative 2% for India. The coefficient of determination shows the ability to explain the independent variable on the country's import proportion value variation

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Thailand</th>
<th>Vietnam</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>p-value</td>
<td>Coefficient</td>
</tr>
<tr>
<td>P_thai</td>
<td>-0.1115853**</td>
<td>0.076</td>
<td>0.0109356</td>
</tr>
<tr>
<td>P_viet</td>
<td>0.0109356</td>
<td>0.829</td>
<td>-0.1297565*</td>
</tr>
<tr>
<td>P_ind</td>
<td>-0.0231303**</td>
<td>0.078</td>
<td>0.0079501</td>
</tr>
<tr>
<td>P_row</td>
<td>0.1237801*</td>
<td>0.001</td>
<td>0.1108709*</td>
</tr>
<tr>
<td>x</td>
<td>-0.0799914*</td>
<td>0.004</td>
<td>0.0774491*</td>
</tr>
<tr>
<td>Cons</td>
<td>1.412556*</td>
<td>0.000</td>
<td>-0.7446493</td>
</tr>
</tbody>
</table>

AIDS model of Thailand

R² = 43.14%
p-value = 0.0006

AIDS model of Vietnam

R² = 32.16%
p-value = 0.0070

AIDS model of India

R² = (2%)
p-value = 0.4758

Note: 1. P_thai: Thailand imported rice price; P_viet: Vietnam imported rice price; P_ind: India imported rice price; P_row: Rest of World imported rice price; x: Indonesia’s total import expenditure

2. Significant at the actual level: * 5% and ** 10%

The price independent variable of each country in the three equations has three criteria: significant at a 5% actual level, significant at a 10% actual level, and insignificant. The insignificant independent variables include the Vietnam price variable in the Thailand equation, the Thailand price and India price variable in the Vietnam equation, and price variables other than Thailand price and total import expenditure in the India equation. Various price effects can be seen from the sign of each coefficient, both on its own price and cross price. A favourable price effect means that if a particular country's price increases, it will increase the proportion/share of imports of that country and vice versa. The coefficient of Indonesia's total import expenditure can be negative or positive. The sign is the effect of
Indonesia's total import expenditure on each country's import share, which, if positive, means that an increase in Indonesia's rice import expenditure will increase the country's rice import share and vice versa.

3.1.2 Estimation of demand elasticity

Elasticity or the level of sensitivity can be information for economic actors, producers, consumers, and governments in making decisions because the demand function can obtain a description of changes in economic conditions (prices and income) on the quantity demanded. However, this information often increases or decreases due to changes in the factors that influence it. Therefore, it is necessary to measure elasticity to determine the size of the quantity sensitivity to these various factors. The calculation of the three elasticities for Thailand and Vietnam is discussed in detail. This is based on the p-value of the Indian model, which is insignificant and means that all independent variables in the model have zero values. According to Gheblawi in Asmarantaka (2018) [21], an AIDS model with an insignificant p-value can cause interpretation bias. Three forms of elasticity are discussed in this study, namely expenditure elasticity, own-price elasticity, and cross-price elasticity. Own price elasticity uses Marshallian elasticity measurement (uncompensated) and cross-price elasticity obtained from Hicksian elasticity (compensated).

Table 2. Import share and expenditure elasticity of import source countries.

<table>
<thead>
<tr>
<th>Import source country</th>
<th>Average share</th>
<th>Expenditure elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thailand</td>
<td>0.359</td>
<td>0.777</td>
</tr>
<tr>
<td>Vietnam</td>
<td>0.334</td>
<td>1.232</td>
</tr>
<tr>
<td>India</td>
<td>0.076</td>
<td>1.197</td>
</tr>
<tr>
<td>ROW</td>
<td>0.231</td>
<td>0.916</td>
</tr>
</tbody>
</table>

Table 2 shows that the source countries of rice imports to Indonesia have an overall average market share of 76.9%, while the market share of other countries, as indicated by the ROW market share value, is 23.1%. Thailand has the most extensive import share in meeting Indonesia's rice import demand at 35.9%. In comparison, Vietnam and India are in the second and third positions in the largest import share, with values of 33.4% and 7.6%, respectively, of the total average share of Indonesian rice imports. The condition also provides information that the country that most frequently exports rice to Indonesia is Thailand. The large amount of Thai rice imports to Indonesia is one of the implementations of the cooperation agreement made between Indonesia and Thailand in 2021. The lack of rice stock, which only reaches 800 thousand tons, underlies the import in the hope that the rice stock is safe to avoid a domestic food crisis [25].

Table 2 also shows that the sign of the expenditure elasticity is positive, indicating that rice from the three source countries is a normal good. Thailand has an expenditure elasticity value of 0.777, which means that if there is an increase in rice import expenditure from Indonesia by 1%, the import expenditure will increase the demand for rice imports from Thailand by 0.777%. Thailand's expenditure elasticity also reflects inelastic expenditure elasticity because its absolute value is less than one. Vietnam has an elastic expenditure elasticity value greater than 1, which is 1.232, meaning that a 1% increase in Indonesia's rice import expenditure will increase the demand for imported rice from Vietnam by 1.232%. The magnitude of the elasticity also indicates that rice from Thailand is not sensitive (inelastic) to changes in total expenditure.

In contrast, Vietnam is more sensitive to changes in total spending on Indonesian rice imports. Thailand is a consistent source of Indonesia's rice imports. Although the largest rice-producing country in the world is Vietnam, Indonesia tends to source more rice from
Thailand because Thailand has the highest market share. Market share is a piece of information that provides an overview of the total sales of a business to a particular market segment. Market share is the sales data divided by the total sales of the same industry. Information from the percentage of market share becomes a reference because it can measure the performance and quality of the trade activity strategy carried out.

Table 3. Own-price elasticities of Indonesia's rice import sources.

<table>
<thead>
<tr>
<th>Country</th>
<th>Thailand</th>
<th>Vietnam</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thailand</td>
<td>-0.95163</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Vietnam</td>
<td>-</td>
<td>-1.05431</td>
<td>-</td>
</tr>
<tr>
<td>India</td>
<td>-</td>
<td>-</td>
<td>-0.78614</td>
</tr>
</tbody>
</table>

Table 3 shows the price elasticity for each import source country in Indonesia. Based on the sign of each country's elasticity, it indicates that Thailand's price elasticity is negative with a value of -0.95163, which means that when there is a 1% increase in the price of the good, it will result in a decrease in demand for imported rice from Thailand by 0.95163%. The sign of the country is following demand theory, which states a negative relationship between demand and price. The price elasticity of Vietnam also has a negative sign of -1.05431, which means that a 1% increase in the price of the good will result in a 1.05431% decrease in the demand for imported rice from Vietnam. The country with an absolute elasticity value of less than one is Thailand, meaning imported rice from Thailand is inelastic. Inelastic means that the rice market share of the exporting country, in this case Thailand, changes by a smaller percentage than the rice price of the exporting country.

Table 4. Cross-price elasticities of Indonesia's rice import sources.

<table>
<thead>
<tr>
<th>Country</th>
<th>Thailand</th>
<th>Vietnam</th>
<th>India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thailand</td>
<td>-</td>
<td>0.10487</td>
<td>-0.04756</td>
</tr>
<tr>
<td>Vietnam</td>
<td>-</td>
<td>-</td>
<td>0.00626</td>
</tr>
<tr>
<td>India</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 4 shows the cross-price elasticity between imported rice from the three countries in Indonesia. The sign expresses the relationship between the two sources of imports with an opposing or complementary relationship between imported commodities from two specific countries, indicating that the two commodities originating from the two countries are different and complementary [24]. In addition, a positive or substitution relationship that occurs between imported commodities from two specific countries indicates that the two commodities originating from the two countries are the same and replace each other so that when a country is unable to supply a sufficient amount of rice, Indonesia has another alternative to get imported rice from other countries because of the same commodity characteristics. This substitution relationship shows competition between countries in controlling the market of export destination countries.

The relationship between imported rice from Thailand and India shows an opposing or complementary relationship. The cross-elasticity value between Thailand and India is -0.04756, which means an increase in the price of imported rice from India will reduce India's import share by 0.04756%. A mutual substitution relationship is shown between imported rice from Thailand and Vietnam with an elasticity value of 0.10487 and rice from Vietnam and India with an elasticity value of 0.00626. when there is an increase in the price of imported rice in one of the import source countries by 1%, it will increase the share of rice imports from other import source countries by that coefficient.
3.2 Why does and does not Indonesia import

The government's rice import policy is a short-term measure to fulfill domestic food needs. One of the limitations of rice reserves in Indonesia is due to the risk of climate change and extreme weather, causing non-optimal harvests [5,26]. Imported rice from Thailand and Vietnam, the countries of origin of imported rice with the largest market share in Indonesia, are substitutes for each other. If Indonesia cannot get imported rice from Thailand, it can choose Vietnamese rice. In addition, Vietnamese rice is substitutable with Indian rice, making it easy for Indonesia to fulfill its imported rice needs. However, this import activity cannot be carried out continuously, especially since rice is a basic need of the Indonesian people, so dependence on imported rice will affect domestic food security. Not to mention, importing will harm Indonesia economically.

![Image](https://doi.org/10.1051/bioconf/202411902014)

**Fig. 1.** Price trend of imported rice (a) Thailand dan (b) Vietnam.

Based on Figures 1(a) and (b), imported rice prices are increasing. The increase is influenced by the domestic situation of Indonesia's imported rice sources. The price of Thai rice tends to grow faster than Vietnamese rice so Vietnamese rice can replace Thai rice in the future. However, it does not break the chain of Indonesia's rice imports if rice production is not proportional to the needs of rice consumption, which is increasing faster. Imports are also a step for the government to avoid staple inflation due to limited rice availability.

Conversely, if Indonesia continuously imports, it will cause a multiplier effect on the Indonesian economy, such as a trade deficit that can cause the country's currency to weaken and high inflation. In addition, the dependence on rice from these two countries will increase. Therefore, the government must start improving the Indonesian rice sector by enhancing the rice agribusiness system in Indonesia.

4 Conclusions and policy recommendations

Indonesia imports rice from the world's three largest rice-producing countries, namely Thailand, Vietnam, and India. However, Indonesia has the most significant dependence on imported rice from Thailand. Thailand has the largest share of imports in fulfilling Indonesia's rice import demand, while Vietnam and India are in the second and third positions. Indonesia's dependence is also evident from the elasticity calculation towards imported Thai rice. Rice from Thailand is not sensitive to changes in total expenditure, whereas Vietnam is more sensitive to changes in total spending on Indonesian rice imports. The country with an absolute price elasticity of less than one is Thailand, meaning imported rice from Thailand is inelastic. Inelastic means that the rice market share of the exporting country, in this case Thailand, changes by a smaller percentage than the rice price of the exporting country. Based on cross-price elasticity, the relationship between imported rice from Thailand and India shows an opposing or complementary relationship. In contrast, a
mutually substitutable relationship is demonstrated between imported rice from Thailand and Vietnam.

Improving Indonesia's rice agribusiness system is a long-term plan that the government must carry out. The government must design an implementable and synergised rice agribusiness system model. Rice farming cannot be done separately but as a system from upstream to downstream. This will improve the rice supply chain and make it easier for the government to monitor and evaluate if rice farming is experiencing problems. Almost every part of the national rice system faces issues and threats, from upstream cultivation to downstream, so improvements made by the government in the long term are based on each component of the agribusiness system. In the upstream subsystem, the availability of inputs in quantity and quality and farmers' ability to obtain or purchase are essential. In the cultivation subsystem, the ability of farmers to conduct cultivation is not only based on experience but utilising technology to increase rice productivity on their land. Currently, land is no longer a renewable resource but is increasingly limited in number, so increasing productivity is a solution to increasing the number of rice harvests. In the downstream subsystem, the availability of rice mills close to farmers' land will further streamline farmers' production costs. In addition, the government also needs to implement Satu Data Indonesia as a step to provide quality data so that government policy programs are up-to-date and directed. The government must design a model of the rice agribusiness system that is implementable and synergised with technological support. Without synergy, rice commodities in Indonesia will face the same problems.

References