Indonesian maize imports: a gravity approach

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Abstract. The implementation of the ASEAN Economic Community (AEC) will affect the trade flow of goods and services in the ASEAN region. The flow of food from surplus countries to the food-insecure countries will improve national food security. The purpose of this study is to investigate the factors that affect Indonesia's maize import in ASEAN trade. The study analyzed the annual data from 1990 to 2016 and cross-section ASEAN member countries, as well as Indonesia's trading partners such as Malaysia, the Philippines, Thailand, Vietnam, Myanmar, and Singapore. The study applies the Gravity model approach to identify factors that influence maize import in Indonesia. The panel data regression applied to the fixed-effect method. The results show that Indonesian maize imports were influenced by growth in GDP per capita, economic distance, import tariffs, the exchange rate of the Rupiah against the Dollar, the implementation of AEC (ASEAN Economic Community), non-tariff barriers, and the population growth. All the independent variables together affected Indonesian maize imports from Southeast Asia. The empirical results of this study reveal the implications for the development of the production and competitiveness of Indonesian maize. The Indonesian government should strive to increase farm productivity and efficiency to increase maize production.

1. Introduction

The implementation of the ASEAN Economic Community (AEC) has a significant impact on the trade of goods and services in the ASEAN region. The increasing of trade cooperation in goods and services in the ASEAN region affected the ease of trade flows between countries. The ease of trade flows will facilitate the flow of food from surplus countries to the food-insecure countries and connect food production and consumption and plays an important role in improving food security.

Maize is one of the strategic food crops commodities. These commodities have multi-purpose functions, both for food, feed, fuel, and industrial raw materials. World maize production is controlled by the United States (34.6%), China (21.4%) and Brazil (7.3%), while Indonesia is ranked 8th in the world's largest maize producer. In Southeast Asia, Indonesia is the largest maize producer with a proportion reaching 48.1% of total maize production in Southeast Asia. Other ASEAN's biggest maize producers are the Philippines, Vietnam, Thailand (ASEAN Secretariat, 2014).

Indonesia's maize production is lower than domestic maize consumption. The use of maize is increasingly widespread, causing the need for maize is increase. To meet the needs of maize, maize imports have become an option for Indonesia. Indonesia imports maize from Brazil, India, and...
Argentina. For the Intra-ASEAN trade, Indonesia imports maize from Malaysia, Singapore, Vietnam, Thailand, and the Philippines. Research on international trade has been carried out in Indonesia using gravity models in Southeast Asia, China, and in the Middle East [1][2][3]. in Indonesia for a variety of leading commodities exported to the European Union [4] investment and manufacturing in Southeast Asia [5], leading export commodities [6] have been carried out. However, research on food trade, especially maize commodities between Indonesia and ASEAN member countries, using panel data analysis with the Gravity Model approach is scant. The aim of this study is to investigate the determinants of the Indonesian maize import on intra-ASEAN trade. The study focus on Indonesia and the bilateral trade relations in ASEAN during the period 1990 to 2016 and applied panel data analyses.

1.1. Gravity Model

The gravity model is based on Newton's law of gravity which states that the gravitational force between two objects is directly affected proportionally by the masses of the two objects and vice versa by the square distance between the two. The formulation of the gravity model is adopted from Newton's general gravity equation which states that 'the interaction between two objects is proportional to its mass and inversely proportional to each other's distance'. The assumption of the gravity model, international trade is defined as a flow of bilateral trade that depends on "mass" or the size of partner countries and the distance between countries [13] [16]. The positive impact of international trade is shown by the "mass" of countries measured by GDP or GDP per capita, while the negative impact is indicated by the distance between countries [7]. Gravity model was first used in the 19th century by Ravenstein (1885) then Zipf (1946). However, the gravity model is used formally by Tinbergen ([11]) and Pöyhönen [12] [7].

A basic gravity model to explain the flow of trade between countries as the following formula [11] [12]:

$$ M_{ij} = \alpha \left( \frac{Y_i^{1.5} Y_j^{0.5}}{d_{ij}^{3.5}} \right) $$

where $M_{ij}$ is the trade flow from country $i$ to country $j$, $Y_i$ ($Y_j$) is the nominal gross domestic product (GDP) or GDP per capita in country $i$ and $j$ representing the market size of trading countries, $D_{ij}$ is the geographic distance from the economic center of country $i$ to that of country $j$, and $\alpha$ is a constant. Using the natural logarithmic equation, the above equation is then transformed into a linear form and becomes a general form of the Gravity Model for econometric analysis, where the constant $M$ is part of $\alpha0$, and GDP illustrates the economic size for the two countries. Generally, the gravity model equation is as follows:

$$ \ln M_{ij} = \alpha_1 \ln Y_i + \alpha_2 \ln Y_j - \alpha_3 \ln d_{ij} + \varepsilon $$

The gravity model states that the size of bilateral trade flows is determined by supply conditions in the country of origin, demand in the destination country and trade flows [18]. Gravity equations have been used to economically estimate the impact economic integration agreements, national borders, currency unions, languages, and other measures of trade costs for bilateral trade flows [8] [9].

2. Materials and Methods

2.1. Data

This study was applied to a panel dataset of Indonesia’s maize trading partners covering 27 years from 1990 to 2016. ASEAN member countries observed as Indonesia's trading partners in the maize import were Malaysia, the Philippines, Thailand, Vietnam, Myanmar, and Singapore. The data extracted from Central Statistics Agency of Indonesia, Indonesia Ministry of Trade, Indonesia
Ministry of Agriculture, Food and Agriculture of the United Nations (FAO), United Nations Conference and Trade Development (UNCTAD). Furthermore, distance data collected from Centre D’Etudes Prospectives Et D’Informations Internationales (CEPII). World Integrated Trade Solution (WITS) World Bank, and ASEAN Secretariat. Dependent variables in this study were the annual values of Indonesian maize imports from ASEAN member countries. The explanatory variables in the import model, such as GDP per capita, distance, tariff, exchange, ASEAN Economic Community implementation (dummy), Non-Tariff barrier (dummy), population growth, were regressed. The economic distance used was calculated by the following formula [21]:

$$\text{Dist} = \frac{\text{Geographic Distance}_{ij} \times \text{GDP}_j}{\sum \text{GDP}_j}$$

The model for this research based on the gravity model to determine the factor that affect Indonesian maize import below:

$$\ln M_{jit} = \beta_0 + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln (DIST_{ij}) + \beta_4 \ln (TRF_t) + \beta_5 \ln (XCG) + \beta_6 \ln (POP_{it}) + \beta_7 \ln (POP_{jt}) + \beta_8 NTB(dummy) + \beta_9 AEC(dummy) + \epsilon$$

where:

- LnMij is trade value between exporter i and importer j in a given year t (US$), In denotes variables in natural logs, GDPit is Indonesia per capita GDP growth (percent), GDPjt is exporter per capita GDP growth (percent), DISTij is economical distance between Indonesia and exporter (percent), XCG is exchange Rupiah to US Dollar (US$), POPit is Indonesia population growth (percent), POPjt is exporter population growth (percent), TRF is Import tariff, NTB is dummy variable indicating the presence or absence of a non tariff barrier in Indonesia, 1 if there is Non Tariff Barier or 0 if there is no Non Tarif Barier., AEC is dummy variable indicating before or after ASEAN Economic Community implementing, which is 1 after the AEC implemented, or 0 before the AEC not implemented yet, ε is random disturbance terms.

3. Result And Discussion

A fixed effed methods was applied in this study to estimate the parameters in the model above. The model was developed on a complete data sample consisting of 6 ASEAN member countries, Indonesia's trading partners. The advantage of panel data is that it combines time-series data and cross-border data to increase sample size, provide more variability and reduce multicollinearity between variables. To decide a model between the Fixed Effect (FE) or Random Effect (RE), the Hausman test was used where the null hypothesis is that the Random Effect (RE) as the preferred model compared to the alternative FE model. The result of the Haussmann test indicates that the FE methods is preferred. The Fixed Effect Model (FE) panel regression is a better choice than the Random Effect Methods (RE) to estimate the trade flows between Indonesia and ASEAN member countries.

3.1. Determinants of Indonesia Maize Import

Indonesia imports maize from Malaysia, the Philippines, Thailand, Vietnam, Myanmar, and Singapore. Indonesia maize import tend to decrease from 2000 to 2016. After the enactment of the ASEAN Economic Community, maize imports decreased by 66.57%.
The coefficient of determination on maize imports is 62.10% which means that variations in the flow of Indonesian maize imports from ASEAN can be explained by, GDP growth per capita exporters and Indonesia, economic distance, import tariffs, exchange rates, AEC, non-tariff barriers, exporter population growth and Indonesia population growth, while 37.90% of the variation in the value of maize imports is determined by other variables outside the model. Panel regression estimates of the determinants of Maize Import see table 1.

**Table 1.** Panel regression estimates of the determinants of Maize Import

| Variable            | Expected sign | Coefficient | Std. Error | t-Statistic | Prob. |
|---------------------|---------------|-------------|------------|-------------|-------|
| Ina GDP             | +             | -0.014135   | 0.024137   | -0.585622   | 0.5591|
| ASEAN GDP           | +             | 0.056037*   | 0.030992   | 1.808148    | 0.0727|
| Ln Distance         | -             | -6.560068***1.241313 | -5.284781 | 0.0000      |
| Ln Tariff           | -             | 1.061939***0.375567 | -2.827566 | 0.0054      |
| Ln Exchange         | -             | -1.565224*  | 0.801045   | -1.953977   | 0.0527|
| AEC                 | +             | -4.056794**2.093986 | -1.937354 | 0.0547      |
| Non Tarif Barrier   | -             | 3.757724***1.202416 | 3.125146  | 0.0022      |
| Ina Population      | +             | 0.514372    | 1.077278   | 0.477474    | 0.6338|
| ASEAN Population    | +             | -6.9681***1.333014 | -5.227319 | 0.0000      |
| C                   |               | 88.37063    | 13.83484   | 6.387543    | 0.0000|
| R-squared           |               | 0.665786    | Sum squared resid | 150.0709   |
| Adjusted R-squared  |               | 0.621067    | Durbin-Watson stat | 1.485155   |
| Prob(F-statistic)   |               | 0.000000    |            |            |

*** significant on 1%
** significant on 5%
* significant on 10%
(Source: Data Analysis 2018)

Partially the factors influencing maize exports to southeast Asia and maize imports from Southeast Asia are as follows:

ASEAN GDP per capita growth significantly affected Indonesia's maize imports from Southeast Asia. 1% increase in ASEAN GDP per capita will increase maize imports by 0.05%. Income is one of the
factors that affect demand. If income increases, demand will increase. GDP per capita is one indicator that can show a country's purchasing power. Increasing a country's per capita income will increase purchasing power and consumption. In Fact, 1% increase in Indonesia's GDP per capita, will reduce the value of maize imports by 0.01%. In recent years, maize in Indonesia has been used as animal feed or non-food industries, therefore, with the increase in GDP in Indonesia, the demand for maize as food consumption will decrease, resulting in a decline in imports. The economic development level of a country is a common proxy for trade demand or supply [2].

Economic distance has a significant effect on the value of Indonesia's maize imports. Indonesia imports maize from Malaysia, the Philippines, Thailand, Vietnam, Myanmar, and Singapore. A 1% increase in economic distance will reduce the value of Indonesia's maize imports by 6.56%.

Distance affects the cost of transportation. The longer the distance between the exporter and the importing country, the greater the transportation costs and the lower the value of trade with the trading partner country in that country. This implies that transportation costs have a negative effect on Indonesian imports. The more expensive the cost of transport, the fewer imports. According to the Linder effect [21], a higher economic distance between trade countries can hamper their bilateral trade, because a higher economic distance implies differences in the demand structure. Countries with different demand structures import and export less differentiated products horizontally. As such, bilateral trade volumes diminish with a higher economy.

Import tariffs have a significant effect on Indonesian maize imports. Every 1% increase in Indonesian Maize import tariffs will reduce the value of Indonesian Maize imports from Southeast Asia by 1.061%. Import tariffs have a significant effect on Indonesian maize imports. Every 1% increase in Indonesian Maize import tariffs will reduce the value of Indonesian Maize imports from Southeast Asia by 1.061%. The increase in import tariffs will have an impact on rising commodity prices which have an impact on reducing imports.

The exchange rate has a significant effect on Indonesia's maize imports. Every 1% increase in the exchange rate will reduce Indonesia's maize imports by 1.57%. The depreciation of the exchange rate will increase production and increase export volumes. Besides, the depreciation of the exchange rate will reduce imports.

The implementation of the ASEAN Economic Community (AEC) has a significant effect on the value of corn imports. After AEC implementation, corn imports from Southeast Asia decreased by 4.06%. One of the AEC's goals is to increase commodity production in ASEAN member countries. Indonesia's maize production also increases every year, and Indonesia's corn competitiveness tends to increase after the implementation of the AEC. The government is trying to become the main supplier of corn to several countries. This has an impact on increasing corn production in Indonesia so that domestic corn needs can be met so that imports will decrease.

Non-tariff barriers have a significant effect on Indonesia's maize imports. With the non-tariff barriers imposed in Indonesia will increase the value of maize imports from Southeast Asia by 3.76%. The Government of Indonesia applies certain requirements and standards regarding maize imports in terms of type/quality, labeling, packaging, and other administrative requirements. Although there are various rules applied in the import of Indonesian maize, it does not reduce the value of Indonesia's maize imports from ASEAN because ASEAN member countries have also implemented rules in the trade of their agricultural commodities. It implies that high-quality standards product are important in the maize trade in Indonesia.

The population growth of ASEAN countries has a significant effect on Indonesia's maize imports. Every 1% increase in ASEAN population growth reduces maize imports by 6.97%. This shows that maize from the ASEAN region is used to meet the domestic needs of producer countries before being exported. Indonesia's population growth has no significant effect on maize imports, however, with a 1% increase in Indonesia's population growth, the value of maize imports from southeast Asia increased by 0.51%. 
4. Conclusion
This research concludes that Indonesia's maize import from Southeast Asia were affected by trading partner country's GDP per capita, economic distance, import tariffs, the exchange rate of the Rupiah against the Dollar, the implementation of AEC (ASEAN Economic Community), non-tariff barriers, the population of Indonesia and ASEAN. ASEAN GDP per capita and Indonesia's population have a positive effect, while distance, tariff, exchange rate, AEC implementation, and ASEAN population have a negative effect on maize import value. All the independent variables together affected Indonesian maize imports from Southeast Asia. The empirical results of this study reveal the implications for the development of the production and competitiveness of Indonesian maize. The Indonesian government should strive to increase farm productivity and efficiency to increase maize production.

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