

## Determinants of Sugar Imports, Sugar Consumption and Production in Indonesia (2000 – 2019 Study Case)

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### ABSTRACT

Sugar is one of the staple foods in Indonesia, and the country was a prime sugar exporter in the past, but since 1967, it has been importing sugar from other countries. Sugar import volume has been increasing every year, so Indonesia has become the second largest sugar importer in recent years. Due to its position in daily life as one of the staple foods, sugar consumption has grown in accordance with the growth of the Indonesian population. On the other hand, sugar production growth is not as firm as its consumption. The growth of domestic consumption and the lack of sugar production eventually led Indonesia to become a country that imports sugar. Based on those problems, this research aims to analyze the determinants of Indonesian sugar imports, sugar consumption, and sugar production. Variables that are assumed to be determinants of sugar import are sugar production, sugar consumption, GDP, sugar price, and exchange rate. Sugar production and consumption are basic variables that form the sugar market and are also the main reason for Indonesian sugar import. Sugar production is affected by sugar prices. Meanwhile sugar consumption is affected by GDP and sugar price. Due to the difference in currency utilization, the exchange rate affects sugar import price. These data in the form of time series that ranged from 20 years (2000 – 2019) were collected from various related agencies. Data analysis uses Seemingly Unrelated Regression (SUR), which was used to analyze the determinants of sugar imports, sugar consumption, and sugar production simultaneously. Analysis of sugar imports volume shows that trend imports grew positively, with an estimated trend of 197.978 tons per year in the 2000 – 2019 period. The result of the SUR analysis shows that only sugar consumption affects sugar import significantly, while sugar production, GDP, domestic sugar prices, international sugar prices, and the rupiah exchange rate do not significantly affect sugar imports. Sugar consumption is affected by GDP and domestic sugar prices, while sugar production is affected by domestic sugar prices. The implication of these findings is to inform the related stakeholders that there will be growth of sugar import volume in the upcoming years. Based on SUR analysis, one policy that can be implemented by the government to resolve the sugar import problems is the policy on sugar prices because high sugar prices will decrease sugar consumption, and on the other hand also increase domestic sugar production. This research also contributes in giving vital information to the government on how to reduce sugar imports effectively.

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## 1. INTRODUCTION

Sugar is one of the most important staple foods due to its utilization in many aspects of life, such as household needs [1], the food and beverage industry [2], [3], [4], [5], [6] as well as for biofuels industry [7], [8], [9]. Even recent developments show the utilization of functional sugar and bio-engineered sugar in the pharmaceutical and chemical industry [10], [11], [12]. All of these conditions impact the amount of world sugar consumption. According to [13], world sugar consumption reached 171.8 million tons in 2020, where Indonesia is ranked 6th with a consumption of 7.5 million tons. Indonesia responded to the sugar consumption problem by importing sugar due to the lack of domestic sugar production [13]. Importing sugar has a long history in Indonesia. The country's first recorded import of sugar was in 1967 [14]. Since then, Indonesia has continued to import sugar from year to year. Even in 2020, from 7.5 million tons of sugar consumption, Indonesia imported almost 6.2 million tons or 80% of total consumption [15]. The dependence on imported sugar should be serious attention because sugar is a staple food. Meanwhile an approximately 80% of world population also rely on import to sustain their food security [16]. The reliance on the world food market is dangerous because the turmoil in the world food market will affect the domestic food market [17]. The turmoil in the sugar sector will in turn impact other sectors because the sugar sector is linked to many downstream sectors [18].

In order to address this problem, related researches has been carried out. [19] analyzed the factors that influenced sugar demand and sugar imports during the period of 1982-2013 using Two-Stage Least Square method. The result is the difference between demand and sugar production, the period and sugar imports in the previous year have a significant effect on sugar imports. Another research using Multiple Linear Regression was carried out by [20] found that only international sugar price variable that affect sugar imports significantly, meanwhile [21] found that only Gross Domestic Product (GDP) that affect sugar imports significantly. The gap between this research and previous researches is the obtained knowledge covered by this research such as specific knowledge of determinants of sugar import, determinants of sugar consumption and sugar production. This study not only analyses the equation model of sugar imports but also seeks to comprehensively examine the problem of sugar imports by conducting a simultaneous analysis of the equations that represent the sugar economic sector, namely sugar imports, sugar consumption, and sugar production. The method used on the data analysis is also different: it is the Seemingly Unrelated Regression (SUR) method. This method was used due to its ability to efficiently estimate structural models with highly correlated variables inside it [22]. Trend analysis is also carried out to determine future import growth. Based on this description, research was conducted on the issue of sugar imports concerning the following research objectives questions: 1) to examine the trend of sugar imports during the period 2000 – 2019, and 2) to analyze the determinants of sugar imports, sugar consumption, and sugar production.

The results from this research contribute to addressing the problem of sugar import. By knowing the trend of sugar import, the government can take appropriate action in order to deal with the problem. For example, if the trend is positive, then the government must prepare the materials for importing sugar or try to decrease sugar import growth. Meanwhile, by knowing the factors that affect sugar imports, sugar consumption and sugar production the government can arrange a policy based on its causing factors. For example, if sugar production is affecting the sugar import negatively and significantly, then the government must arrange a policy that leads to the growth of sugar production, and at the same time, by knowing the factors that affect sugar production, the government is able to arrange appropriate policy in order to boost sugar production.

## 2. METHODS

This research will be carried out based on descriptive research method [23] with quantitative approach [24] in order to solve the defined questions. Indonesia is purposively chosen as research location due to its condition as world major sugar importer [25]. The data that is used in this research is panel data [26] for the period of 2000 – 2019. Required data for this research is obtained from several related sources as shown in the Table 1. Obtained data is analyzed using OLS for trend analysis and SUR method for affecting factors analysis. Data analysis carried out by using STATA 14 and Microsoft Excel. Research flowchart can be seen in Fig. 1.

### 2.1. Trend Analysis

The growth of sugar imports during a specific period forms a pattern, which is commonly referred to as a trend. Trend can be analyzed using Ordinary Least Square (OLS) method [27], [28], [29]. By knowing import

volume specifically each year ( $Y_t$ ) and the import period year ( $X_t$ ), the growth of import volume each year can be calculated using simple OLS equation. The equation refers to the simple OLS method as follows:

$$Y_t = \alpha + \beta \cdot X_t + e \quad (1)$$

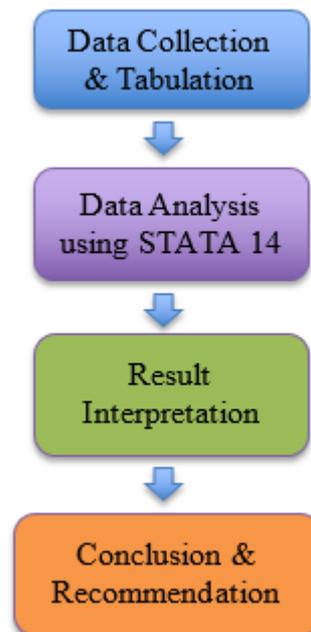
with  $Y$  is volume of imports in year ( $t$ ),  $X$  is import period year ( $t$ ),  $\alpha$  is constant that is the value of  $Y$  (if  $X=0$ ) and  $\beta$  is regression coefficient whose magnitude of change in  $Y$  changes is 1 unit ( $t$ ). Based on the equation above can be inferred that import volume growth each year ( $t$ ) is determined by how many  $\beta$  is multiplied by  $X_t$ . The value of  $\beta$  as import trend can be calculated as follows:

$$\beta = \frac{Y_t - \alpha}{X_t} \quad (2)$$

**Table 1.** Data Sources

Data	Data Sources
Sugar import volume (ton)	Central Statistics Bureau of Indonesia (BPS)
Sugar production (ton)	Central Statistics Bureau of Indonesia (BPS)
Gross Domestic Products (billion rupiah)	Central Statistics Bureau of Indonesia (BPS)
Sugar consumption (ton)	Central Statistics Bureau of Indonesia (BPS)
Sugar domestic price (rupiah/kg)	Indonesian Ministry of Agriculture
Sugar world price (cent/pound)	United States Department of Agriculture (USDA)
USD-Rupiah Exchange rate (rupiah/USD)	Central Statistics Bureau of Indonesia (BPS)

Source: secondary data processed, 2021.



**Fig. 1.** Research flowchart

## 2.2. Seemingly Unrelated Regression (SUR)

In order to better understand the sugar market, this study divides the analysis of factors that affect sugar imports into three equations that reflect the sugar market ecosystem. Consequently, three equations must be analyzed simultaneously, because estimating these equations by an equation-by-equation least squares causing inefficiency [30]. According to [31], the OLS method is not appropriate when applied in a simultaneous test of the structural model because it can cause bias and inconsistency. Among the cause of these problems is the correlation between the disturbances of several models or the Contemporaneous correlation bias [32]. In this regard, the Seemingly Unrelated Regression (SUR) method is used, where this method can be used to analyze several models together and their relation each other [33]. In this research, there will be three equations based

on supply and demand theory: sugar import equation, sugar consumption equation and sugar production equation.

Variables that are included in each equation must be defined previously. In accordance, the first to be defined are variables that included in the sugar import equation. Basically, sugar import is a trade activity that occurs in the world market, so production and consumption are among the basic variables that affect sugar imports. Based on the research that was done by [34], sugar import in Indonesia is caused by a lack of domestic production and growth of consumption which eventually led to a domestic shortage of sugar. Similarly, [20] found that not only sugar production and consumption, but international sugar price was also significant factor that affect sugar imports. Another research by [35] concluded that Gross Domestic Product (GDP) and exchange rate were affecting sugar imports significantly. Based on those researches, can be concluded that among significant variables that affect sugar imports (Y1) are sugar production (X1), GDP (X2), sugar consumption (X3), domestic sugar price (X4), international sugar price (X5), and rupiah-dollar exchange rate (X6).

Variables that are included in the sugar consumption equation and sugar production equation must also be defined previously. [19] found that sugar demand is affected by income and domestic sugar price (X4). In this research, GDP (X2) can be used as a variable that represent aggregate income of a country. Meanwhile, according to supply theory, domestic sugar price (X4) can be seen as affecting variable toward sugar production. The overall SUR analysis equations are formed as follows:

$$Y1 = a + \beta1.X1 + \beta2.X2 + \beta3.X3 + \beta4.X4 + \beta5.X5 + \beta6.X6 + e \quad (3)$$

$$Y2 = a + \beta2.X2 + \beta4.X4 + e \quad (4)$$

$$Y3 = a + \beta4.X4 + e \quad (5)$$

where Y1 is Imported Sugar (tons), Y2 is Sugar Consumption (tons) Y3 is Sugar Production (tons), a is Constant,  $\beta1$  is Regression coefficient X1, X1 is Sugar production (tons),  $\beta2$  is Regression coefficient X2, X2 is GDP (billion rupiah),  $\beta3$  is Regression coefficient X3, X3 is Domestic sugar consumption (tons),  $\beta4$  is Regression coefficient X4, X4 is Domestic sugar price (rupiah/kg),  $\beta5$  is Regression coefficient X5, X5 is International sugar price (cent/pound),  $\beta6$  is Regression coefficient X6, X6 is Rupiah-Dollar Exchange Rate (rupiah/USD).

## 2.3. Statistical Analysis

### 2.3.1. R<sup>2</sup> Test

The R<sup>2</sup> is used to see how well a statistical model in predicting the outcome that represented by the value of dependent variable. Practically, the R<sup>2</sup> value shows the proportion of dependent variable's variance that is explained by the model [36], [37]. The value of R<sup>2</sup> test ranges from 0 to 1, with simplified assumption that the closer the R<sup>2</sup> test value to 1 is, the better it is [38].

### 2.3.2. Z-Test

The z test is used to see partial effect of independent variable on the dependent variable. The test is carried out by referring to following hypotheses:

H<sub>0</sub>: Independent variable has no significant effect on the dependent variable partially,

H<sub>1</sub>: Independent variable has significant effect on the dependent variable partially.

If the p-value is equal or less then  $\alpha$  (0.05) H<sub>0</sub> is rejected and H<sub>1</sub> is accepted [39], [40].

## 3. RESULTS AND DISCUSSION

### 3.1. Sugar Import Trend

The sugar import graphic shows yearly sugar import growth from the year 2000 to 2019. Although Fig. 2 shows that the actual sugar import quantity in 2000-2019 is fluctuative, aggregately it can be seen that there is tendency of sugar import volume to increase. Indonesian rapid population growth has led to the growth of sugar demand [41]. The large demand for sugar has created domestic shortage of sugar and in turn, causing the country to import sugar from other countries [18]. This phenomenon also found in rice consumption case, as it also has grown in accordance with the population growth [42]. The highest growth of sugar import happened in the year 2007, where import volume increased more than 1,5 million ton or more than 100% from previous year. However, surprisingly in the year 2008 import volume decreased significantly to less than 1 million ton [43] due to the increasing volume of domestic sugar production [44].

Meanwhile, Table 2 shows that the trend of sugar imports during the period 2000-2019 is a positive trend with annual increase around 197,978 ton per year. The result of this calculation can be written in the following equation:

$$Y = a + bXt$$

$$Y = 376.729 + 197.978.Xt.$$

This analysis was done by taking import volume as dependent variable (Y) and the import year (Xt) as independent variable that determines sugar import volume.

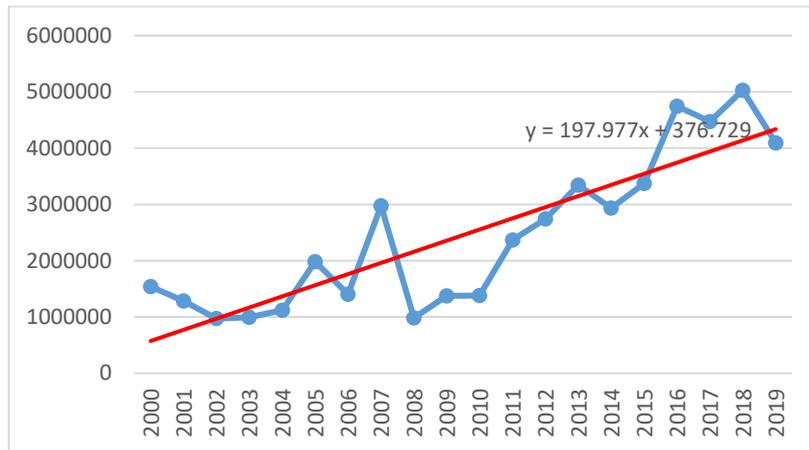


Fig. 2. Sugar Import Growth in the 2000-2019 period

Table 2. Ordinary Least Square (OLS) Test Result

Variable	Coefficient	Standard Error
1 (Constant)	376729.111	326572.905
Periode (T)	197977.461	27261.779

Source: Data analysis, 2021.

Indonesia importing sugar in three different forms: the raw sugar, the refined sugar and plantation white sugar [45]. The raw sugar is imported for domestic refineries and only distributed for industrial needs not retail consumers. The refined sugar is imported specially if some companies need certain qualities of refined sugar that is not available locally. The plantation white sugar is imported for direct household consumption and usually imported in small quantity compared to raw sugar or refined sugar [45]. From May 2022 to January 2023, Thailand (36%) has been the main supplier of Indonesian raw sugar import, followed by Brazil (33%), Australia (17%) and India (13%), meanwhile Indonesia's refined sugar import also mainly supplied by Thailand (91%), India (4%) and South Korea (4%) [46].

### 3.2. Determinants of Sugar Import, Sugar Consumption and Sugar Production

Table 3 shows that the  $R^2$  of (3) test results value is 0.88. Means that the independent variables can explain 88% of the volume of sugar imports in the model, namely sugar production, GDP, sugar consumption, domestic sugar prices, international sugar prices, and the dollar-rupee exchange rate. 12% of the volume of sugar imports is explained by other variables not examined, such as import tariffs, population, and the number of importers. High  $R^2$  value means that regression model can predict the dependent variable well [47].

The  $R^2$  result of (4) is 0.922 means that the independent variables can explain 92.2% of sugar consumption in the model, namely GDP and domestic sugar prices. The remaining 7.8% of sugar consumption is explained by other variables not examined, such as income per capita, age, gender, and prices of substitute goods. The value of  $R^2$  of (5) is 0.489, which means that the dependent variable influences 48.9% of sugar production in the model, namely domestic sugar prices. The remaining 51.1% was influenced by other variables not examined, such as agricultural commodity prices, land fertility, yield effectiveness, and milling hours of sugar mills.

Table 3 shows that in the (3), sugar production has a significance value of  $0.141 > \alpha (0.05)$ , and a regression coefficient of  $-0.734$  means that the sugar production variable partially has no significant and negative effect on the volume of sugar imports. [48] also found similar result that sugar production does not affect sugar import significantly. One reason behind this is because of Indonesian sugar production has been

very low, so that it is insufficient to even meet the half of domestic consumption [49]. GDP has a significance value of  $0.352 > \alpha$  (0.05) with a regression coefficient of -0.289, so it can be concluded that the GDP variable has no significant and negative effect on the volume of sugar imports partially. Sugar is one of staple food, so the income elasticity on sugar consumption is less than 1 or inelastic [50]. This means that changes in income does not bring changes in sugar consumption and sugar import.

The significance value of the sugar consumption variable is  $0.011 < \alpha$  (0.05), and the regression coefficient value is 0.576. This shows that individual sugar consumption has a significant and positive effect on sugar imports at the 95% confidence level, so an increase in sugar consumption will lead to an increase in sugar imports and vice versa. The regression coefficient value of 0.576 means that an increase in consumption of 1% will increase the volume of sugar imports by 0.576%. This result is coherent with the research that conducted by [51]. Domestic consumption is one major reason that made Indonesia importing sugar [52]. The domestic sugar price variable has a significance value of  $0.05 = \alpha$  (0.05) with a regression coefficient of 286.18, meaning that the domestic sugar price has no significant effect on the 95% confidence level and is partially positive for sugar imports. However, if the significance level is reduced to 90%, then the domestic sugar price has a significant effect partially.

**Table 3.** Seemingly Unrelated Regression (SUR) Test Result

	Coef.	Std. Error	z	p >  z	95% Conf. Interval	
<b>Import Volume (Y1)</b>						
Production	-0.734	0.4986	-1.47	0.141 <sup>ns</sup>	-1.711	0.2432
GDP	-0.290	0.3117	-0.93	0.352 <sup>ns</sup>	-0.901	0.3210
Consumption	0.576	0.2265	2.54	0.011 <sup>***</sup>	0.132	1.020
Domestic Price	286.190	145.726	1.96	0.050 <sup>ns</sup>	0.572	571.8075
International Price	-380.0206	432.346	-0.88	0.379 <sup>ns</sup>	-1227.403	467.3617
Exchange Rate	40.1638	156.4201	0.26	0.797 <sup>ns</sup>	-266.414	346.7416
Cons.	1166626	1604822	0.73	0.467	-1978769	4312020
R <sup>2</sup> (3)	0.8809					
<b>Consumption (Y2)</b>						
GDP	1.228536	.1651274	7.44	0.000 <sup>***</sup>	.9048923	1.55218
Domestic Price	-264.3814	94.46623	-2.80	0.005 <sup>***</sup>	-449.5318	-79.23098
Cons.	-1799081	479447.7	-3.75	0.000 <sup>***</sup>	-2738781	-859381.2
R <sup>2</sup> (4)	0.9220					
<b>Production (Y3)</b>						
Domestic Price	57.98539	13.25741	4.37	0.000 <sup>***</sup>	32.00133	83.96944
Cons.	1753905	123502.2	14.20	0.000 <sup>***</sup>	1511845	1995965
R <sup>2</sup> (5)	0.4889					

Source: Data analysis, 2021.

\*Significant with  $\alpha=10\%$ , \*\*significant with  $\alpha=5\%$ , \*\*\*significant with  $\alpha=1\%$ , ns= not significant.

The international sugar price has a significance value of  $0.379 > \alpha$  (0.05) and a regression coefficient of -380, so it can be said that the international sugar price variable partially has no significant and negative effect on the volume of sugar imports. The significance value of the dollar-rupiah exchange rate is  $0.797 > \alpha$  (0.05) with a regression coefficient of -40.2, so it can be concluded that the dollar-rupiah exchange rate variable is partially negative and has no significant effect on the sugar import variable. Another research by [48] also confirmed that exchange rate does not affect sugar import significantly.

The statistical test on (3) shows that despite the model is able to predict the sugar import volume well with R<sup>2</sup> value 88%, only sugar consumption that has significant effect on sugar import partially. This might happen if the relation of several independent variables on dependent variable is not a linear relationship. For example, sugar import is affected by sugar consumption, while sugar consumption is significantly affected by sugar price [19].

Table 3 shows that in the (4), the significance value of the GDP variable is  $0.00 < \alpha$  (0.01) with a regression coefficient of 1.2. means that the GDP variable partially has a significant and positive effect on the sugar consumption variable at the 99% confidence level so that an increase in the value of GDP impacts an increase in sugar consumption and vice versa. Another research by [53] also found that consumption of sugar is directly associated with GDP. The regression coefficient of 1.2 means that an increase in GDP of 1% impacts an increase in consumption volume of 1.2%. The results of the z-test of the consumption equation show that the domestic sugar price variable has a significance value of  $0.005 < \alpha$  (0.01) with a regression coefficient of -264.4. Based on this, it can be concluded that the domestic sugar price variable has a significant and negative

effect on sugar consumption, so increasing domestic sugar prices makes consumption decline. The regression coefficient -264.4 indicates that every 1% increase in domestic sugar prices causes a 264.4% decrease in domestic sugar consumption. Sugar price is one element of the marketing mix that affects perception in the customer's mind [54].

Table 3 shows that in the (5), the p-value for the domestic price variable is  $0.000 < \alpha$  (0.01) with a regression coefficient of 57.9. This shows that the price of domestic sugar partially has a significant effect on sugar production at the 99% confidence level, so that when the domestic sugar price increases by 1%, there will be an increase in sugar production of 57.9% and vice versa. Regarding price policy at the producer (farmers) level, the government has set a basic price policy for sugar, for example, through Kepmenperindag No. 527/MPP/Kep/9/2004 with a base price of Rp. 3,410/kg, Regulation of the Minister of Trade No.08/M-Dag/Per/4/2005 with a base price of Rp. 3,800/kg, and Permendag No.19/M-Dag/Per/4/2006 with a base price of Rp. 4,800/kg. The impact of this policy is considered quite positive, and in the 2003-2005, the production of Indonesian sugar started to increase significantly [18].

The analysis of the (3) concludes that only sugar consumption variables have a significant effect on the 95% significance level and are optimistic for sugar imports. This indicates that sugar consumption is not affected by price or income because sugar is a staple food, so price control policies are ineffective if used to suppress imports. Policies to suppress imports can be done by diversifying sugar sources by consuming sugar substitutes, such as palm sugar, coconut sugar, and honey. Reducing sugar consumption can also be done by adjusting the pattern of sugar consumption. Reducing sugar consumption has not only an economic impact but also benefits the health of consumers [55]–[57].

#### 4. CONCLUSION

Based on the discussion above, several conclusions can be drawn from this research. The trend of sugar imports in Indonesia during the period 2000 – 2019 was 197,978 tons/year. All independent variables (sugar production, GDP, domestic sugar consumption, international sugar prices, and the dollar-rupiah exchange rate) have a significant simultaneously effect on the dependent variable (sugar imports). Only the domestic sugar consumption variable partially affects sugar imports. Other dependent variables (sugar production, GDP, international sugar prices, and the dollar-rupiah exchange rate) partially have no significant effect on sugar imports. The consumption variable determining sugar imports is influenced by GDP and domestic sugar prices, while the production variable is expected to be an import solution influenced by domestic sugar prices.

Sugar consumption is getting more significant day by day, and this adds to the burden on sugar imports. The government and related stakeholders must be more intensive in developing sugar substitute products so that they can be an alternative to minimize the consumption of plantation white sugar (Gula Kristal Putih). Some of these products are palm sugar, palm sugar, palm sugar, and similar products. The government should formulate a sugar policy with a priority on providing profit for domestic producers through a domestic sugar price policy. This is expected to encourage production because when prices rise, consumers continue to consume sugar. In contrast, falling prices can reduce interest in production.

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