The Effect of Supply and Demand on Sugar Production Indonesia

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Abstract

Sugar is a vital commodity in Indonesia, serving as a staple ingredient in households and industries. The interplay of supply and demand significantly impacts sugar production, influencing prices, farmer incomes, and national food security. Comprehending these factors assists policymakers and stakeholders in devising strategies for a stable and sustainable sugar industry.

Sugar is a staple foods that plays an important role in the Indonesian economy because Indonesia is one of the countries that produces granulated sugar, but still imports it every year. among the staple food that holds a significant role in the Indonesian economy since Indonesia is one of the countries that produce granulated sugar but still import it annually. This study aims to: (1) determine the demand trend for granulated sugar in Indonesia, (2) ascertain the supply trend of granulated sugar in Indonesia, (3) identify the gap between supply and demand trends for granulated sugar in Indonesia, (4) analyze the factors influencing demand for granulated sugar in Indonesia, and (5) examine the factors affecting the supply of granulated sugar in Indonesia. This study employs descriptive methods, cause and effect analysis, and a quantitative approach utilizing secondary data. The study was intentionally conducted in Indonesia, considering that Indonesia is among the countries that produce granulated sugar but still import it annually. The data utilized is secondary data sourced from various channels. The analysis methods employed include trend analysis and multiple analyses of the Cobb-Douglas model. The results of the study concluded that: (1) the trend of demand for granulated sugar in Indonesia is increasing, (2) the trend of supply of granulated sugar in Indonesia is increasing, (3) the trend of the gap between supply and demand for granulated sugar in Indonesia is increasing, (4) factors that significantly influence the demand for granulated sugar in Indonesia are the price of granulated sugar, the price of tea, the price of ground coffee, while factors that do not significantly influence are the price of brown sugar, population, per capita income. (5) Factors that significantly influence the supply of granulated sugar in Indonesia are the farmer's benchmark price, the price of granulated sugar, and the price of SP-36 fertilizer.

Keywords: granulated sugar, supply, demand. Import, Cobb Douglas, import, eksport.

Introduction

Food is the most important basic human need and must be met; its fulfillment is part of human rights guaranteed in the 1945 Constitution of the Republic of Indonesia. Fulfillment of food needs is also related to efforts to improve the quality of public health so that the quality of Indonesian resources is obtained, which has strong competitiveness and is superior as a nation. During the economic crisis, the agricultural sector was a sector that was strong enough to face economic shocks and turned out to be reliable in the recovery of the national economy. One of the sub-sectors with quite large potential is the plantation sub-sector. The contribution of the plantation sub-sector to GDP was around 3.30 percent in 2018 or was the first in the Agriculture, Livestock, Hunting, and Agricultural Services sectors. Sugar cane, as a raw material for the sugar industry, is a key plantation commodity that plays a strategic role in Indonesia's economy. Sugar is a staple food of significant importance to the Indonesian people, whether consumed directly or indirectly through processed foods and beverages. In terms of household expenditure share, sugar has a significant contribution with a share of around 4% in the last 10 years (BPS, 2013). The demand for granulated sugar is expected to rise annually in tandem with the growing population, necessitating efforts to boost production, land availability, and potential yields, and technology. This situation presents sugarcane farming with favorable and promising prospects, encompassing demand and selling price considerations. The annual growth rate of granulated sugar demand in Indonesia stands at 1.64%, with an average demand of 3,105,497 tons per year. The peak growth rate of granulated sugar demand in Indonesia was recorded in 2016 at 10.21%, with the lowest growth observed in 2017 at -3.12%.

The growth pattern of direct consumption of granulated sugar in Indonesia mirrors the overall demand trend, with the highest growth rate seen in 2016 at 11.02% and the lowest in 2017 at -5.93%. The growth rate of special consumption (hotels, restaurants, catering, hospitals) has increased In 2016 by 10.39%, while the lowest growth is estimated to occur in 2019 at 1.04%. The peak growth rate of granulated sugar consumption for the household industry in Indonesia was in 2016 at 6.32%, with the lowest growth projected for 2019 at 1.04%. The peak growth rate of granulated sugar supply in Indonesia was recorded in 2016 at 9.77%, with the lowest growth observed in 2017 at 0.97%. Based on Table 1.4, the growth rate of granulated sugar production increased estimated in 2019 by 12.67%, while the lowest growth occurred in 2016 at -13.94%. The growth rate of granulated sugar stocks at the beginning of the year in Indonesia was highest in 2017 at 52.46%, while the lowest growth occurred in 2016 at -

30.94%, leading Indonesia to import sugar with a growth rate of 39.40% and the lowest growth rate of granulated sugar exports occurred in 2017 at -5.61%. The growth rate of granulated sugar exports in the period 2015-2019 increased in 2018 by 20.05% while the lowest growth occurred in 2016 at -3.72%. Based on the explanation above, the research objectives are as follows: (1) to determine the trend of demand for granulated sugar in Indonesia, (2) to analyze the trend of supply of granulated sugar in Indonesia, (3) to identify the gap between supply and demand for granulated sugar in Indonesia, (4) to explore the factors influencing demand for granulated sugar in Indonesia, and (5) to investigate the factors influencing the supply of granulated sugar in Indonesia.

The shortfall in domestic production is driven by the supply of imported sugar. The percentage of imports to the total national sugar supply in 2021 will reach 62 percent (Figure 1).

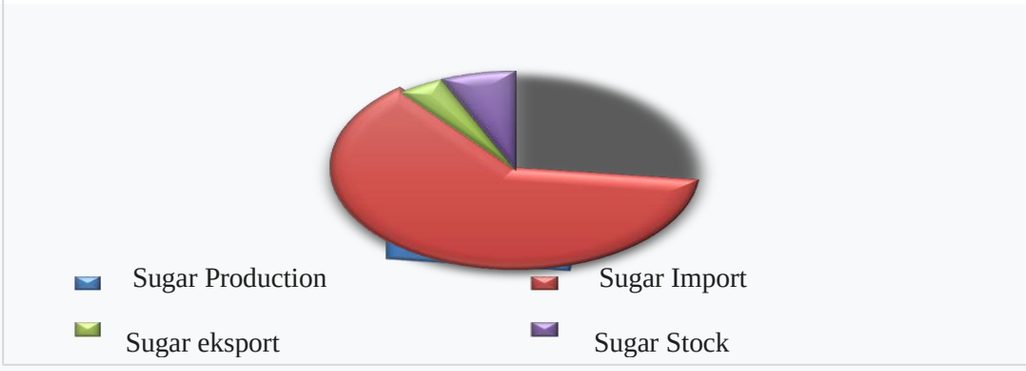

Figure 1. Percentage of Indonesian Sugar Supply in 2023
Source: FAO, 2023; Central Statistics Agency, 2024

If the import of sugar cannot be suppressed and the export cannot compensate, then this can lead to a larger trade balance deficit (Pudjiastuti, 2014). In addition, the entry of imported sugar into the domestic market also creates another problem, where the price difference between domestic production and imported sugar is quite high.

A significant increase in the price of sugar will have an impact on the inflation rate, given that the contribution of sugar to inflation reaches 0.40 percent (Badan Pusat Statistik, 2019). In addition, high prices will also affect people's spending on food. The public expenditure on sugar is 1.18 percent of the total expenditure on foodstuffs (food). In addition, the contribution of sugar to the poverty line in urban areas is 1.99 percent and 2.78 percent in rural areas (Badan Pusat Statistik, 2019).

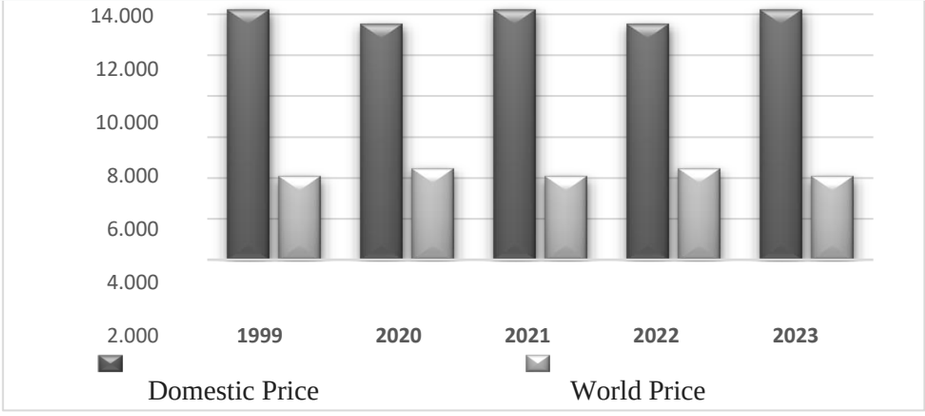

Figure 2 Comparison of Domestic Price and World Sugar Price (Rp)
Source: Director General of Plantations, 2023; World Bank, 2024

A study of sugar supply is needed to see the dominant factors that affect the availability of sugar supply in the domestic market. Various studies have been conducted to analyze the factors that affect the supply of sugar in Indonesia. The research conducted by (Sadiyah et al., 2014) shows that several factors that affect the supply of sugar in Indonesia are fertilizer prices, wages, interest rates, domestic sugar prices, sugar cane production and sugar imports in the previous year. Similar research conducted by (Apriyanto, 2009) shows that the supply of sugar in Indonesia is significantly influenced only by the area of sugar cane. Another study from (Abdul et al., 2017) shows that Indonesia's sugar supply is an identity function of the amount of sugar production and Indonesia's sugar imports. Research that has been done before shows various variations in results. Previous research focused more on the object of research, which is white crystal sugar. In addition, the previous research calculated the amount of

sugar supply only on the amount of production and import of sugar, while the variables of stock and export have not been included in the calculation

Domestic Sugar Consumption Variable (DSCV) have a positive effect on growth Indonesian sugar imports at a significance level of 1 percent. Domestic sugar consumption has a short-term elasticity value of 2.4816 and long term as much as 3.4186 at a real level of 1 percent. Based on value said, sugar consumption has a responsive effect on sugar imports, di where if there is an increase in sugar consumption domestic as much as 1 percent, then it can increase imports by 2.4816 percent for the long term short term and 3.4186 percent for long term, ceteris paribus. The limited availability of domestic sugar supplies encourages imports to meet domestic consumption needs. Positive relationship between consumption domestic and imported sugar in line with the research of Rusdi et al. (2021) related factors which affects Indonesia's sugar imports.

The sugar import control policy then turned into strengthening the domestic sugar industry. According to (Syahnaz et al., 2022) the import of sugar is not only done to reduce the price of sugar during the off-season but also mainly to meet the national sugar needs. According to (Dwipurwanti & Sasana, 2022) old machines that are still used especially by sugar factories located in Java Island and the relatively low level of yield from sugar cane produced by farmers also trigger why domestic sugar productivity is still said to be low

Problems in the sugar industry in Indonesia occur in the on-farm and off-farm subsystems. In the on-farm subsystem, low sugar productivity and limited land are the main problems. While in the off-farm subsystem, the problem is mainly related to the inefficiency of domestic sugar factories (Yunitasari et al., 2021). Problems in the on-farm and off-farm subsystems can trigger the disruption of the national sugar supply. This is due to the increase in demand for sugar that is not balanced by sufficient domestic production, causing excess demand (Sutanto & Muljaningsih, 2022; Zainuddin et al., 2017).

Meanwhile The Exchange Rate Variable (KURS) has a negative effect on the growth of Indonesian sugar imports at a significance level of 5 percent. This is shown by the value of short-term elasticity of -0.8494 and long-term of -1.1701 at a real level of 5 percent. This can be caused by the exchange rate appreciation making sugar imports more expensive, thus reducing the purchasing power of consumers towards imported sugar. In addition, the strengthening exchange rate will increase the competitiveness of sugar local in the domestic market. The high elasticity in the long term indicates that changes in the exchange rate will have a greater impact on sugar imports in the long term. The results of this analysis show findings that are different from Putri and Sentosa's (2021) research, which shows that there is a positive relationship between the exchange rate and imports.

RESEARCH METHOD

Type and Method of Research

The method used in this study is descriptive, cause and effect, and quantitative approach using secondary data. The descriptive method is intended to describe in detail the demand and supply of granulated sugar in Indonesia. The cause and effect method is used to describe the influence of one or more independent variables on the dependent variable because changes in demand and supply variables are caused by several other variables. This study also uses a quantitative approach based on secondary data because information or data is presented in the form of numbers and analyzed based on regression analysis, both simple and multiple.

Determination of Research Location

The determination of the research area was carried out purposefully, namely intentionally in Indonesia, with the consideration that Indonesia is one of the countries producing granulated sugar but still imports it every year.
The research was conducted in 2024.

Data Collection Method

The data used in this study are secondary data. Secondary data in the form of time series data from 2019-2024, which was collected from the Central Statistics Agency (BPS), the Center for Agricultural Data and Information, publications of the Ministry of Agriculture, publications of the Ministry of Trade, and other related sources in order to obtain data and information related to the demand and supply of granulated sugar in Indonesia.

$$Y = \beta 0 + \beta 1X$$

$$\beta 0 = \frac{\Sigma Y}{n}$$

$$\beta 1 = \frac{\Sigma XY}{}$$

ΣX^2

where:
Y = predicted variable
X = year t (time)
β0 = constant
$\beta 1$ = the amount of change in variable Y that occurs
for every one unit change in variable X (value
of trend regression coefficient)
n = number of data
The statistical hypothesis is proposed as follows:
H0: there is no trend in demand and supply of granulated sugar, or $\beta j = 0$
Ha: there is a trend in demand and supply of granulated sugar, or $\beta j \neq 0$

Hypothesis testing is carried out statistically with the t-test as follows:

$$t\ test = \frac{bg - \beta * g}{sbj}$$

where:
bg = regression coefficient of estimated results
β∗g= β corresponds to the null hypothesis (H0)
sbg = standard error of the regression coefficient bg
2. Multiple Regression Analysis of Cobb-Douglas Model
Hypothesis testing on factors that influence the demand for granulated sugar in Indonesia uses multiple regression analysis of the Cobb-Douglas model with the following equation:
$Dx = \beta 0\ X1\ \beta 1 X2\ \beta 2\ X3\ \beta 3\ X4\ \beta 4\ X5\ \beta 5\ X6\ \beta 6\ \boldsymbol{eu}$

By transforming the model into a natural logarithm, it becomes simpler as follows:
$ln\ Dx = \beta 0 + \beta 1 lnX1 + \beta 2 lnX2 + \beta 3 lnX3 + \beta 4 lnX4 + \beta 5 lnX5 + \beta 6 lnX6$
where:
Dx = demand for granulated sugar
$\beta 0 \ldots \beta i$ = constant
$X1$ = price of granulated sugar in year t
$X2$ = price of brown sugar as a complementary good in year t
$X3$ = price of coffee
$X4$ = price of tea
$X5$ = population in year t
$X6$ = income per capita in year t
u = nuisance error
e = natural logarithm number = 2.7183

Hypothesis testing on factors that influence the supply of granulated sugar in Indonesia uses multiple regression analysis model Cobb-Douglas with the following equation:
$Sx = \beta 0\ X1\ \beta 1 X2\ \beta 2\ X3\ \beta 3\ X4\ \beta 4\ X5\ \beta 5\ \boldsymbol{eu}$

By transforming the model into natural logarithm form, so that it becomes simpler as follows:
ln $Sx = \beta 0 + \beta 1 lnX1 + \beta 2 lnX2 + \beta 3 lnX3 + \beta 4 lnX4 + \beta 5 lnX5$

in where:
Sx = supply of granulated sugar
$\beta 0 \ldots \beta i$ = constant
$X1$ = price of granulated sugar in year t
$X2$ = production of granulated sugar in year t
$X3$ = initial stock of granulated sugar in year t
$X4$ = import of granulated sugar in year t
$X5$ = export in year t
u = nuisance error
e = natural logarithm number = 2.7183

RESULTS AND DISCUSSION

Trend of Granulated Sugar Demand in Indonesia The demand for granulated sugar in Indonesia is determined by direct consumption, special consumption, and household industry consumption. Direct consumption of

granulated sugar involves crystal sugar consumed directly by the public as an ingredient in food and beverages. Household industry consumption involves using granulated sugar as an ingredient in various products like baked goods, snacks, and chip manufacturing.

The trend in demand for granulated sugar is the tendency of the development of demand for granulated sugar in Indonesia over a certain period of time, namely from 2019-2024. National demand for sugar is expected to continue to increase along with the high consumption of sugar.

To see the development of demand for granulated sugar in Indonesia, it can be analyzed using a trend test. The results of the analysis of the trend test of granulated sugar demand in Indonesia are presented in Table 6.1. The equation of the trend line for granulated sugar demand in Indonesia obtained from the analysis results is:

$$\boldsymbol{Y} = \mathbf{2.68}.\mathbf{223}^{***} + \mathbf{72}.\mathbf{513}\,\boldsymbol{X}^{**}$$

Based on the equation of the trend line for granulated sugar demand in Indonesia obtained from the analysis, it states that the regression coefficient has a positive value, meaning that the demand for granulated sugar in Indonesia has increased by 72,513 tons/year. The projection of granulated sugar demand in Indonesia for the upcoming year can be based on the existing trend of granulated sugar demand. The projection of granulated sugar demand is carried out for the next 5 years, namely from 2019 to 2024. The development of granulated sugar demand in Indonesia over the next five years is presented in Table 6.2 below. The regression coefficient shows that granulated sugar exports in Indonesia correlate positively with the supply of granulated sugar within the country.

Table 1. Projection of Granulated Sugar Demand in Indonesia 2019-2023

Year	Projected Granulated Sugar Demand (tons)
2019	3,217,298
2020	3,288,811
2021	3,360,323
2022	3,431,836
2023	3,503,349
2024	3,612.332

Based on Table 6.1, it is explained that the projection of demand for granulated sugar in Indonesia from 2019 to 2024 has increased annually by 72,513 tons/year. The development of demand for granulated sugar can be used with the assumption that if the current situation is almost the same as the future situation. If the trend analysis is reviewed based on the demand for granulated sugar for direct consumption, special consumption, and household industrial consumption in Indonesia, it can be explained in table 2 as follows.

Table 2. Projection of Demand for Granulated Sugar Demand Based on Direct Consumption, Special Consumption, and Household Industry Consumption in Indonesia 2019-2023

Year	Direct Consumption (tons)	Special Consumption (tons)	Household Industry Consumption (tons)
2019	1,750,853	953,047	513,398
2020	1,746,801	996,266	545,744
2021	1,742,749	1,039,484	578,090
2022	1,738,697	1,082,703	610,436
2023	1,734,645	1,125,921	642,782
2024	1,752.662	1,154,231	661.646

Source: Secondary Data Analysis (2024).

1. Demand for Granulated Sugar for Direct Consumption

Direct consumption of granulated sugar in the form of crystal sugar consumed directly by the public as a complementary ingredient for food and beverages.The trend line equation for granulated sugar demand for direct consumption obtained from the analysis results is:

$$Y = 1{,}675{,}166^{***} - 4{,}042\ X^{ns}$$

The regression coefficient of -4,042 indicates that there is a trend in demand for granulated sugar for direct consumption decreasing by 4,042 tons/year. Thus, the demand for granulated sugar for direct consumption shows a negative or decreasing trend from year to year during the period from 2019 to 2020.

2. Demand for Special Consumption Granulated Sugar

Special consumption of granulated sugar refers to the demand for granulated sugar for direct consumption which is used in processed food and beverages in several places, such as hotels, restaurants, catering, hospitals. The trend line equation for demand for granulated sugar for special consumption obtained from the analysis results is: $Y = 683{,}736^{***} + 42{,}219\ X^{**}$

The regression coefficient indicates a positive relationship between the demand for granulated sugar for special consumption in the country and the overall demand for granulated sugar in Indonesia. Demand for granulated sugar for special consumption tends to increase, this indicates that demand for granulated sugar for special consumption in Indonesia from 2019-2024 shows an increasing development of 42,219 tons/year

Demand for Granulated Sugar for Household Industry Consumption

Household industry consumption is the demand for granulated sugar used as one of the ingredients in making various products, such as bakeries, snacks, and chip factories. The trend line equation for demand for granulated sugar for household industry consumption obtained from the analysis results is:

$Y = 329{,}321^{***} + 33{,}346\ X^{***}$

The analysis results indicate a rising demand for granulated sugar for household industry consumption in Indonesia. This indicates that the demand for granulated sugar for household industry consumption in Indonesia from 2019-2024 shows that there has been an increase in the demand for special consumption granulated sugar of 33,346.064 tons/year. Sugar Demand Trend in Indonesia

The sugar supply trend is a projection of the development of sugar supply in Indonesia over a certain period of time, namely from 2019-2024. Sugar supply is influenced by the amount of domestic sugar production,sugar imports, and the amount of sugar exports. To see the development of sugar supply in Indonesia, it can be analyzed using a trend test. The equation of the sugar supply trend line in Indonesia obtained from the analysis results is: $Y = 5{,}307{,}477^{***} + 321{,}330\ X^{***}$

Based on the equation of the sugar supply trend line in Indonesia, obtained from the analysis results, it indicates that the sugar supply in Indonesia shows a tendency to increase year after year during the period from 2019 to 2024 This is due to the high price of the goods themselves, which allows domestic sugar supply to increase. The development of granulated sugar supply in Indonesia in the coming year can be projected using the trend of granulated sugar supply. The projection of granulated sugar supply is conducted for the next six years, specifically from 2019 to 2024. The development of granulated sugar demand in Indonesia over the next five years is presented in Table 6.3. Based on Table 6.3, it can be seen that the projection of granulated sugar supply in Indonesia from 2019-2024 has increased by 321,330 tons/year. The development of granulated sugar supply can be used with the assumption that if the current situation is almost the same as the future situation.

Table 3. Projection of Development of Granulated Sugar Supply in Indonesia in 2019-2024.

Year	Projected Granulated Sugar Supply (tons)
2019	7,134,258.855
2020	7,455,389.164
2021	7,776,519.473
2022	8,097,649.782
2023	8,418,780.091
2024	8,671,554,390

Source: Secondary data analysis (2024).

Domestic granulated sugar supply is the result of adding domestic production and imports minus exports. Sugar production in Indonesia in 2008-2018 continued to increase every year. If the trend analysis is reviewed based on production, imports, and exports in Indonesia, it can be explained in the following table 4.

Table 4 Projection of Demand for Supply of Granulated Sugar based on Granulated Sugar Production, Granulated Sugar Imports, and Exports of Granulated Sugar in Indonesia 2019-2024

Year	Production (tons)	Imports (tons)	Exports (tons)
2019	2,234,628	5,552,998	653.368
2020	2,201,468	5,974,353	720,432
2021	2,168,308	6,395,707	787,496
2022	2,135,148	6,817,062	854,560
2023	2,101,988	7,238,416	921,625
2024	2,128,887	7,412,330	941,725

Source: Secondary data analysis (2024).

1. Granulated Sugar Production in Indonesia

Granulated sugar production in Indonesia is the total amount of production produced each year during the period from 2008 to 2018. The trend line equation for granulated sugar production obtained from the analysis results is:

$Y = 2{,}443{,}588^{***} - 34{,}160\ X^{ns}$

The regression coefficient of -34,160 indicates that there is a trend of decreasing granulated sugar production by 34,160 tons/year. Thus, granulated sugar production in Indonesia shows a negative trend or decline in the supply

of granulated sugar in Indonesia from year to year during the period from 2019 to 2024 . Import of Granulated Sugar in Indonesia

2. Import of granulated sugar in Indonesia
is the total amount of granulated sugar imports each year during the period 2008 to 2018. The equation of the trend line of granulated sugar imports obtained from the analysis results is:
Y = 3,025,874*** + 425,354 X***
The regression coefficient shows that the import of granulated sugar in Indonesia has a positive relationship to the supply of granulated sugar in Indonesia. The import of granulated sugar tends to increase, indicating that the import of granulated sugar in Indonesia from 2019-2024 shows an increasing development of 425,354 tons/year.

3. Export of Granulated Sugar in Indonesia
Granulated sugar exports in Indonesia represent the total amount of granulated sugar exports each year during the period 2008 to 2018. The equation of the granulated sugar export trend line obtained from the analysis results is:
Y = 255.983** + 66.064 X**
The regression coefficient shows that granulated sugar exports in Indonesia have a positive relationship with the supply of granulated sugar in Indonesia. Imports of granulated sugar tend to increase, indicating that imports of granulated sugar in Indonesia from 2019-2024 show an increasing development of 66.064 tons/year.

Trend Gap of Supply and Demand for Granulated Sugar in Indonesia

The trend gap of granulated sugar is the difference in the projected development of supply and demand for granulated sugar in Indonesia over a certain period of time, specifically from 2008-2018. Domestic staple food products, according to the Ministry of Trade (2014), still have a gap between production and consumption due to the high price of food products in Indonesia. The national gap in granulated sugar is expected to continue. Table 5 shows that there is a gap in supply and demand for granulated sugar in Indonesia during the period 2019-2024.
Table 5. Supply and Demand Gap of Granulated Sugar in Indonesia 2019-2024

Year Supply (tons)	Supply(tons	Demand (tons)	Gap (tons)
2019	7,134,259	3,217,298	3,916,961
2020	7,455,389	3,288,811	4,166,578
2021	7,776,519	3,360,323	4,416,196
2022	8,097,650	3,431,836	4,665,814
2023	8,418,780	3,503,349	4,915,432
2024	8,631,775	3,689,467	4,942,308

.Source: Center for Agricultural Data and Information (2019-2024).

To observe the progression of the supply and demand gap for granulated sugar in Indonesia, it can be assessed through a trend analysis. So that the equation of the trend line of the gap in supply and demand for granulated sugar obtained from the results of the analysis is :
Y = 2,519,254*** + 245,618 X**
Referring to Table 5, it is evident that the disparity in supply and demand for granulated sugar in Indonesia tends to increase and shows a positive and significant trend at the 1% test level. Table 6.5 explains that the development pattern of the gap in supply and demand for granulated sugar in Indonesia from 20019 to 2024 has a value that tends to increase by 245,618 tons/year.

The development of the gap in supply and demand for granulated sugar in Indonesia in the coming years can be projected using the trend gap in supply and demand for granulated sugar. The projection of the gap in supply and demand for granulated sugar is carried out for the next 5 years, namely from 2019 to 2024.

Factors Affecting the Demand for Granulated Sugar in Indonesia

Factors affecting the demand for granulated sugar in Indonesia are analyzed using Cobb-Douglas multiple regression analysis. The dependent variable used in the model equation is the demand for granulated sugar (Y) which is thought to be influenced by the price of granulated sugar ($X1$), the price of brown sugar ($X2$), the price of tea ($X3$), the price of ground coffee ($X4$), population ($X5$), and per capita income ($X6$). This multiple regression analysis is intended to determine the influence of independent variables on the dependent variable by entering factors that affect demand as variables (X) and demand for granulated sugar as variables (Y), an estimation model for the function of granulated sugar is obtained. The results of estimating the function of granulated sugar demand are presented in Table 6.6.

The equation of regression analysis of the demand function for granulated sugar in Indonesia can be formulated as follows:

$$\ln Y = 66.595 - 0.545 ln\ X_1 + 0.936\ ln\ X_2 - 0.775\ ln\ X_3 + 0.714\ ln\ X_4 - 3.005\ ln\ X_5 + 0.142\ ln\ X_6$$

$$Y = 2.272.10^{29}\ X_1^{\ -0.543}\ X_2^{\ 0.937}\ X_3^{\ -0.779}\ X_4^{0.711}\ X_5^{-3.0}$$

Based on the analysis, it shows that the level of demand for granulated sugar in Indonesia is assumed to be influenced by: (1) the price of granulated sugar, (2) the price of brown sugar, (3) the price of tea, (4) the price of ground coffee, (5) the population, (6) income per capita. As seen from Table 6.6, the F-count value (=8.934) shows that the factors influencing the demand for granulated sugar are significant at the 5% test level. The coefficient of determination adjusted r square $\bar{R}^2$ of 0.826 shows that the independent variables (price of granulated sugar, price of brown sugar, price of tea, price of ground coffee, population, income per capita) included in the analysis model are able to explain the variation of the dependent variable (demand for granulated sugar) well with a value of 83%, while the other 17% is explained by other variables not included in the model, such as consumer tastes. Therefore, Ha is accepted, and Ho is rejected. This means that together, the factors included in the model have a significant effect on the demand for granulated sugar in Indonesia.

Table 6. Results of Regression Analysis of Sugar Demand Function in Indonesia

Variable	Parameter	Regression Regression	t	Sig
Constant	$\beta 0$	667.595	2.087^{ns}	0.104
Price of Granulated Sugar	$\beta 1$	-0.545	-4.110^{**}	0.016
Price of Brown Sugar	$\beta 2$	0.936	1.847^{ns}	0.139
Price of Tea	$\beta 3$	-0.775	-2.837*	0.047
Price of Ground Coffee	$\beta 4$	0.714	2.593*	0.062
Population	$\beta 5$	-3.005	-1.678^{ns}	0.169
Income Per Capita	$\beta 6$	0.142	0.620^{ns}	0.569
Std. Error Estimate	Se	0.049		
R Square	R^2	0.931		
Adjusted R Square	$\bar{R}^2$	$\bar{2}$ 0.826		
Multiple R	R	0.965		
F count			8.934	0.026
N		11		

Note: Hypothesis testing uses a one-way t-test, where * and ** indicate significance at the 90% and 95% levels.
Source: Secondary data analysis (2024).

Individually, the results of the partial regression coefficient test indicate that the price of granulated sugar, the price of tea, and the price of ground coffee have a significant effect on the demand for granulated sugar, but the price of brown sugar, population, and per capita income do not have a significant effect on the demand for granulated sugar. 1. Granulated Sugar Price The influence of the granulated sugar price factor has a negative effect on the demand for granulated sugar and is very statistically significant at the 5% test level. This is in accordance with the theory of the law of demand that if the price of a good increases, the amount demanded by consumers for the good will decrease; conversely, if the price of the good decreases, the amount demanded by consumers will increase. The value of the granulated sugar price regression coefficient of -0.545 indicates that every one percent increase in the price of granulated sugar results in a decrease in demand for granulated sugar by 0.545 percent, assuming that other granulated sugar demand variables are considered constant. The negative regression coefficient value indicates an inverse relationship, signifying that each price rise of granulated sugar leads to a decline in its demand.

2. Brown Sugar Price

The brown sugar price factor has a positive effect on the demand for granulated sugar and is not statistically significant at the 10% test level. The brown sugar price regression coefficient value is 0.936. The positive regression coefficient value indicates a positive relationship, meaning that every increase in the price of brown sugar will reduce the demand for brown sugar. If the price of brown sugar increases by one percent, it will result in an increase in the demand for granulated sugar by 0.936 percent, assuming that other granulated sugar demand variables are held constant.

3. Tea Price

The price of tea is a factor that influences the demand for granulated sugar because tea is a complementary good for the direct consumption of granulated sugar. The impact of the tea price factor negatively affects the demand for granulated sugar and is statistically significant at the 10% test level. The value of the tea price regression coefficient of -0.775 shows that every one percent increase in the price of tea results in a decrease in the demand for tea.
will decrease. Granulated sugar is a complementary good for tea, so if the demand for tea decreases, the demand for granulated sugar will also decrease. According to the analysis results, the demand for granulated sugar will

decrease by 1.064 percent, assuming other granulated sugar demand variables remain constant. The negative regression coefficient value signifies a negative relationship, indicating that an increase in tea price will lead to a decrease in the demand for granulated sugar.

4. Price of Ground Coffee

The price of ground coffee is a factor that influences the demand for granulated sugar because ground coffee is a complementary good for the direct consumption of granulated sugar. The price of ground coffee positively impacts the demand for granulated sugar and is statistically significant at the 10% test level. The regression coefficient value for the price of ground coffee is 0.714, meaning that every increase in the price of ground coffee by one percent will result in an increase in the demand for granulated sugar by 0.714 percent assuming that other granulated sugar demand variables are considered constant. The results of the analysis
show that currently ground coffee is not a complementary good and not a substitute for granulated sugar. This is because of the large demand for granulated sugar for household and industrial consumption, which is used as one of the ingredients in making several products, such as bakeries, snacks, and chip factories.

5. Population

The population factor negatively impacts the demand for granulated sugar and is statistically significant at the 10% test level. The regression coefficient value of the population of -3.005 indicates that every one percent increase in the population results in a decrease in the demand for granulated sugar by 3.005 percent, assuming that other granulated sugar demand variables are considered constant.

This result is in line with the theory according to Sukirno (2009), that population growth does not necessarily cause an increase in demand. However, population growth can be followed by an increase in work because the distribution of the population at productive age is increasing. For instance, rice, being the staple food of the Indonesian population, and the demand for rice is positively related to population growth. The higher the population, the more job opportunities will be expanded. Thus, more people will receive income, thus increasing the combination of people's purchasing power. Increased income causes people to consume food that is considered better. Thus
that granulated sugar as a food ingredient is not a normal commodity because the increase in population does not cause demand for granulated sugar in Indonesia. This aligns with the analysis of direct granulated sugar consumption, which has a tendency to decrease, although the population based on BPS data (2019) has increased. This trend may be attributed to the significant awareness among individuals regarding the health implications of excessive sugar consumption.

6. Per Capita Income

The per capita income factor has a positive effect on the demand for granulated sugar in Indonesia, statistically insignificant at the 10% test level. The regression coefficient value of per capita income is 0.142. indicating that every one percent increase in per capita income results in an increase in demand for granulated sugar by 0.142 percent, assuming that other granulated sugar demand variables are considered constant. The rise in demand for granulated sugar in this scenario is not driven by direct consumption needs because previous results showed that the demand for granulated sugar for direct consumption tends to decrease every year. If the demand for these business outcomes rises, the demand for raw materials like granulated sugar will also increase. The analysis results indicate that the rise in community per capita income stimulates an increase in the use of granulated sugar for special consumption and household industry purposes. According to BPS data (2016),the per capita income of the Indonesian population is on an upward trend. Therefore, considering the analysis results, it can be said that the demand for granulated sugar for special consumption needs and household industry consumption also tends to increase.

Factors Affecting the Supply of Granulated Sugar in Indonesia

The factors affecting the supply of granulated sugar in Indonesia were analyzed using Cobb-Douglas multiple regression analysis. The dependent variable used in the model equation is the supply of granulated sugar (Y) which is thought to be influenced by the farmer's reference price ($X1$), the price of granulated sugar ($X2$), the price of P-36 fertilizer ($X3$).

This multiple regression analysis aims to determine the impact of independent variables on the dependent variable. By entering factors that affect supply as variables (X) and granulated sugar supply as variables (Y), an estimation model is obtained for the granulated sugar supply function. Referring to Table 6.7, the F-count value (=37.782) indicates that collectively, the factors influencing granulated sugar supply in Indonesia are statistically significant at the 1% test level. Judging from the adjusted R-squared coefficient value $\bar{R}2$ of 0.917, it shows that the independent variables (farmer's benchmark price, granulated sugar price, SP-36 fertilizer price) entered into the analysis model are able to explain the variation of the dependent variable (supply of granulated sugar) well with a value of 92%, while the other 8% is explained by other variables that are not included in the model, such as technological progress and natural disasters. Ha is accepted and Ho is rejected. This indicates that there is a regression coefficient for other factors that significantly affect the supply of granulated sugar in Indonesia. The

equation of the regression analysis for the supply function of granulated sugar in Indonesia can be formulated as follows :

$\ln Y = 17.295 + 1.276\ ln\ X_1 + 0.335\ ln\ X_2 - 2.177\ ln\ X_3$

$Y = 32{,}473{,}172\ X1^{\ 1.275}\ X2^{\ 0.339}\ X3^{\ -2.171}$

Table 7. Results of Regression Analysis of the Supply Function of Granulated Sugar in Indonesia

Variable	Parameter	Regression Coefficient	t	Sig
Constant	$\beta 0$	17.295	10.575	0.000
Farmers' Reference Price	$\beta 1$	1.276	5.886	0.001
Price of Granulated Sugar	$\beta 2$	0.335	2.425	0.046
Price of SP-36 Fertilizer	$\beta 3$	-2.177	-6.774	0.000
Std. Error of Estimate	Se	0.066		
R Square	R^2	0.942		
Adjusted R Square	$\bar{R}^2$ 0.917	0.917		
Multiple R	R	0.970		
F-Count		0.000		
N		11		

Note: Hypothesis testing uses a one-way t-test, where ** and *** indicate significance at the 95% and 99% levels.
Source: Secondary data analysis (2024).

Individually, the results of the partial regression coefficient test show that the farmer's benchmark price, granulated sugar price, and SP-36 fertilizer price have a significant effect on the supply of granulated sugar in Indonesia. The analysis of the granulated sugar supply factors in Indonesia is as follows:

1. Farmer's Benchmark Price

The farmer's benchmark price factor positively impacts the supply of granulated sugar in Indonesia and is statistically significant at the 1% test level. The value of the farmer's benchmark price regression coefficient of 1.275 indicates that every one percent increase in the farmer's benchmark price will cause the amount of granulated sugar to increase by 1.275 tons/year.

2. Granulated Sugar Price

The granulated sugar price factor has a positive effect on the supply of granulated sugar in Indonesia and is statistically significant at the 10% test level. The value of the sugar price regression coefficient of 0.339 indicates that every one percent increase in the price of granulated sugar will result in an increase of 0.339 tons per year in the supply of granulated sugar.

3. SP-36 Fertilizer Price

The SP-36 fertilizer price factor has a negative effect on the supply of granulated sugar in Indonesia and is statistically significant at the 1% test level. The SP-36 fertilizer price regression coefficient value of -2.171 indicates that every one percent increase in the price of SP-36 fertilizer will cause the supply of granulated sugar to decrease by 2.171 tons/year.

Conclusion

Based on the formulation of the problem, objectives, hypothesis, and research results and discussions, the following conclusions can be drawn:

1. The development of demand for granulated sugar in Indonesia during the period from 2019 to 2023 shows an increasing trend.
2. The development of supply of granulated sugar in Indonesia during the period from 2019 to 2023 shows an increasing trend.
3. The development of the gap in supply and demand for granulated sugar in Indonesia during the period from 2019 to 2023 shows an increasing trend and has a larger gap value, resulting in a surplus supply.
4. Factors that significantly influence the demand for granulated sugar in
5. Indonesia are the price of granulated sugar, the price of tea, and the price of ground coffee. Factors that do not significantly influence the demand for granulated sugar in Indonesia include the price of brown sugar, population, and per capita income.
6. Factors that significantly influence the supply of granulated sugar in Indonesia are the farmers' reference price, the price of granulated sugar, and the price of SP-36 fertilizer.

Suggestions

Based on the formulation of the problem, objectives, hypotheses, and research results and discussions, the following suggestions are put forward:

1. The government is expected to increase domestic granulated sugar production, because the demand for granulated sugar based on the results of the analysis has increased.
2. The supply of granulated sugar in Indonesia has increased, but most of it comes from imports, so that the gap between the supply and demand of granulated sugar in Indonesia in 2019-2023 is getting bigger. Therefore, the government is expected to reduce the amount of granulated sugar imports because it causes an excess supply of domestic granulated sugar and has the potential to cause a decrease in sugar prices which is detrimental to domestic producers.
3. The government is expected to continue to stabilize the price of SP-36 fertilizer, because if the price of SP-36 fertilizer increases, it has the potential to reduce domestic granulated sugar production.

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