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DEMAND ANALYSIS OF WHITE CRYSTAL SUGAR IN INDONESIA

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ABSTRACT

This study aims to analyze the impact of white crystal sugar prices, brown sugar prices, tea prices, and income on the demand for white crystal sugar in Indonesia, addressing the ongoing supply deficit caused by inefficiencies in the national sugar industry. As sugar is a staple food in Indonesia, maintaining a stable supply and price is crucial. This research utilizes a quantitative approach through linear regression analysis of panel data, using secondary data from the Central Statistics Agency (BPS) and the Ministry of Agriculture, covering annual data from 34 provinces in Indonesia from 2015 to 2019. The findings reveal that, during this period, the demand for white crystal sugar showed a negative trend, while prices of brown sugar, tea, and income levels exhibited a positive trend. At a 0.05 significance level, all independent variables, except for brown sugar prices, significantly affect white crystal sugar demand. Interestingly, by incorporating the income effect as a control variable, white crystal sugar demonstrates characteristics of Giffen goods, suggesting that higher income does not necessarily reduce its consumption. These findings highlight the unique demand patterns of sugar in Indonesia and imply that policy measures should focus on addressing supply chain inefficiencies to stabilize the sugar market and ensure affordability for the lower-income population.

1. INTRODUCTION

Among the nine basic necessities, sugar is considered a strategic commodity in Indonesia due to its widespread use, not only by households as consumers but also by various industries that process sugar into products with added value. Based on government regulations, white crystal sugar, known as GKP (Gula Kristal Putih), is intended for public consumption, while refined sugar is designated for industrial use. This distinction is formally regulated in the Ministry of Industry Regulation, Permenperin No. 3 Tahun 2021, which outlines the guidelines for the use of refined crystal sugar as a raw material for industry, highlighting the need for proper management of sugar supplies to meet diverse consumer needs (Peraturan Menteri Perindustrian Republik Indonesia Nomor 3 Tahun 2021 Tentang Jaminan Ketersediaan Bahan Baku Industri Gula Dalam Rangka Pemenuhan Kebutuhan Gula Nasional, 2021).

The supply-demand imbalance in the sugar industry can be attributed to inefficiencies in various stages of production, including both on-farm and off-farm processes, as well as government intervention strategies that have not effectively addressed these issues. Such inefficiencies have resulted in the national sugar industry's inability to keep pace with the rising demand, exacerbating the supply deficit. Without significant improvements in production efficiency and more effective policy interventions, this deficit is likely to persist, posing a risk to the stability of sugar supply in Indonesia. Ensuring an adequate supply of GKP is critical for maintaining domestic food security, as sugar is a staple commodity required by every household (Andina, 2019; Yunita et al., 2022).

This study seeks to analyze the demand for GKP in Indonesia, focusing on the factors influencing its consumption patterns. Although the scope of the research is limited to the demand side, excluding supply-side factors, understanding consumer behavior and demand drivers is essential for developing strategies to achieve a better balance between sugar supply and demand. In particular, this study explores the role of income and price effects in shaping demand for GKP, including the potential classification of GKP as a Giffen good, where an increase in price may lead to an increase in quantity demanded due to the dominant income effect over the substitution effect (Varian, 1992). Such characteristics are important to identify, as they highlight the unique economic behavior of consumers in response to changes in sugar prices and income levels.

The imbalance between supply and demand for GKP has broader economic and social implications, affecting not only consumers but also sugar producers, the food and beverage industry, and overall market stability. A continuous supply deficit could lead to higher prices, increasing the financial burden on households, especially low-income families who allocate a significant portion of their income to purchasing staple goods like sugar. This scenario could potentially exacerbate food insecurity and economic inequality, undermining social welfare goals (World Bank, 2017). Additionally, industries reliant on sugar as a key input may face increased production costs, impacting their competitiveness in both domestic and international markets.

While several studies have addressed the production challenges and policy interventions in the Indonesian sugar industry (Andina, 2019; Yunita et al., 2022), there has been limited focus on the demand-side analysis, particularly from the perspective of income and substitution effects. The concept of Giffen goods, although well-documented in economic theory, has not been extensively studied in the context of sugar demand in developing countries like Indonesia. This study aims to fill this gap by examining whether GKP exhibits characteristics of a Giffen good, providing new insights into consumer behavior and informing future policy measures to stabilize the sugar market.

The primary objective of this study is to understand the factors influencing the demand for white crystal sugar in Indonesia and to analyze how changes in income and prices of GKP and related goods affect consumer demand. By employing a quantitative approach using panel data regression analysis, this research will provide empirical evidence on the demand elasticity of GKP and the income effect, contributing to a deeper understanding of sugar consumption patterns in Indonesia.

Understanding the demand dynamics of GKP is crucial for policymakers, industry stakeholders, and researchers. The findings of this study will help in formulating targeted policies that address the supply-demand gap, ensuring stable and affordable sugar prices for consumers. Zhou (2022) highlights that the pandemic has led to a sharp reduction in supply and high demand for Giffen goods, such as sugar, resulting in extremely high prices. Identifying whether GKP qualifies as a Giffen good could therefore have significant implications for designing subsidy programs and other interventions aimed at supporting low-income households, enhancing overall food security, and promoting equitable economic growth.

In conclusion, the persistent supply deficit of white crystal sugar in Indonesia underscores the need for comprehensive research that not only addresses production inefficiencies but also delves into consumer demand patterns. By focusing on the demand side and exploring the unique economic behavior of sugar consumption, this study aims to contribute valuable insights to the ongoing discourse on food security and market stability in Indonesia.

2. RESEARCH METHODS

The statistical method used in this study to determine the factors affecting the demand for GKP in Indonesia is the panel data regression method to analyze and draw conclusions about the effect of independent variables on the dependent variable in the form of GKP demand. To interpret the linear demand function of GKP in Indonesia and estimate the total effect of price changes rather than price elasticity, the data in this study is not transformed using a natural logarithm. The choice not to use logarithmic transformation is based on the goal of maintaining a linear interpretation of the demand function and obtaining coefficients that directly reflect changes in absolute terms rather than percentage changes. This approach aligns with the perspective that linear models can serve as a viable alternative to nonlinear models in transforming demand functions without resorting to logarithmic transformations (Alkhalifa, 2021). To ensure that this choice does not compromise the validity of the results.

To ensure the reliability and robustness of the regression results, several statistical tests were conducted. The R-squared value indicates the proportion of the variance in the dependent variable explained by the independent variables, while the F-statistic evaluates the joint significance of all coefficients in the model. P-values were used to test the null hypothesis that each coefficient is equal to zero, helping to identify statistically significant relationships. The best model test is conducted through Chow-Test, Hausman Test, and Lagrange Multiplier Test. The results show that the best model is the random effect model. Chow-Test, Hausman Test, and Lagrange Multiplier Test, the results show that the best model is the random effect model.

The inclusion of substitute goods (brown sugar and tea) as explanatory variables is based on their relevance to consumer preferences in Indonesia, especially considering health-related factors. Brown sugar is preferred over white sugar due to its higher antioxidant content, which has been analyzed based on total phenolic content at 300 mg/kg sugar (Bujang, 2018). This makes brown sugar a close substitute for white crystal sugar not only because of its similar use in households and food industries but also due to its perceived health benefits. The price of tea is included as a complementary good because sugar is often consumed alongside tea in Indonesian households (Istiqomah, 2020). This rationale ensures that the model captures both substitution and complementary effects, which are crucial for understanding the demand dynamics for GKP.

The basic model in this study is:

$$\text{Q GKP}_{it} = \alpha_0 + \alpha_1 \text{P GKP}_{1it} + \alpha_2 \text{P BS}_{2it} + \alpha_3 \text{P TEA}_{3it} + \alpha_4 \text{GRDP}_{4it} + \varepsilon_{it} \quad \ldots\ldots (1)$$

To determine the effect of income caused by price changes, a control variable is included, so the model becomes:

$$\text{Q GKP}_{it} = \beta_0 + \beta_1 \text{P GKP}_{1it} + \beta_5 \text{P IE}_{5it} + \beta_2 \text{P BS}_{2it} + \beta_3 \text{P TEA}_{3it} + \beta_4 \text{GRDP}_{4it} + \varepsilon_{it} \quad \ldots\ldots (2)$$

Where as:

Q GKP	: GKP demand per capita
P GKP	: Price of GKP
P BS	: Price of brown sugar
P TEA	: Price of tea
GRDP	: Income percapita
IE	: Income effect
α_0	: Constant
β_0	: Constant
$\alpha_1, \ldots, \alpha_4$	: Coefficients of independent variables
$\beta_1, \ldots, \beta_5$	: Coefficients of independent variables
ε	: Error term
i	: Number of cross section units (1, 2, …, 34) in the form of provinces
t	: Number of time series data (1, 2, … , 5) years

The dependent variable in the form of aggregate GKP demand is measured using the amount of GKP consumption per capita per province measured in units of kilogram/capita/year. Then, there are 5 independent variables. For the price of GKP, the price of brown sugar, and the price of tea used is the average price at the consumer level per year in units of rupiah. The income variable is measured by Gross Regional Domestic Product (GDRP) based on business fields at constant 2010 prices by province expressed in units of thousand rupiah. As well as variable control of income effects expressed in units of rupiah, in accordance with the unit price of GKP. The income effect is measured by:

$$EP = \frac{E}{p_x} . \frac{\Delta E}{\Delta P} \quad (3)$$

Where $\frac{E}{p_x}$ is ΔQ, so the income effect is a change in the quantity of GKP demanded due to changes in expenditure along with changes in the price of GKP. Expenditure data is the average expenditure made to buy GKP products per capita/year. The type of data used in this research is secondary data. The source of data in this study comes from the Food Security Agency of the Ministry of Agriculture and the Indonesian Central Bureau of Statistics (BPS).

3. RESULTS AND DISCUSSION

3.1. RESULTS

Based on the results of selecting the best model for panel data estimation of GKP demand in Indonesia with various tests, the Random Effect Model (REM) is concluded to be the best model. The following is a table of Panel Data Regression Test results with the Random Effect Model (REM). Model 1 is a model without control variables, namely income effects While model 2 is a model using control variables, namely the income effect.

Table 1. Panel Data Regression Test Results (REM)

Variable	Model 1			Model 2		
	Coefficient	T-stat	P-Value	Coefficient	T-stat	P-Value
Constanta	17.65236	13.07711	0.0000	17.60905	13.20477	0.0000
GKP Price	0.000203	3.080751	0.0024	0.000512	2.289018	0.0234
Income Effect				4.278751	2.941374	0.0038
Brown Sugar Price	2.000000	-0.992006	0.3227	-2.377777	-1.200667	0.2317
Tea Price	-0.000516	-3.474763	0.0007	-0.000398	-2.639132	0.091
GRDP	-4.999999	-3.331312	0.0011	-4.622222	-3.073437	0.0025

Source: Processed data (2022)

The results of the research hypothesis of the effect of GKP prices, income effects, brown sugar prices, tea prices, and total income (representing GDRP) on GKP demand in Indonesia partially based on table 1 above can be explained as follows.

The constant coefficient in model 1 of 17.65236 indicates that if there is a change in the independent variables, namely GKP price, brown sugar price, tea price, and total income of 1 unit, it will cause the demand for GKP in Indonesia to increase by 17.65236 kg. While in model 2 the constant coefficient of 17.60905 indicates that if there is a change in the independent variables by 1 unit, namely the price of GKP, income effect, brown sugar price, tea price, and total income by 1 unit, it will cause the demand for GKP in Indonesia to increase by 17.60905 kg.

The coefficient of GKP price in model 1 is 0.000203, indicating that if the price of GKP increases by 1 unit, it will cause the demand for GKP in Indonesia to increase by 0.000203 kg. In model 1, the t-statistic of GKP price is 3.080751 which is greater than the t-table value of 1.654. In addition, the probability value of GKP price is 0.0024 which is smaller than the significance value of 0.05, so it can be said in model 1 that the price of GKP has a positive and significant effect on the demand for GKP in Indonesia.

Meanwhile, in model 2, the coefficient of GKP price of 0.000512 shows that if the price of GKP increases by 1 unit, it will cause the demand for GKP in Indonesia to increase by 0.000203 kg. In model 2, the t-statistic of GKP price is 2.289018 which is greater than the t-table value of 1.654. In addition, the probability value of GKP price is 0.0234 which is smaller than the significance value of 0.05, so it can be said in model 2 that the price of GKP has a positive and significant effect on the demand for GKP in Indonesia.

The coefficient of brown sugar price in model 1 of -2.000000 indicates that if the price of brown sugar increases by 1 unit, it will cause the demand for GKP in Indonesia to decrease by 2.000000 kg. In model 1, the t-statistic of brown sugar price is -0.992006 which is smaller than the t-table value of 1.654. In addition, the probability value of brown sugar price is 0.3227 which is greater than the significance value of 0.05, so it can be said in model 1 that the price of brown sugar has a negative and insignificant effect on the demand for GKP in Indonesia.

While in model 2 the coefficient of brown sugar price of -2.377777 indicates that if the price of brown sugar increases by 1 unit it will cause the demand for GKP in Indonesia to decrease by 2.377777 kg. In model 2, the t-statistic of brown sugar price is -1.200667 which is smaller than the t-table value of 1.654. In addition, the probability value of brown sugar price is 0.2317 which is greater than the significance value of 0.05, so it can be said in model 2 that the price of brown sugar has a negative and insignificant effect on the demand for GKP in Indonesia.

The coefficient of tea price in model 1 of -0.000516 indicates that if the price of tea increases by 1 unit, it will cause the demand for GKP in Indonesia to decrease by 0.000516 kg. In model 1, the t-statistic of tea price is -3.474763 which is greater than the t-table value of 1.654. In addition, the probability value of GKP price is 0.0007 which is smaller than the significance value of 0.05, so it can be said in model 1 that the price of tea has a negative and significant effect on the demand for GKP in Indonesia.

Whereas in model 2 the coefficient of tea price of -0.000398 indicates that if the price of tea increases by 1 unit, it will cause the demand for GKP in Indonesia to decrease by 0.000398 kg. In model 2, the t-statistic of tea price is -2.639132 which is greater than the t-table value of 1.654. In addition, the probability value of GKP price is 0.0091 which is smaller than the significance value of 0.05, so it can be said in model 2 that the price of tea has a negative and significant effect on the demand for GKP in Indonesia.

The GRDP coefficient in model 1 of -4.999999 indicates that if total income increases by 1 unit, it will cause the demand for GKP in Indonesia to decrease by 4.999999 kg. In model 1, the t-statistic of GRDP is -3.331312 which is greater than the t-table value of 1.654. In addition, the probability value of GRDP is 0.0011 which is smaller than the significance value of 0.05, so it can be said in model 1 that GRDP has a negative and significant effect on the demand for GKP in Indonesia.

While in model 2, the GRDP coefficient of -4.622222 indicates that if the total income increases by 1 unit, it will cause the demand for GKP in Indonesia to decrease by 4.622222 kg. In model 2, the t-statistic of GRDP is -3.073437 which is greater than the t-table value of 1.654. In addition, the probability value of GRDP is 0.0025 which is smaller than the significance value of 0.05, so it can be said in model 2 that GRDP has a negative and significant effect on the demand for GKP in Indonesia.

The income effect coefficient in model 2 of 4.278751 indicates that if the income effect increases by 1 unit, it will cause the demand for GKP in Indonesia to increase by 4.278751 kg. In model 2, the t-statistic of the income effect is 2.941374 which is greater than the t-table value of 1.654. In addition, the probability value of the income effect is 0.0038 which is smaller than the significance value of 0.05, so it can be said in model 2 that the income effect has a positive and significant effect on the demand for GKP in Indonesia.

The next analysis is the F-test, a test to determine the effect of all independent variables on the dependent variable. The following is a table of F-test results.

Table 2. F-Test Results

Model	F-statistic	Prob.
Model 1	11.02209	0.0000
Model 2	11.10627	0.0000

Source: Processed data (2022)

Table 2 above shows the results of panel data regression output to see the effect of independent variables on the dependent variable simultaneously. In this study, the calculated f-statistic value in both model 1 (without control variables) and model 2 (with control variables) is greater than the f-table value (2.4.). Thus, it can be said that the independent variables simultaneously have a significant effect on the dependent variable. This can also be seen in the probability value which is smaller than the significance value of 0.05.

The next analysis is the Coefficient determination test, a test to see the effect of how much the independent variable explains the dependent variable. The following is a table of Coefficient Determination Test results.

Table 3. Coefficient Determination Test Results

Model	R-squared
Model 1	0.216026
Model 2	0.258850

Source: Processed data (2022)

Based on table 3 above, it can be seen that the R-squared value of model 1 is 0.2160, meaning that the independent variables in model 1, namely GKP price, brown sugar price, tea price, and GRDP, affect the dependent variable, namely GKP demand by 21.60%, while the remaining 78.40% of GKP demand is influenced by other variables outside this study.

While in model 2, the R-squared value is 0.2588, meaning that the independent variables in model 2, namely GKP price, brown sugar price, tea price, and GRDP as well as the control variable, namely the income effect, affect the dependent variable, namely GKP demand by 25.88%, while the remaining 74.12% of GKP demand is influenced by other variables outside this study.

3.1. DISCUSSION

The first discussion is the effect of GKP price on GKP demand. Based on the results of data processing, the price of GKP has a significant positive effect on the demand for GKP. The sign of the estimated coefficient shows a different direction from the economic theory used and the hypothesis proposed. According to the law of demand, when the price of goods, in this case GKP, falls, the quantity demanded of the product will increase. From this law, the demand curve has a negative slope. The test results show a relationship in the opposite direction, an increase in the price of GKP causes the demand for GKP to increase.

There are reasons why GKP prices may have a positive effect on demand, even though traditional economic theory suggests otherwise. One possibility is the Veblen or Giffen goods phenomenon, where consumers may perceive GKP as a luxury or essential good so that an increase in price actually increases the perceived value or need for the product, driving demand higher. Thus, it can be argued that GKP is a Giffen Goods. This is in line with Yandri's (2017) research which states that the price slope is positive (meaning that the relationship between price and demand is positive). In conventional demand theory, the price slope should be negative, where an increase in price reduces demand. However, this result shows an indication that the good is a Giffen Good, where if the price rises, demand increases, and conversely if the price falls, demand falls.

The second discussion is the effect of brown sugar price on GKP demand. Brown sugar in this case is assumed to be a substitute good for GKP. According to economic theory, substitute goods are goods that can be used for the same purpose or fulfillment of needs. Substitute goods have a negative relationship, as in the case of brown sugar against GKP. When the price of substitute goods, namely the price of brown sugar, rises, the quantity demanded for brown sugar will decrease. Then, people will look for substitute goods in this case in the form of GKP so that it will cause the demand for GKP to increase, so the relationship between the price of substitute goods a and the demand for substitute goods b is positive. The results of this study show that the relationship between the price of brown sugar and the demand for GKP is negative, so it is not in accordance with economic theory and the proposed hypothesis. Apart from the direction of the relationship between the two variables that is not in accordance with the theory, based on the regression results, changes in the brown sugar price variable also have no significant effect on the GKP demand variable.

The test results that show that the price of brown sugar has an insignificant effect on the demand for GKP can be caused by the level of substitution of brown sugar for GKP. The relationship between the two goods is in the form of partial substitution where the two goods are not identical. Economically, the utility obtained by consumers in using the two goods is not the same. The position of GKP, which is one of the basic needs of Indonesian society, makes it necessary for everyone and difficult to replace other goods. In addition, it can also be caused by the emergence of substitute goods for GKP. Consumer choices to replace GKP are becoming more diverse. This causes the elasticity of GKP to brown sugar to become smaller. Price changes that occur in brown sugar have little or no effect on the demand for GKP. This finding aligns with DeLong & Trejo-Pech (2022), who observed that in certain markets, changes in brown sugar prices do not significantly impact white sugar demand due to their differing utilities and the essential nature of white sugar. Similarly, Saputri & Respatiadi (2018) found that in Indonesia, white crystal sugar remains a staple, making it less substitutable. High domestic prices of GKP, driven by import restrictions and productivity issues, further underscore its inelastic demand, reducing the influence of brown sugar price changes.

The third discussion is the effect of tea price on GKP demand. Types of goods that are closely related other than substitute goods are complementary goods. Complementary goods are goods that have a relationship with other goods and are used together. In this study, it is assumed that tea is a complementary good along with GKP. If the test results are viewed using economic theory, the sign of the coefficient generated by the estimated model is in accordance with the economic theory used and the resulting hypothesis. In the hypothesis based on economic theory, an increase in the price of tea will lead to a decrease in the demand for GKP. The relationship between the two is seen from the negative coefficient sign. If based on the panel data regression results, the tea price variable has a significant effect on the GKP demand variable.

No different from substitute goods, there are also levels of complementary goods. Perfect complementary goods if both goods must be used together, without one of the goods the function of the goods will not be perfect. The cross-elasticity of perfect complementary goods is high. In this study, the relationship between tea and GKP is partially complementary. Tea can still be consumed properly with or without sugar. The use of sugar in tea is highly influenced by each person's preference. Thus, the elasticity or dependence of GKP on tea is low. Changes in the price of tea have only a weak effect on the demand for GKP. Research, including studies by Stern (2011), Berry et al. (2014), and Sartika et al. (2022), supports this, showing that while sugar often complements tea, its necessity is preference-based, leading to weak effects on sugar demand when tea prices change.

The fourth discussion is the effect of income on GKP demand. The income factor received by the community will have a positive effect on the amount of consumption of goods and services. With greater income, people will be able to buy more goods and services. Based on the results of this study, income represented by GRDP per capita per province has a significant effect on the demand for GKP. However, the direction of the relationship between income and GKP demand indicated by the sign on the estimated coefficient is negative, which means it is not in accordance with the economic theory used and the hypothesis proposed.

The trend of GKP consumption by households on a capita basis in the last 5 years has continued to decline. This phenomenon is also shown in research conducted by Pratama et al. (2020). Meanwhile, the trend of household income based on data from BPS over the last 5 years has continued to increase. This explains why the relationship between income and GKP demand is negative. The negative direction of the relationship between GRDP and GKP demand supports the indication that GKP is a giffen good as seen from changes in GKP prices, income effects, and substitution effects. Public income has increased so that the ability to buy GKP products has increased, but what happens to the community is that the increase in income does not make the demand for GKP consumption increase.

The last discussion is the effect of income effect on GKP demand. The income effect arises due to price changes. In normal goods, the relationship between the two variables is always negative, because with an increase in prices, real income and purchasing power will decrease, and vice versa. From the change in real income, the expenditure made by the community will also change. In the end, the demand for GKP goods will also change.

The magnitude of the income effect in this study is expressed in the regression coefficient of 4.278751. Based on Pindyck & Rubinfeld (2000) the total effect is the sum of the income effect and the substitution effect. So through subtracting the total effect (0.000512) from the income effect (4.278751) will get a substitution effect of -4.278239. The direction of the income effect weakens the substitution effect due to the difference in direction. The value of the income effect that is greater than the substitution effect indicates that GKP based on this study indicates that it is a giffen good. Giffen goods are a special case in economics, as the law of demand does not apply to these goods. An increase in income actually causes the amount of goods purchased to fall, so the demand curve is positive.

4. CONCLUSION

In conclusion, this study highlights key factors influencing GKP demand, including price, income, and the relationship with substitute and complementary goods. The findings suggest that GKP may exhibit characteristics of Giffen goods, where higher prices and income paradoxically reduce demand. This deviation from conventional demand theory underscores the need for a nuanced understanding of consumer behavior in Indonesia. Policymakers should consider the inelastic nature of GKP when designing fiscal policies, potentially focusing on stabilizing prices to ensure affordability.

Additionally, the lack of significant substitution effects from brown sugar and the partial complementarity of tea suggest limited alternatives to GKP, reinforcing its essential status. Future research could explore regional variations and consumer preferences in more depth, as well as potential impacts of emerging substitutes. The study's limitations, such as the assumption of constant preferences and potential regional disparities, should be addressed in subsequent research to refine our understanding of GKP demand dynamics.

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