Analysis of Corn (Zea mays) Demand in Boyolali

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Abstract

The research aims to analyze the factors of corn price, corn demand, and the elasticity of corn demand in Boyolali Regency. The basic method used in this research is analytical-descriptive. The selection of the research location was purposive, with Boyolali Regency chosen as the location due to the consistent increase in corn demand. The results of the data analysis using multiple linear regression reveal the equation Ln Qd = -367.983 - 0.191 Ln X1 + 0.541 Ln X2 + 0.875 Ln X3 - 0.729 Ln X4 + 27.253 Ln X5 + e. This model has an $\bar{R}^2$ value of 21.9%, indicating that 21.9% of the corn demand in Boyolali Regency cannot be explained by the variables of corn price, rice price, soybean price, per capita income, and population, while the remaining 78.1% is explained by other variables not studied. Based on the F-test, the combined effect of corn price, rice price, soybean price, per capita income, and population on corn demand in Boyolali Regency is not significant. The t-test for individual variables also indicates that corn price, rice price, soybean price, per capita income, and population have no significant effect on corn demand in Boyolali Regency at both 99% and 95% confidence levels. The coefficient of price elasticity is -0.191, indicating inelasticity as it is less than one. Rice price has a positive cross-elasticity value of 0.541, signifying that rice is a substitute good for corn. Soybean price has a positive cross-elasticity value of 0.875, also acting as a substitute for corn. The coefficient of income elasticity is -0.729, indicating that corn is an inferior good due to its negative sign.

Keywords: Demand, Corn, Elasticity, Regression

Introduction

One of the essential staple commodities in Indonesia is corn (Zea Mays). Besides being a source of calories and protein crucial for human health, corn can also be utilized for various purposes. The benefits of corn include its use as food, animal feed, biofuel, as well as raw material for pharmaceutical and other industries. The nutritional content of corn is almost on par with rice and can serve as a substitute for rice as a staple food.

The magnitude of corn demand in Boyolali Regency is influenced by several factors such as the price of the commodity itself (corn price), prices of other goods closely related to it (substitute and complementary goods prices), population size, and people's income (Sukirno, 2005).

Fluctuating corn production from year to year is not balanced with its increasing demand in Boyolali Regency, though the demand does not rise significantly, resulting in surplus. The disproportionate demand for corn in Boyolali Regency compared to its production leads to an excess in supply, prompting the local community to process corn into value-added products like "marning" (corn-based snacks), as mentioned by Soeharjono (2001). One way to enhance the value of corn is by processing it into various corn-based products, thus increasing the market price of these processed items. Price is the amount of money exchanged by consumers for the benefits of owning or using products and services. Price

is the only element in the marketing mix that generates revenue, while other elements incur costs. Other goods' prices encompass substitute and complementary goods prices. Substitute goods are products that can replace each other in consumption. Complementary goods are products used together, meaning that individuals will increase the use of both goods simultaneously.

Method

The fundamental method employed in this study is analytical descriptive. The research was conducted in Boyolali Regency, chosen due to the fact that Boyolali is one of the corn-producing regencies in Central Java Province, with corn demand consistently increasing over the past five years. The data used in this research consists of secondary time series data from 2008 to 2017, along with supporting data. Secondary data was acquired from the Food Security Agency and the Central Statistics Agency, while supplementary data was obtained from the Agriculture Department as well as the Industry and Trade Department of Boyolali Regency.

Data Analysis Method
Model Specification

The data analysis method used in this study is the *Ordinary Least Squares* (OLS) method, which will result in the best, linear, and unbiased estimator with minimum variance (*Best Linear Unbiased Estimator*/BLUE) (Arsyad, 2008 in Ludianzah, 2010).

The relationship between corn demand and the factors considered to influence it can be analyzed using a power demand function model. The equation's form is as follows:

$$Qd = bo. \, X1^{b1} . \, X2^{b2} . \, X3^{b3} . \, X4^{b4} . \, X5^{b5}$$

The demand function can be transformed into the natural logarithm form as follows:

$$Ln \, Qd = Ln \, b_0 + b1 \, Ln \, X1 + b2 \, Ln \, X2 + b3 \, Ln \, X3 + b4 \, Ln \, X4 + b5 \, Ln \, X5 + e$$

The Coefficient of Determination (R^2) test is conducted to determine the proportion of influence of independent variables on the demand for corn in Kabupaten Boyolali.

$$\bar{R}^2 = 1 - (\, 1 - R^2) \frac{N-1}{N-k}$$

When :
$\bar{R}^2$: Adjusted coefficient of determination
R^2 : Coefficient of determination
N : Number of observations (data points)
k : Number of independent variables

The F-test is used to determine whether the independent variables collectively influence the quantity of corn demand in Kabupaten Boyolali.

$$F = \frac{R^2 /(k-1)}{(1-R^2)/(n-k)}$$

Explanation:
R^2 : Coefficient of determination
k : Number of variables
N : Sample size

The t-test is used to determine the influence of each independent variable on corn demand in Kabupaten Boyolali.

$$t_{\text{Calculate}} = \frac{bi}{Se\,(bi)}$$

When :
bi   : coefficient of the i-th regression
Se (bi)   : Standard error of the i-th regression coefficient

RESULT AND DISCUSSION

Based on the results of data analysis, the regression equation obtained is as follows:

Ln Qd = - 367,983 – 0,191 Ln X1 + 0,541 Ln X2 + 0,875 Ln X3 – 0,729 Ln X4 + 27,253 Ln X5 + e

The demand function is then reverted to its original form, resulting in the following shape :

$$Qd = -367{,}983\,X1^{-0{,}191} \cdot X2^{0{,}541} \cdot X3^{0{,}875} \cdot X4^{-0{,}729} \cdot X5^{27{,}253}$$

Explanation:
Qd   : Corn Demand Quantity
b_0 : Constant
X_1 : The corn price in year t is considered as the base price (Rp/Kg)
X_2 : Rice price in year t as a substitution price (Rp/Kg)
X_3 : Soybean price in year t as a complementary price (Rp/Kg)
X_4 : Household Income in Boyolali in year t (Rp)
X_5 : The population of Boyolali in year t (jiwa)
b_1-b_5 : Regression coefficient
e   : error

a. Adjusted R-squared Test

From the regression analysis results, the coefficient of determination ($\bar{R}^2$) value obtained is 21.9%. This means that the contribution of the variables of corn price, rice price, soybean price, per capita income, and population to corn demand in Kabupaten Boyolali is 21.9%, while the remaining 78.1% is influenced by other variables outside the ones being studied.

b. F-test

Used to determine the influence of independent variables on corn demand in Kabupaten Boyolali. The results of the F-test analysis are as follows :

Table.1 Results of Analysis of Variance of Corn Demand in Boyolali

Model	Sum Of Squares	Df	Mean Square	F	Sig
Regression	0,257	5	0,051	1,505	0,357
Residual	0,137	4	0,034		
Total	**0,394**	**9**			

Based on the table, it can be observed that the significance value is 0.357, which is greater than α = 0.01. Therefore, the variables of corn price, rice price, soybean price, per capita income, and population studied together do not have a significant effect on corn demand in Kabupaten Boyolali at the 99% confidence level.

c. T-test

Used to determine the partial influence of the independent variables under study on the demand for corn in Kabupaten Boyolali. The results of the t-test analysis are as follows :

Table.2 Results of the t-test Analysis for Each Independent Variable

Variabel	Koefisien Regresi	t hitung	Sig
Harga jagung (X_1)	-0,191	-0,167	0,875
Harga Beras (X_2)	0,541	0,432	0,688
Harga Kedelai (X_3)	0,875	1,443	0,222
Pendapatan per kapita (X_4)	-0,729	-1,813	0,144
Jumlah Penduduk (X_5)	27,253	1,638	0,177

Based on the table, it is known that these variables do not have a significant impact on corn demand in Kabupaten Boyolali at a confidence level of 99% and 95%. This is indicated by the significance values of each variable, which are greater than the threshold values of α = 0.01 and 0.05.

Elasticity of Corn Demand

Variable	Elasticity
Corn Price (X_1)	-0,191
Rice Price (X_2)	0,541
Soybean Price (X_3)	0,875
Per capita income (X_4)	-0,729
Population Size (X_5)	27,253

a. Price Elasticity

Based on the analysis results, it is known that the elasticity value of corn price is -0.191, with a negative sign indicating an inverse relationship between corn price and corn demand. The elasticity value is less than one, indicating that the price elasticity is inelastic as the coefficient of elasticity falls between 0 and 1. This means that if the price of corn increases by 1%, corn demand will decrease by -0.191%, and vice versa.

b. Cross-elasticity

The cross-price elasticity value of rice is 0.541, with a positive sign indicating that rice is a substitute good for corn. If the percentage of rice price increases by 1%, the percentage of corn demand will increase by 0.541%, and vice versa.

Meanwhile, the cross-price elasticity value of soybean is 0.875, with a positive sign, meaning that if the price of soybean increases by 1%, the demand for corn will increase by 0.875%, and vice versa. The positive sign of the cross-price elasticity value

for soybean indicates that soybean is a substitute good for corn, which contradicts the theory that complementary goods should have a negative sign.

c. Income Elasticity

The income elasticity value of -0.729 is negative, indicating that when income increases by 1%, the percentage of demand will decrease by -0.729%. Similarly, the opposite is true. This contradicts the theory that should have a positive sign. A negative income elasticity figure indicates that corn is an inferior good, meaning its demand will decrease as the income of the society increases.

d. Corn Price (X1)

The price of corn has no significant effect on the demand for corn, both in the simultaneous F-test and the partial t-test. The lack of influence in price is due to the fact that societal consumption is heavily influenced by habits and preferences that are difficult to eliminate (Sitohang and Hutabarat, 2014).

As mentioned in Aldillah's research (2018), corn needs for households account for only 14%, while industrial needs make up 86% of the national corn consumption, leading to continuous fluctuations in corn prices. Changes in corn prices are also influenced by the location or region. If an area is a major corn production center, prices could be lower compared to regions with lower corn production. In Boyolali Regency, corn is not a staple food for the community; instead, it is mainly used as a raw material for both the food and feed industries. Therefore, fluctuations in corn prices do not affect the demand for corn in Boyolali Regency.

With an elasticity of -0.191, corn price elasticity indicates that corn demand is inelastic. This is because the elasticity value is less than one, implying that the quantity of corn demanded changes by a smaller percentage compared to the change in corn prices. The negative sign of the elasticity value indicates an inverse relationship between the corn price variable and corn demand. A 1% increase in corn prices leads to a decrease in corn demand by -0.191%, and vice versa.

e. The price of rice (X2)

An item is considered a substitute good when its usage can replace that of another item. In this study, rice is assumed to be a substitute for corn. Based on the analysis of demand, the price of rice does not have a significant effect on corn demand, both in the simultaneous F-test and the partial t-test. According to Nur et al. (2012), rice still remains a staple food necessity for the community, thus regardless of price fluctuations, people continue to consume rice. Therefore, fluctuations in rice prices do not impact corn demand.

The cross-elasticity of rice price with respect to corn demand is 0.541. The coefficient value bears a positive sign, indicating that rice is indeed a substitute for corn. This is reasonable as rice can serve as an alternative food and is a daily staple (Mulyo, 2011). If the rice price experiences a 1% increase, the demand is projected to rise by 0.541%, and conversely, a decrease in rice price would lead to a decrease in corn demand.

f. The Soybean Price (X3)

A good can be referred to as a complementary good when it is used together with another good. In this study, soybeans are assumed to be complementary goods to corn. Based on the demand analysis results, the price of soybeans has no significant effect on corn demand, both in the simultaneous F-test and the partial t-test. This implies that the price of soybeans does not impact the demand for corn and is not considered a complementary good to corn.

As stated in the research by Rohana and Duakaju (2008), the lack of significant influence of soybean prices on demand is due to the fact that regardless of the price set by traders, consumers will still purchase soybeans. The value of soybeans is not determined by the high price set by traders, but rather by the functional aspects of soybeans as raw materials for making tofu, tempeh, and soy milk, as well as the protein content present in soybeans.

g. Per Capita Income

In determining the demand variation for various types of goods, income is a crucial factor due to its capacity to reflect consumer purchasing power. Based on the demand analysis results, per capita income has an insignificant influence on corn demand, both in the simultaneous F-test and the partial t-test.

Income elasticity reveals a coefficient of -0.729, indicating a negative sign. This implies that a 1% increase in income leads to a decrease of approximately -0.729% in demand, and vice versa. This situation signifies that corn is an inferior good.

As noted in Ananingsih's study (2011), the lack of impact of per capita income on corn demand stems from the reality that, in constrained income conditions, a significant portion of income is allocated towards fulfilling basic needs first. Therefore, if per capita income rises and basic needs are met, individuals allocate their income towards non-food necessities (secondary and tertiary needs).

h. The population amount of non-food needs (secondary and tertiary needs)

Based on the results of the demand analysis, the population size does not have a significant influence on corn demand, both in the simultaneous F-test and the partial t-test. Therefore, changes in corn demand are not affected by the population size. This is inconsistent with the study conducted by Oktafita (2010), which states that the population size is the most influential variable on corn demand.

Conclusion

The research regarding corn demand in Boyolali Regency yields the following conclusions:
1. The prices of corn, rice, soybeans, per capita income, and population, either simultaneously or collectively, do not have a significant influence on corn demand in Boyolali Regency. Meanwhile, on a partial or individual basis, the prices of corn, rice, soybeans, per capita income, and population do not significantly affect corn demand in Boyolali Regency at a confidence level of 99% as well as 95%.
2. The analysis of corn demand elasticity in Boyolali Regency indicates that the value of the price elasticity at -0.191 with a negative sign signifies that corn demand is inelastic. The cross-elasticity with the price of rice is 0.541 with a positive sign, indicating that rice is a substitute good for corn. Additionally, the cross-elasticity with the price of

soybeans is 0.875 with a positive sign, suggesting that soybeans are a substitute good and not a complementary good for corn. This contradicts the theory which expects complementary goods to have a negative sign. Furthermore, the income elasticity is -0.729 with a negative sign, indicating an inverse relationship between income and demand. This contradicts the theory which should have a positive sign, classifying corn as an inferior good.

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