The Factors Affecting Beef Demand In Indonesia (Dynamic Demand Analysis Model)

by Ikhsan Sadik

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(Dynamic Demand Analysis Model)

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Abstract:

Background: Population growth and the improvement of Indonesian living standards will encourage the increasing fulfillment of food needs, including animal protein derived from beef. From 2016 to 2020, Indonesian consumption of beef equivalent per capita fluctuated and tended to decrease by an average of 0.14% per year. During this period, the highest peak consumption in 2019 increased by 2.40%, from 2.50 kg/cap/year in 2018 to 2.56 kg/cap/year in 2019. To meet the demand for domestic beef consumption by increasing the population of cattle and buffalo, the government issued the latest program called the SIKOMANDAN (Buffalo Mainstay Cattle) program. This program intestify the use of modern technology, particularly in the cultivation sector (on-farm), so that the production process becomes faster and more efficient. This has proven to be effective in increasing national cattle and buffalo populations. However, even though the beef cattle population is increasing every year, domestic beef production has not been able to meet the demands of the Indonesian people. According to the table above, it can be seen that beef demand in Indonesia continues to increase every year and cannot be adjusted by domestic beef production. This triggers an increase in beef prices. Every year, beef prices have increased. The importance of researching on the problem of beef demand is associated with changes in population, price levels, and population incomes, among other things, is to estimate the magnitude of the parameter of beef demand. The purpose of this study is to (1) determine the effect of the previous year's beef, chicken meat, and egg prices, as well as population income, population, and beef demand in Indonesia. (2) To determine the response rate to partial changes in beef demand in Indonesia.

Materials and Methods: This study was conducted in the Unitary State of the Republic of Indonesia. This study uses secondary data from time-series for 31 years from 1990 to 2020. The analysis of this study uses multiple and dynamic regression analysis of partial adjustment models with beef demand as the dependent variable and beef prices, chicken meat prices, eggs prices, population income, and beef demand in the previous year as independent variables. With the partial adjustment model, this study will show that the dynamic response to public demand for beef is not instantaneous but gradual, partial, and requires adjustment due to inert habitual, technological, and institutional factors.

Results: According to the analysis findings, Based on the F test, that all independent variables a significant effect on the amount of beef demand in Indonesia. Based on the partial t-test of the six independent variables, there were 3 (three) independent variables that had a significant effect on the demand for beef in Indonesia with a confidence level above 90%, in which the demand for beef in the previous year had a significant effect on the 99% confidence level; the egg price variable showed a significant effect on the 95% confidence level; the beef price variable indicated an effect on the 90% confidence level. The adjusted coefficient of determination (R2adj) shows how much demand for beef can be explained by all independent variables (beef prices, chicken meat prices, egg prices, population, and income). Based on table 5, the value of R2adj is 0.870. This shows that 87% of the total demand for beef is influenced by factors such as beef prices (X1), chicken meat prices (X2), egg prices (X3), population (X4), and population income (X5), while 13% is influenced by other variables that may not be included in the regression model mentioned in the research. The response to changes per period is 76.2%, with the determining factors that have a significant effect on eggs prices, the price of beef itself, and the demand for beef in the previous year.

Conclusion: (1) The diversity of beef prices, chicken meat prices, egg prices, population income, population, and beef demand in the previous year can explain the diversity of beef demand by 87%. It partially shows of the six independent variables, there were 3 (three) independent variables that had a significant effect on the demand for beef in Indonesia with a confidence level above 90%, in which the demand for beef in the previous year had a significant effect on the 99% confidence level; the egg price variable showed a significant effect on the 95% confidence level; the beef price variable indicated an effect on the 90% confidence level. While the other three independent variables which were the price of chicken meat, population and income of the population had no significant effect because the results of the analysis show that the error rate is more than 10%. The elasticity of demand for beef in the short run is smaller than

in the long *run*. (2) *The* response to changes per period is 76.2%, with the determining factors that have a significant effect on eggs prices, the price of beef itself, and the demand for beef in the previous year.
Key Word: Beef; Demand; Partial adjustment model

I. Introduction

Livestock is an agricultural sub-sector that produces meat, eggs, and milk products. Population growth and the improvement of Indonesian living standards will encourage increased fulfillment of food needs, including animal protein derived from beef (Asmaki, 2009). From 2016 to 2020, Indonesian consumption of beef equivalent per capita fluctuated and tended to decrease by an average of 0.14% per year. During this period, the highest peak consumption in 2019 increased by 2.40%, from 2.50 kg/cap/year in 2018 to 2.56 kg/cap/year in 2019. However, there was a 9.77% decrease in consumption in 2020, from 2.56 kg/cap/year in 2019 to 2.31 kg/cap/year in 2020. This is the effect of the Covid-19 virus outbreak, which lasted from March to the end of 2020. The growth of beef consumption in Indonesia in 2016-2020 can be seen in Table 1.

Table no 1: Population growth and beef consumption per capita in 2016-2020.

Year	Population (million)	Beef Consumption (kg/capita/year)	Growth (%)
2016	258.705	2,285	-
2017	261.891	2,361	3,32
2018	265.015	2,500	5,89
2019	266.912	2,560	2,40
2020	271.066	2,310	-9,77

Source: Agricultural data and information center, 2020

To meet the demand for domestic beef consumption by increasing the population of cattle and buffalo, the government issued the latest program called the SIKOMANDAN (Buffalo Mainstay Cattle) program. This program intestify the use of modern technology, particularly in the cultivation sector (on-farm), so that the production process becomes faster and more efficient. This has proven to be effective in increasing national cattle and buffalo populations. Based on the Center for Agricultural Data and Information (2020), the population of beef cattle in Indonesia in 2019 reached 16.930 million cattles, a 3.02% has increased from the previous year's population of 16.433 million cattles. In 2020, the beef cattle population increased by 3.17% to 17.467 million head.

Table no 2: Shows the Indonesian beef cattle population growth from 2016 to 2020.

Year	Population (thousand head)	Growth (%)
2016	15.997	-
2017	16.429	2.70
2018	16.433	0.02
2019	16.930	3.02
2020	17.467	3.17

Source: Agricultural data and information center, 2020

However, even though the beef cattle population is increasing every year, domestic beef production has not been able to meet the demands of the Indonesian people. This can be seen in Table 3.

Table no 3: The growth of beef production and demand in Indonesia

Year	Production (000 ton)	Demand (000 ton)	Lack of Demand (000 ton)
2016	518,48	591,14	-72.66
2017	486,32	618,32	-132
2018	497,97	662,53	-164.56
2019	504,80	683,29	-178.49
2020	515,63	626,16	-110.53

Source: Agricultural data and information center (2020)

According to the table above, it can be seen that beef demand in Indonesia continues to increase every year and cannot be adjusted by domestic beef production. This triggers an increase in beef prices. Every year, beef prices have increased. Table 4 exhibits that the growth of beef prices at the consumer level tends to continue to increase by an average of 2.92% per year from 2016 to 2020. The highest increase in 2016 was 8.84% to Rp. 113.555/kg from 2015, amounting to Rp. 104, 328,-/kg. The price of beef in the last 2 years (2019–2020) tends to be stable, from Rp. 118.200,-/kg to Rp. 120, 201,-/kg with an increase of 1.69% per year.

Table no 4: The growth of beef prices in Indonesia in 2016-2020.

Year	Price (Rp)	Growth (%)
2015	104.328	-
2016	113.555	8,84
2017	115.932	2,09
2018	117.058	0,97
2019	118.200	0,98
2020	120.201	1,69

Source: Agricultural data and information center, 2020

The importance of researching on the problem of beef demand is associated with changes in population, price levels, and population incomes, among other things, is to estimate the magnitude of the parameter of beef demand.

II. Research Methods

Research Location and Time

This research was conducted in the territory of the Unitary State of the Republic of Indonesia. The implementation starts from January 2021 to December, starting from data collection, processing, and analysis stages to preparing a thesis research report.

Data Type and Sources

Secondary data in the form of time series data was used in this research (time series data). The Central Statistics Agency (BPS) and the Ministry of Agriculture provided the data. The data obtained was annual data for 31 years. The data of beef demand, beef price, and chicken meat price, chicken egg price, Indonesian population income, and Indonesian population were all investigated. Data on beef prices from 1990 to 2020, chicken meat prices from 1990 to 2020, and beef demand from 1990 to 2020 were obtained from the Ministry of Agriculture's data center and information system in 2020. The Central Statistics Agency (BPS) released data on Indonesia's population from 1990 to 2020 in 2021. See Table 5 for more information.

Table no 5: Secondary data information for beef demand research, broken down by data and unit.

No.	Data Information	Data Sources
1	Beef demand	Agriculture Department Information System
2	Beef Price	Agriculture Department Information System
3	Broiled Chicken Price	Agriculture Department Information System
4	Population	Central Bureau of Statistics
5	Income Level	Central Bureau of Statistics

Source: Secondary data processed

Data Analysis

This research uses the Ordinary Least Square (OLS) regression and dynamic analysis with the Nerlove partial adjustment model. After fulfilling some classical assumptions, the OLS estimator will have the most efficient (best), linear and unbiased (BLUE) properties, or abbreviated as BLUE (Best Linear Unbiased Estimator). Meanwhile, using Nerlove's partial adjustment model as part of a dynamic linear model allows one to see the possibility of a long-term equilibrium relationship between economic variables. The dynamic analysis model is used to estimate the long-run demand function for beef, which is estimated using Nerlove partial estimation from the short-run demand function. This model was chosen because it has several advantages: (1) the error of the partial adjustment model is not directly related to the previous error because it is assumed that the error (et) is not self-correlated; (2) the partial adjustment coefficient of the dependent variable Yt-1 has a clear economic meaning; and (3) the elasticity of the long-term demand response can be calculated using the value of the partial adjustment coefficient. Furthermore, the response to changes in variables that affect beef demand does not occur simultaneously, and it takes time to respond to changes. There are three major reasons for this, which are as follows: 1) psychological reasons, 2) technological reasons, and 3) institutional or institutional reasons. People do not change their consumption habits immediately after a decrease in prices or an increase in income for psychological reasons, possibly because the process of change can cause immediate disability.

The long-run demand for beef can be expressed as an expected beef demand in its dynamic form. If the expected beef demand is Yt*, then the beef demand function is as follows:

$$Y_t^* = \beta_0 + \beta_1 HDS_t + \beta_2 HDA_t + \beta_3 HT_t + \beta_4 JP_t + \beta_5 \ln Pend_t + \upsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
(1)

with :

Y_t^* = expected quantity of beef demand

HDS = beef prices (Rp/kg)

HDA = chicken meat prices (Rp/kg)
HT   = eggs prices (Rp/kg)
JP   = population (million)
JPend= total income (million)
t   = period (year)

The partial adjustment hypothesis is used since Yt* cannot be estimated directly. In this demand model, it is distinguished between changes in actual demand and changes in desired demand, which are explained by the following equation:

$$Y_t - Y_{t-1} = \delta\ (Y_t^* - Y_{t-1})\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$
(2)

With :

$Y_t - Y_{t-1}$ = change in actual demand value
$Y_t^* - Y_{t-1}$ = change in expected demand value / long-term
δ = adjustment coefficient ($0 < \delta < 1$)

By substituting the first equation into the second equation above, the following equation is obtained:

$$Y_t = \delta\beta_0 + \delta\beta_1\ HDS_t + \delta\beta_2\ HDA_t + \delta\beta_3\ HT_t + \delta\beta_4\ JP_t + \delta\beta_5\ JPend_t + (1-\delta)\ Y_{t-1} + \delta\upsilon_t\ \dots\dots\dots\dots\dots\dots\dots\dots$$
(3)

The above equation is a short-term beef demand function, which in the double logarithm function can be written:

$$\ln Y_t = \delta\beta_0 + \delta\beta_1 \ln HDS_t + \delta\beta_2 \ln HDA_t + \delta\beta_3 \ln HT_t + \delta\beta_4 \ln JPP_t + \delta\beta_5 \ln JPend_t + (1-\delta) \ln Y_{t-1} + \delta\upsilon_t\ \dots\dots$$
(4)

By including a lag variable, dynamic analysis in this research is intended to determine the effect of the independent variables, namely beef prices, chicken meat prices, income, population, and beef production, on beef demand in the short and long term (lagged dependent variable). (Y_{t-1}), that is, the demand for beef in the previous year. Based on the dynamic short-run analysis results using the Ordinary Least Square (OLS) method, the relationship between the dependent and independent variables is quantitatively expressed in elasticity. Elasticity is the percentage change in quantity demanded caused by a one percent change in the value of one of the variables influencing demand. Because this study uses time-series data and includes a lag variable (Y_{t-1}), the elasticity of demand for beef in the short and long term can be determined from the equation. The results of the OLS estimation of equation (4) produce information related to price elasticity, income elasticity, and the influence of other determinants in the short term as well as adjustment coefficients with the following details:

$\delta\beta_1, \delta\beta_2, \delta\beta_3$ = price elasticity
$\delta\beta_4$ = population elasticity
$\delta\beta_5$ = income elasticity

III.   Result
Partial Adjustment Model Analysis
The results of the regression analysis of beef demand in Indonesia are presented in Table 6 as follows:

Table no 6: Partial adjustment model of beef demand in Indonesia, 1990-2020.

Independent Variable	Regression Coefficient	t-test	Sig.	Collinearity Statistics	
				Tolerance	VIF
(Constant)	-31,658	-1,380	0,181		
Beef prices (LnX1)	-0,723**	-1,831	0,080	0,007	139.864
Chicken meat prices (LnX2)	0,496*	1,578	0,128	0,017	58.902
Eggs prices (LnX3)	-0,242**	-2,400	0,025	0,133	7.509
Population (LnX4)	0,156*	1,395	0,176	0,051	19.781
Resident income (LnX5)	3,119*	1,515	0,144	0,018	54.858
Beef demand in the previous year (LnY_{t-1})	0,762***	6,719	0,000	0,289	3.466
Adj. coefficient of determination (R^2_{adj})	0,870				
F-test	31,044***				
Durbin Watson (DW)	2,065				

Source: Data processing results, 2021
Description:
*** = Significant at the level of confidence 99% (α 0,01= 2,787)
**= Significant at the level of confidence 95% (α 0,05= 2,059)
*= Significant at the level of confidence 90% (α 0,10= 1,708)

Based on the F test, it can be seen that the results of the F statistical test with an error rate of 1% obtained an F_{count} value of 33,345 with a df1 value of 6 and a df2 value of 24, the Ftable value (3.67). From these results, it can be concluded that the value of F_{count} 33,345 is greater than Ftable 3.67, meaning that all independent variables (X1, X2, X3, X4, X5) have a significant effect on the amount of beef demand in Indonesia.

Based on the partial t-test of the six independent variables, there were 3 (three) independent variables that had a significant effect on the demand for beef in Indonesia with a confidence level above 90%, in which the demand for beef in the previous year had a significant effect on the 99% confidence level; the egg price variable showed a significant effect on the 95% confidence level; the beef price variable indicated an effect on the 90% confidence level. While the other three independent variables which were the price of chicken meat, population and income of the population had no significant effect because the results of the analysis show that the error rate is more than 10%.

The adjusted coefficient of determination (R2adj) shows how much demand for beef can be explained by all independent variables (beef prices, chicken meat prices, egg prices, population, and income). Based on table 5, the value of R2adj is 0.870. This shows that 87% of the total demand for beef is influenced by factors such as beef prices (X1), chicken meat prices (X2), egg prices (X3), population (X4), and population income (X5), while 13% is influenced by other variables that may not be included in the regression model mentioned in the research.

Based on the autocorrelation test using the Durbin Watson table at an error rate of 5%, the dL and dU values were 1.020 and 1.920, respectively. In contrast, the DW value from the analysis results is 2.065. Because of the value of dL, it can be concluded that the regression equation model does not contain autocorrelation problems. In the analysis results, there are four independent variables: the price of beef, the variable price of chicken meat, the population variable, and the population variable income that have a VIF value of more than 10. This indicates that there is multicollinearity between these independent variables.

The response to changes per period in the study was 76.2%, while the determining factors that had a significant effect were the price of eggs, the price of beef itself, and the demand for beef in the previous year with a confidence level above 95%.

Interpretation of Regression Results
This research analyzes the independent variables that affect the demand for beef.

Table no 7: Estimating the short-term and long-term effects of beef demand in Indonesia

Independent Variable	Notation	Effect	
		Short-term	Long-term
(Constant)		-31,658	-133,017
Beef Prices (X1)	**	-0,723	-3,037
Chicken meat prices (X2)	*	0,496	2,084
Egg prices (X3)	**	-0,242	-1,016
Population (X4)	*	0,156	0,655
Resident income (X5)	*	3,119	13,105
Beef demand in the previous year (LnY_{t-1})	***	0,762	3,201
δ	0,238		

Source: Data processing results, 2021
Description:
*** = Significant at the level of confidence 99% (α 0,01= 2,787)
** = Significant at the level of confidence 95% (α 0,05= 2,059)
* = Significant at the level of confidence 90% (α 0,10= 1,708)

From the results of the regression output of the partial adjustment model above, the short-term and long-term effects on beef demand can be seen. The short-term effect can be seen directly from the coefficients of each parameter estimator. The adjustment coefficient must be determined in order to identify the long-term effect. The value of the adjustment coefficient (δ) is $1 - 0.762 = 0.238$. This value implies that approximately 23% of the difference between the expected demand for beef and the actual demand for beef can be eliminated within a year. Furthermore, each parameter is divided by the value of the adjustment coefficient.

Short-term Effect
Effect in the Short-Term Beef prices (X1) harm beef demand in Indonesia. In other words, as the price of beef rises, so will the demand for beef, or vice versa. Assuming that the value of other variables does not change or remains constant, every 1% increase in beef prices reduces demand by 0.723%. This condition is consistent with the theory of demand, which states that an increase in the price of goods reduces demand for the goods themselves.

The price of chicken meat (X2) positively affects beef demand; for every one percent increase in the price of chicken meat, the demand for beef increases by only 0.496 percent, assuming all other variables remain constant. In other words, changes in the price of chicken meat will impact on beef demand.

Egg prices (X3) harm beef demand. In other words, if the price of eggs rises, demand for beef falls, and vice versa. If the price of eggs rises by 1%, the demand for beef falls by 0.242 %, assuming all other variables remain constant.

The population (X4) positively influences beef demand, and as the population grows, so does the demand for beef. If all other variables remain constant, the demand for beef will increase by 0.156% for every 1% increase in population. The population has the most significant influence on beef demand than other variables.

The population's income (X5) positively affects beef demand, or an increase in income will increase beef demand. If the population's income rises by 1%, the demand for beef rises by 3.119%, assuming all other variables remain constant.

Long-Term Effects

In the long term, the effects increase in the same direction as the short-term effects. This is because the adjustment coefficient is positive. The price of beef (X1) harms beef demand. For every 1% increase in the price of beef, the demand for beef will decrease by 3.037%, assuming the value of other variables does not change or remain.

The price of chicken meat (X2) positively affects on beef demand. With the assumption that the other variables have a fixed value, for every 1% increase in the price of chicken meat, the demand for beef increases by 2.084%.

The price of eggs (X3) harms beef demand. If the price of eggs rises, the demand for beef will fall, and vice versa. If the price of eggs increases by 1%, the demand for beef decreases by 1.016%, assuming the other variables remain constant.

The population (X4) positively affects beef demand. If all other variables remain constant, a 1% increase in population results in an increase by 0.655% in beef demand.

The population's income (X5) positively affects beef demand. If the population's income rises by 1%, the demand for beef rises by 13.105%, assuming all other variables remain constant.

Demand Price Elasticity

The price elasticity of beef shows the relationship between the price of beef and the demand for beef in the short and long term. In this research, the value of the short-term price elasticity coefficient is -0.723 and the long-term is -3.037. This indicates that the price elasticity of beef to beef demand is inelastic. This means that a relatively significant change in the price of beef will not change its demand in large quantities. This is under the demand theory, where the price is inversely proportional to the quantity demanded. The elasticity of beef price to beef demand in the short term is greater than that of demand in the long term (-0.723 -3.037). The difference in short-term elasticity and long-term elasticity is due to the delay in adjusting the dependent variable to the independent variable so that the amount of beef demanded is different between the short and long term.

Elasticity of Income-Demand

The income elasticity of demand in the short term is 3.119, while it is 13.105 in the long term. The income elasticity value is more significant than one, indicating beef demand in both the short and long term. This means that beef demand is elastic to changes in income or that the percentage change in income is responsive to beef demand. When the elasticity of demand for an item exceeds one, the item is said to be elastic, which occurs when the number of goods demanded is strongly influenced by the size of the income.

Price Elasticity in Cross-Demand

The cross-price elasticity of chicken meat is 0.496 in the short term and 2,084 in the long term. The positive effect of changes in the price of chicken on beef demand shows the existence of a substitute product relationship between beef and chicken. The obtained cross elasticity value is less than one in the short term and greater than one in the long term. This shows that the price of chicken meat is inelastic to beef demand in the short term, or that the percentage change in chicken meat prices is not responsive to changes in beef demand in the short term. However, the price of chicken is elastic to beef demand in the long term, or that the percentage change in chicken meat prices is responsive to changes in beef demand in the long term. Based on the analysis results, the cross elasticity of egg prices for the short term was -0.242 and the cross elasticity of egg prices for the long term was -1.016. The cross-elasticity value of the egg price is less than one, which means that demand is inelastic. The negative effect of changes in egg prices on the demand for beef shows that the relationship

between eggs and beef is complementary.

The Elasticity of Population Demand

The population's elasticity is 3.119 in the short term and 13,105 in the long term. This figure implies that a 1% increase in population will result in a 3.11% increase in short-term beef demand and a 13.1% increase in long-term beef demand. A population elasticity value is greater than one indicates that the population is responsive to changes in beef demand.

IV. Conclusions

Based on the results of the discussion that has been carried out, the authors can draw the following conclusions:

1. The diversity of beef prices, chicken meat prices, egg prices, population income, population, and beef demand in the previous year can explain the diversity of beef demand by 87%. It partially shows of the six independent variables, there were 3 (three) independent variables that had a significant effect on the demand for beef in Indonesia with a confidence level above 90%, in which the demand for beef in the previous year had a significant effect on the 99% confidence level; the egg price variable showed a significant effect on the 95% confidence level; the beef price variable indicated an effect on the 90% confidence level. While the other three independent variables which were the price of chicken meat, population and income of the population had no significant effect because the results of the analysis show that the error rate is more than 10%. The elasticity of demand for beef in the short run is smaller than in the long run.

2. The response to changes per period in the study was 76.2%, while the determining factors that had a significant effect were the price of eggs, the price of beef itself, and the demand for beef in the previous year with a confidence level above 95%.

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