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The demand for beef in Indonesian urban

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Abstract The low consumption of animal protein food is one of the causes of the increasing number of stunting in Indonesia. This study analyzes the effect of changes in prices and incomes on demand for five animal food groups, namely fish, chicken, beef, eggs, and milk. The demand function approach uses the Almost Ideal Demand System model with the parameter estimates using Seemingly Unrelated Regression. The research data using 124,513 households from Indonesian National Socio-economics Survey in 2016. The results showed that beef was the most elastic animal food among all animal foods with a demand elasticity of 1,031%, followed by chicken meat (0.564%), milk (0.451%), eggs (0.313%), and sea fish (0.151%). Beef is a luxury item. Beef is substituted with sea fish, eggs, or chicken meat. Beef is complementary to milk. The increase in beef prices is one of the policies that need to be considered so that the target of protein consumption is immediately reached.

1. Introduction

Towards sustainable Indonesian food security in 2025, Indonesia has ten national development priorities in 2018 including food security and poverty reduction [1]. Beef is one of the commodities to be achieved in food self-sufficiency, besides rice, corn, soybeans, and sugar. Animal food of marine fish, shrimp/squid, beef, eggs, chicken meat, and milk traps are important food sources of animal protein that must be consumed by households [2]. Lack of protein consumption, among others, has an impact on stunting, poor nutrition, and decreased intelligence, which is permanent [3][4] especially in pregnant women and toddlers (babies under five years old). Low protein consumption is caused by increasing prices [5][6][7]. Therefore, increasing protein consumption is an important key in improving people's welfare.

Price increases reduce real consumer incomes and reduce animal food consumption [8][9][2][10]. Animal food prices have tended to increase in the last five years. Price increases mainly occurred in beef, followed by chicken meat, milk, eggs, and sea fish. Price increases are related to poverty and



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household welfare [11][12]. By knowing the factors that influence the demand for protein consumption, especially beef, it is expected to be able to obtain solutions in overcoming the policy of protein consumption, especially beef. By knowing the factors that influence the demand for protein consumption, especially beef, it is expected to be able to obtain solutions in overcoming the policy of protein consumption, especially beef.

Research on animal food demand systems, especially meat (food demand system) using the Almost Ideal Demand System (AIDS) approach has been carried out in various countries, including in China [13], in South Africa [14], in Kenya [15], in Saudi Arabia [16], in France [17], in Tunisia [18], in Jordan [19], in Iran [20], in Turkey [21]. Research on the impact of price changes on welfare and poverty has also been carried out in various countries, including in Mexico and Columbia [22], in Ghana [11], and in Ethiopia [23]. Research like this, along with the latest literature studies and studies, is still rarely found in Indonesia, especially those relating to the application of the LA-AIDS model to explain patterns of relationship to well-being. Theoretically, the LA-AIDS model that has been applied to the number of studies and analyzes is limited to its relationship with the demand system, which shows reasonable strength, but has not yet been analyzed in other aspects, namely welfare. Therefore, this research is important to do to see the impact of changes in animal food prices on demand and welfare in Indonesia. Through the analysis of the LA-AIDS model, the price elasticity and income of each animal food will be calculated. From the price elasticity, it can be concluded whether animal food is elastic or inelastic, or a substitution or complementary nature. Through income elasticity, it will be concluded whether animal foods are normal, luxurious, or inferior goods. These conclusions are very valuable information to support programs to increase animal protein self-sufficiency and national food security.

2. Methods

2.1. Model Specification: Almost Ideal Demand System

The analytical model used in this study is the Almost Ideal Demand System (AIDS) model. This AIDS model is used because it can provide estimates of own-price elasticity, cross-price elasticity, and expenditure elasticity. Although AIDS is a nonlinear model, the use of the stone price index can solve nonlinear problems making it easy to estimate. Mathematically, the AIDS model used is as follows:

$$W_i = \alpha_0 + \sum_j \gamma_{ij} \log p_j + \beta_i \log(X/P) \quad (1)$$

P is price index, defined as:

$$\log P = \alpha_0 + \sum_i \alpha_i \log P_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \log P_i \log P_j \quad (2)$$

To prevent non-linearity and reduce the effects of multicollinearity in the model, equation (2) is usually approximated by Stone's Price Index: $\log P^* = \sum_i W_i \log P_i$. Thus, AIDS changed to Linear Approximation AIDS (LA/AIDS). And this LA/AIDS model will be used in research.

The following form of AIDS model was used in the present analysis to estimate the system of demand functions for food items like sea fish, chicken meat, eggs, beef and milk. From the estimated demand function price and income elasticities were derived. Following [24], the linier approximation AIDS was used:

$$W_i = \alpha_0 + \sum_j \gamma_{ij} \log p_j + \beta_i \log(X/P^*) \quad (3)$$

Where, W_i is average budget share of the i^{th} commodity, P_j is price of the j^{th} commodity, X is expenditure on food commodities (sea fish, chicken meat, eggs, beef and milk), $\ln P^*$ is price index, and α_0 , γ_{ij} , and β_i are the parameters that need to be estimated.

² The demand elasticities are calculated as functions of the estimated parameters, and they have standard implications. The specific form of expenditure elasticity (η_i), which measures sensitivity of demand in response to changes in consumption expenditure, is as:

$$\eta_i = 1 + \frac{\beta_i}{w_i} \quad (4)$$

The uncompensated (I) own-price elasticity (ϵ_{ii}^M) and cross-price elasticity (ϵ_{ij}^M) measure how a change in the price of one product affects the demand of this product and other products with the total expenditure and other price held constant. The form of uncompensated own and cross-price elasticities is as, respectively:

$$\epsilon_{ii}^M = -1 + \frac{Y_i}{w_i} - \beta_i \quad (5)$$

$$\epsilon_{ij}^M = \frac{Y_{ij}}{w_i} - \beta_i \frac{w_j}{w_i} \quad (6)$$

⁷ The compensated price elasticities own and cross (ϵ_{ii}^H and ϵ_{ij}^H) which measures the price effects on the demand assuming the real expenditure X/P * is constant, is describe as:

$$\epsilon_{ii}^H = -1 + \frac{Y_i}{w_i} + w_i \quad (7)$$

$$\epsilon_{ij}^H = \frac{Y_{ij}}{w_i} + w_j \quad (8)$$

³ To ensure that the assumption of maximizing satisfaction is not violated, there are three restrictions that must be inserted into the model:

1. Adding-up: $\sum_i \alpha_i = 1$, $\sum_i \alpha_{ij} \text{ households households households} = 0$, $\sum_i b_i = 0$, ³ allows an expenditure share of a single value.
2. Symmetry: $C_{ij} = C_{ji}$, shows the consistency of consumer's choices
3. Homogeneity $\sum_j C_{ij} = 0$, which is based on the assumption that changes are proportional in to all prices and expenditures do not affect the number of purchased items.

⁵ 2.2. Data

The data used in this research is secondary data of 124,513 households from Indonesian National Socio-economics Survey in 2016. The data consist of data consumption and expenditure of animal food commodities. The expenditure is divided into five groups, namely groups of sea fish, beef, chicken meat, eggs, and milk. The sea fish group includes shrimp, common squid/scuttle fish, fresh squid, common squid preserved, the beef group includes beef and trimming, the egg group includes broiler eggs, local chicken eggs, duck eggs and quail eggs, and groups milk includes fresh milk, preserved milk, sweetened condensed milk, canned powder milk and infant milk. Data on animal food prices are calculated from the total expenditure of each animal food commodity divided by the amount of consumption.

3. Results and Discussion

3.1. Factors affecting animal food demand

Price and income affect consumption patterns and household animal food demand. Table 1 shows the estimated results of the parameters of demand for animal food in Indonesian urban households. Estimation of this parameter has passed the LA/AIDS restriction test that is adding-up, homogeneity, and symmetry [25][26][27].

Sea fish prices, chicken meat prices, beef prices, egg prices, and milk prices have a very significant effect on animal food demand. The number of household members greatly influences the demand for chicken meat and milk. Total expenditure greatly influences the demand for chicken, beef, and milk. The R^2 value for each of the highest demand models in milk commodities is 99.7%, followed by the demand models for sea fish, chicken, eggs, and beef, respectively 71.2%, 71.2%, 62.7%, and 45.3%. The beef demand model has the lowest R^2 , meaning that the beef demand model is influenced by the price of fish, chicken prices, beef prices, egg prices, milk meat, total expenditure, and the number of household members, the remaining 55% is another variable not included in the model, including processed food or drink, vegetables and fruit, oil and fat, and not food. This is consistent with the results of research on the meat demand system in Iran [20] that the R^2 of the animal food demand system is between 45 to 70% [28]. The total variable expenditure on chicken and beef is positive, indicating that chicken and beef are luxury items because the increase in income increases demand chicken and beef [29][30].

Table 1. AIDS Parameter estimates of animal food demand

Variable	Beef	Chicken meat	Eggs	Milk	Sea fish
Intercept	-0.118	-0.017*	0.511*	-0.085	0.577*
Beef prices	-0.116*	-0.043*	-0.043*	-0.023*	-0.007*
Chicken meat prices	-0.043*	0.043*	-0.033*	0.026*	0.007*
Eggs prices	-0.043*	-0.033*	0.116*	-0.026*	-0.014*
Milk prices	-0.023*	0.026*	-0.026*	0.057*	-0.033*
Sea fish prices	-0.007*	0.007*	-0.014*	-0.033*	0.047*
Total of expenditure	0.024*	0.043*	-0.033*	-0.003	-0.874
Household size	0.004	0.013*	-0.004	0.015*	0.798
B	-0.015*	-0.020*	0.000	-0.003*	0.003*
R^2	0.453	0.712	0.627	0.997	0.712

Source: Indonesian National Socio-economics Survey in 2016

*significant at 0.01

The parameter estimation results from the AIDS model show that animal protein demand is interrelated, where an increase in demand for beef, eggs, and milk has a negative impact on demand for chicken meat and fish. This indicates that the increase in animal protein food prices should not occur together because there is a tendency to substitute between rising prices of beef, eggs, and milk with demand for chicken meat and sea fish. This is in line with the research in [7][31].

The number of household members has a positive effect on demand for beef, chicken, and sea fish, while with eggs is negative. It can be interpreted that the increase in the number of household members one person increases the consumption of animal food, beef, chicken, milk. But unlike eggs, that the increase in household size decreases egg demand. This phenomenon explains that Indonesian urban households consume an enormous amount of animal protein from the egg group.

3.2. Marshallian (uncompensated) own and cross-price elasticities

Marshallian elasticity describes the percentage change in the number of goods demanded as a result of price changes. The Marshallian price elasticity is greater than the Hicksian price elasticity because the Marshallian price elasticity contains income and substitution effects, whereas the Hicksian price elasticity only contains the substitution effect. Table 2 is the result of the Marshallian price elasticity of both own and cross-prices in urban households in Indonesia.

The most elastic beef in both Marshallian and Hicksian. Beef is the highest of Marshallian price elasticity is 1.05%, followed by chicken meat (0.89%), eggs (0.66%), milk (0.73%), and sea fish by 0.21%. Beef is the most elastic among other animal foods. It means that beef is most responsive to price changes. It is means that an increase in beef prices reduces the greatest demand among other animal foods. Alternatively, in other words, the price of beef responds to the community is greater than 1%. Marshallian price elasticity of meat by 1.05 can mean that an increase in the beef price of 1% causes a decrease in demand of 1.05%. Beef is a substitution with sea fish (0.79%), eggs (0.308%), chicken meat (0.141%), whereas, with milk, beef is complementary. This finding is quite interesting because only milk is complementary to beef. Milk in this study consisted of **factory liquid milk, sweetened condensed milk, baby milk powder**, and baby milk powder. It can be interpreted that Indonesian urban households consume beef together with the milk group.

Table 2. Marshallian own and cross-price elasticities of Indonesian urban

Animal food groups	Beef	Chicken meat	Eggs	Milk	Sea fish
Marshallian (uncompensated) elasticity					
Beef	-1.050	1.949	1.907	1.981	2.048
Chicken meat	0.141	-0.894	0.092	0.117	0.140
Eggs	0.308	0.328	-0.664	0.318	0.308
Milk	-0.122	-0.118	-0.117	-0.731	-0.122
Sea fish	0.791	0.791	0.791	0.791	-0.209

Source: Indonesian National Socio-economics Survey in 2016

Animal food, the second source of protein that is responsive to prices, is **chicken meat**. The own-price elasticity of Marshallian chicken meat is 0.894. It indicates that a 1% **increase in the price of chicken meat** reduces **the** demand for chicken by 0.89%. Cross price elasticities indicate the relationship between animal food, whether substitution or complementary. If positive means there is a substitution relationship between commodities, on the contrary, if negative means there is a complementary relationship. Chicken meat is substitution with beef (1.95%), sea fish (0.79%), and eggs (0.33%). Chicken meat is substituted with milk (0.12%).

Eggs are animal foods with a Marshallian own-price elasticity of 0.664, meaning that a 1% increase in egg prices reduces egg demand by 0.66%. Eggs are substituted with beef, sea fish, and chicken with cross-price elasticity, respectively 1.91%, 0.79%, and 0.09%. Whereas with milk, eggs are complementary (0.12%). Milk also substitutes with beef, sea fish, eggs, and chicken meat, with cross-price elasticity of 1.98%, 0.79%, 0.32%, and 0.12%. Sea fish is the least elastic animal food among other animal foods. The price elasticity of Marshallian marine fish is 0.21. It can be interpreted that an increase in sea fish price of 1% decreases demand by 0.21%. Sea fish with beef, egg, and chicken meat are a substitution, while with milk, sea fish are complementary. All of the Marshallian cross-price elasticity are almost positive. It means that animal foods are substitution. Only milk is negative, meaning that all animal foods are complementary to milk. In other words, Indonesian urban households consume milk together with beef, chicken, eggs, and sea fish.

3.3. Hicksian (compensated) own and cross-price elasticities

Hicksian price elasticity is an indicator of changes in demand as a result of price changes, where the Hicksian elasticity only contains a substitution effect. So, it is often called the elasticity of demand. Table 3 shows the results of the calculation of the Hicksian price elasticity, both the price elasticity itself and the cross-price elasticity.

Hicksian's own-price elasticity of the most elastic is also beef with the highest elasticity of demand that is 1.03. It means that an increase in beef prices reduces demand by 1.03%, followed by chicken meat (0.56%), milk (0.45%), eggs (0.31%), and sea fish by 0.15%. Changes in household consumption

of animal protein sources are strongly influenced by prices. Beef is the most elastic compared to chicken, eggs, milk, and sea fish. An increase in beef prices lowers the demand for beef. This decrease in demand is more than a change in price. An increase in beef price by 1% decreases beef consumption by 1.03% and increases the consumption of sea fish by 0.85%, or eggs (0.36%), or chicken meat (0.21%). So that said beef is a substitution with sea fish, eggs, or chicken meat. Beef is complementary to milk. In other words, Indonesian urban households consume milk together with beef, chicken, eggs, and sea fish. Or milk as a complement to other animal foods.

Table 3. Hicksian own and cross-price elasticities of Indonesian urban

Animal food group	Beef	Chicken meat	Eggs	Milk	Sea fish
Hicksian (compensated) elasticity					
Beef	-1.030	2.361	2.458	2.288	2.133
Chicken meat	0.205	-0.564	0.533	0.362	0.208
Eggs	0.359	0.590	-0.313	0.517	0.362
Milk	-0.609	-0.378	-0.281	-0.451	-0.605
Sea fish	0.846	1.078	1.174	1.004	-0.150

Source: March 2016, Susenas

3.4. Expenditure elasticity⁶

Expenditure elasticity is the percentage change in the amount requested as a result of the percentage change in income. Marginal expenditure share is an additional amount of goods requested as a result of additional expenditure. Table 4 shows the expenditure elasticity and marginal expenditure share of Indonesian urban households.

Table 4. Expenditure elasticity and marginal expenditure share

Animal food group	Expenditure Elasticity	Marginal Expenditure Share
Beef	1.063	0.059
Chicken meat	1.044	0.299
Eggs	0.991	0.381
Milk	1.072	0.229
Sea fish	0.994	0.059

Source: March 2016, Susenas

Milk is the most elastic with the highest expenditure elasticity is 1,072%, followed by beef (1,063%), chicken meat (1,044%), sea fish (0.994%), and eggs (0.991%). Milk, beef, and chicken meat are luxury items, while sea fish and eggs are normal goods, not inferior [32]. Indonesian urban households consume sea fish and eggs as a source of animal protein. Marginal Expenditure Share (MES) is an additional share of animal food expenditure to total expenditure. The highest MES is eggs, followed by chicken meat, milk, and sea fish. It means that the marginal expenditure of eggs is greater than other animal foods.

Beef, chicken, egg, and sea fish mutually substitutes. The increase in the price of one of the animal-based animal protein sources has resulted in a decrease in demand for the goods themselves and an increase in the demand for other animal foods. Therefore, the increase in animal food prices should not increase simultaneously because it will cause more burdens to the people so that protein consumption decreases. While milk is complementary, it means that milk is an animal source of protein which is consumed complementary with other animal foods and has become a complement to animal protein in Indonesian urban.

4. Conclusion

Animal food as a source of protein is very important for consumption because there is one amino acid that cannot be replaced by other foods. Price and income determine the amount of consumption of animal food. This study explains the effect of price and income changes. The model approach uses LA-AIDS with a total sample of 124,513 households. The results of analysis shows that in urban of Indonesia, the most animal food consumption as a source of protein is eggs, followed by chicken meat, milk, beef, and sea fish. Beef is the most elastic among other animal foods with a Marshallian price elasticity of 1.05%, followed by chicken meat (0.89%), eggs (0.66%), milk (0.73%), and sea fish by 0.21%. Beef is also the most responsive to prices with the highest elasticity of demand, amounting to 1.03%. then followed by chicken meat (0.56%), milk (0.45%), eggs (0.31%) and sea fish by 0.15%. Beef, chicken meat, eggs, and sea fish are a substitute, but different from milk that has been consumed with other animal foods (complementary). It means that households have consumed milk with other animal foods, namely beef, chicken meat, eggs, and milk.

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