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Income and price elasticities of animal food demand and welfare in Indonesian urban: an application of the LA-AIDS

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Protein consumption can be a measure of the welfare of society. Developed countries consume more protein than developing countries. This study analyzes rising prices and income on demand and welfare in urban Indonesia. The research data use the 2018 Household National Socio-Economic Survey (Susenas) data in household consumption and expenditure data collected by the Central Statistics Agency (BPS). The number of samples is 133,873 households. The demand systems approach uses the Almost Ideal Demand System (LA-AIDS). The welfare change approach uses Compensating Variation (CV) and Equivalent Variation (EV). The results showed that the meat group was the most elastic animal food with a demand elasticity of 13,936%, followed by milk (0.991%), sea fish (0.649%), eggs (0.284%), and chicken meat (0.057%). Beef is a substitute for sea fish and eggs. Beef with chicken and milk is complimentary. All animal food is a luxury item except sea fish, a normal item. In the long term, the highest marginal expenditure share is marine fish at 0.592%, followed by milk (0.123%), beef (0.102%), eggs (0.078%), and the lowest is chicken meat at 0.012%. Considering the substitution, the price increase simultaneously requires CV compensation of Rp. 244,830/HH/month, EV of Rp.231,858/HH/month. Especially for the animal food group, the biggest compensation for eggs needs CV compensation of Rp. 10,083/HH/month, and EV of Rp. 9,493/HH/month. In general, EV compensation is more effective than CV compensation.

1. Introduction

A country's food consumption, especially protein, is often a measure of a nation's welfare. People in developed countries consume more stable protein food than developing countries (Umaroh & Pangaribowo, 2020, Sa'diyah 2019). The world's commitment to food sufficiency is contained in the 17 goals of Sustainable Development Goals (SDGs). The number one and two SDGs goals are without hunger and poverty (Horne et al., 2020), (Naidoo & Fisher, 2020). To realize the second goal of the SDGs food sufficiency, including protein adequacy, is very important (Robert et al., 2005). Indonesia, as a developing country, is also strongly committed to achieving the SDG's goals. Data from the Indonesian Central Bureau of Statistics (BPS) states that the proportion of daily consumption of protein per capita by food commodity groups and urban and rural classification, September 2018 for fish/shrimp/squid/clams is 12.89 (urban), 14.55

(rural), and 13.59 (urban + rural). For the meat group, it was 8.08 (urban), 5.24 (rural), and 6.89 (urban + rural). Household consumption of eggs and milk is 6.09 (urban), 4.23 (rural), and 5.31 (urban + rural). This protein consumption is still much smaller than in developed countries(McCarthy, 2020), (Khonje et al., 2020).

Indonesians' food consumption habits are diverse and vary depending on the season and region. Food consumption patterns may range from one area to the next depending on the environment, including local resources and culture, the dynamics of Indonesian food consumption, tastes, and incomes. Similarly, food consumption patterns will alter over time as a result of changes in income, price changes, and public awareness of food and nutrition, and lifestyle changes. As a result of these changes, both between regions and over time, how much food must be provided and how it will be distributed will decide how much food must be provided and how it will be divided so that the community can afford to buy it. As a result, one of the entrance points and sub-systems for strengthening food security is the usage or consumption of food. Food supply policies, both from domestic production and imports, can be established by understanding people's food consumption patterns. The food production policy considers the amount and type of food that can be produced, as well as land, air, technology, and other supporting infrastructure. It can be established how much and what kind of food should be produced domestically or imported by taking into consideration the potential for food production and demand. Furthermore, by understanding changes in people's food consumption, policies on food prices and distribution may be developed to ensure that people have access to the food that is available. As a result, society's well-being improves.

In the last five years, the price of animal protein food, especially beef, has increased quite rapidly (Nendissa et al., 2019). Food prices and income greatly influence demand, especially animal food. This decrease in order causes a reduction in consumption (Zhang et al., 2020), (Gouel & Guimbard, 2019), (Bairagi et al., 2020). Apart from prices and income, household socio-economic factors, including the number of household members and settlement type, also influence food demand. Urban households consume more protein food than rural households (Kharisma et al., 2020) (Khoiriyah et al., 2020), and (Nikmatul et al., 2020).

Research on food demand systems has been carried out in several countries, i.e., Switzerland (Abdulai, 2002), Germany (Bronnmann et al., 2019), (Beznoska, 2019), Saudi (Alnafissa & Alderiny, 2019), Brazil (Coelho & Aguiar, 2007), and several countries (Dong et al., 2003), (Pereda, 2008), (Elijah Obayelu et al., 2009). In general, these studies analyze limited food demand. This research not only discusses the demand for animal food but also explores changes in welfare. The research data use the 2018 National Social Economic Survey (Susenas) data collected by the BPS. Research data is in the form of data on consumption and expenditure of all food and non-food items. Food data discussed in detail in this study is animal food consisting of five animal food groups, namely sea fish, chicken, beef, eggs, and milk. The demand systems approach uses LA-AIDS. Analysis of changes in welfare is done using Compensating Variation (CV) and Equivalent Variation (EV), and estimating parameters using Seemingly Unrelated Regression (SUR). The results showed the price elasticity and income of each animal's food. Price elasticity consists of price elasticity itself and cross prices. Price elasticity can infer whether animal food is elastic, inelastic, or unitary elastic. Cross-price elasticity can conclude whether animal foods are substitutes or complementary. Income elasticity concludes whether animal food is a normal good, a luxury good, or an inferior good. On the welfare aspect, supposed whether the price increases simultaneously or partially impact increasing welfare (better-off) or decreasing welfare (worse-off). All research results are expected to be valuable input for food policy formulation to accelerate the fulfilment of protein consumption according to national protein adequacy.

2. Materials and Methods

2.1. Price and income elasticities: Almost Ideal Demand System (AIDS)

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

$$W_i = \alpha_n + \sum_i \gamma_{ii} log p_i + \beta_i \log (X/P) \quad (1)$$

P is the price index, defined as:

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

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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 the AIDS model was used in the present analysis to estimate the system of demand functions for food items like sea fish, chicken meat, beef, eggs, and milk. From the estimated demand function, price and income, elasticities were derived. Following (Bronnmann et al., 2019), the LA/AIDS was used:

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

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

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

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

The uncompensated (l) 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 for this product and other products with the total expenditure, and other prices held constant. The form of uncompensated own and cross-price elasticities are as, respectively:

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

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

The compensated (Hicksian) 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 described as:

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

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

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

1. Adding-up:

   $\sum_i \alpha_i = 1$, $\sum_i \alpha_{ij}\ households = 0$, $\sum_i b_i = 0$, 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 to all prices and expenditures, that do not affect the number of purchased items.

2.2 Measuring Welfare: Compensating Variation and Equivalent Variation

Compensating Variation (CV) is a paid amount of money that must be given to households to return to their original satisfaction. In contrast, Equivalent Variation (EV) is the amount of money compensated to families to return for their actual income (Bellemare et al., 2013). The exact measure of the change in welfare can be described in terms of the cost function based on price differences. To measure changes in interest related to price changes, a measure of CV can be used (CV_1), with the formula:

$$CV_1 = C(U_i^0, P_i^1) - C(U_i^0, P_i^0) \quad i = 1, \ldots, 4. \quad (9)$$

Where U is utility and P is a vector of prices, the superscript 0 and 1 refer to before and after price changes, respectively.

$$CV = -\int_{P_1}^{P^0} \sum_i X_i(P, U^0) dP_i + \Delta m \quad (10)$$

$$U_0 = \left[\ln C - \left(\alpha_0 + \sum_{j=1}^{8} \alpha_j \ln p_j + \frac{1}{2}\sum_{j=1}\sum_{k=1} \gamma_{jk} \ln P_j \ln P_k\right)\right] / \beta_0 \pi P_i^{\beta_i} \quad (11)$$

According to Huffman & Johnson (2002), the procedure for calculating CV and EV using the AIDS model as in the AIDS model, the expenditure function, e (u, p), is stated in the formula as follows:

$$log\{e(p,u)\} = (1-u) log\{a(p)\} + u \log\{b(p)\} \quad (12)$$

Where p is the price, a (p) and b (p) a positive linear homogeneous functions at p;u as a utility level that has a value between 0 and 1.

The form of specific functions that are given in log {a (p)} and log {b (p)} (Deaton & Muellbauer, 1980) are expenditure functions that can be written as a percentage change in welfare based on the following formula:

$$log\{e(p,u)\} = \alpha_0 + \sum \alpha_k \log p_k + (1/2) \sum\sum \gamma_{kj} log p_k log p_j + \mu \beta_0 \pi (p_k)^{\beta k} \quad (13)$$

Where p_k is an animal food price consumed by the household; $\alpha_k, \beta_k, \gamma_{kj}$ is a parameter. To meet that requirement a(p), b(p), and e(p,u) are linear and homogenous to p, parameter must fulfil: $\sum \alpha_k = 1$, $\sum \gamma_{kj} = \sum \gamma_{jk}$ $\sum \beta_k = 0$. Also, symmetry in the second order from $log\{e(p,u)\}$ concerning pk and pj requires $\sum \gamma_{kj} = \sum \gamma_{jk}$.

By using the theory of duality, the Marshallian demand function in the form of a budget share can be derived as

$$w_i = \alpha_i + \sum \gamma_{ij} log p_j + \beta_i \log(\frac{m}{p^*}) \quad (14)$$

Where is the budget share of animal food; m represents total household expenditure; p* price index is determined using the Stone price index (Deaton & Muellbauer, 1980).

The utility function can indirectly be determined based on the equation (11):

$$u = V(p,m) = \{\log m - \alpha_0 - \sum \alpha_k log p_k - (1/2) \sum\sum \gamma_{kj} log p_k log p_j\} / \{\beta_0 \pi (p_k)^{\beta k}\} \quad (15)$$

For calculating CV and EV, we can use the estimation results of equation (14). Where $\alpha_i, \beta_i, \gamma_{ij}$, which is estimated based on data w_i, p_i, and m.

By using the starting point (P^0, m^0) dan endpoint (p^1, m^1) of price changes and income changes, then equation (31) can be used to calculate $u^0 = V(p^0, m^0)$ dan $u^1 = V(p^1, m^1)$. Then equation (11) can be used to calculate $\log e(p^0, u^0)$, $\log e(p^1, u^0)$, $\log e(p^0, u^1)$, and $\log e(p^1, u^1)$, where we know $m^0 = e(p^0, u^0)$ dan $m^1 = e(p^1, u^1)$. Finally, CV and EV can be calculated as follows:

$$CV = m^1 - e(p^1, u^0)$$

$$CV = m^1 - exp\{\log e(p^1, u^0)\} \quad (16)$$

$$EV = e(p^0, u^1) - m^0$$

$$EV = \exp\{\log e(p^0, u^1)\} - m^0 \quad (17)$$

We can also calculate the starting point for total expenditure as follows:

$$pcv = CV / m^0 \quad (18)$$

Where pcv is the percentage change in welfare with CV and also called the welfare price elasticity as follows:

$$e_{iw} = pcv / (\frac{\Delta p_i}{p_i}) \quad (19)$$

$$\text{And} e_{gw} = pcv / (\Delta p_g / p_g) \quad (20)$$

We can also calculate the starting point for total expenditure as follows:

Where e_{iw} or e_{gw} is the price elasticity of welfare due to the percentage change in commodity price i (Δp_i / p_i) or commodity bundle price i $(\Delta p_i / p_i)$ or commodity bundle price g $(\Delta p_g / p_g)$, generally, e_{iw} or e_{gw} are negative, which means that welfare will decrease if there is a price increase, nevertheless, if the positive sign shows a powerful substitution effect.

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2.3 Analysis of the impact of changes in food prices on welfare

In principle, there are five methods for measuring welfare (Araar & Verme, 2016): 1) Consumer's Surplus variation (CS for short); 2) Compensating Variation (CV); 3) Equivalent Variation (EV); 4) Laspeyer Variation (LV); dan 5) Paasche Variation (PV). In this study, the impact of price changes on welfare is analyzed using the concept of CV and EV approaches (Alem, 2011; Friedman & Levinsohn, 2002; Jansen, 2000; Vu & Glewwe, 2011, 2011) Using observations of the household budget share after price changes and price elasticity are estimated as derived from the LA/AIDS model. A CV is the amount of money needed to compensate households after a price change and restore utility levels after a change. With the LA-AIDS model, the CV can be estimated using a second-order Taylor expansion of the expenditure function as an equation formula as follows:

$$\Delta \ln e = \sum_{i=1} W\_kel_i \, \Delta lnP_i + \frac{1}{2}\sum_{i=1}\sum_{j=1} W\_kel_i \; \epsilon^*_{ij} \, \Delta lnP_i \Delta lnP_j \quad (21)$$

Where ϵ^*_{ij} is the compensated price elasticity of good *i* concerning the price of good *j*.

In this study, a CV will be calculated only for households in rural areas. Based on the formula above, a positive CV represents an increase in the level of interest (welfare gain), and vice versa if a negative value means a decrease in welfare (welfare loss) due to changes in prices (Varian, 2010). In addition to using a CV, EV is also used to see the impact of price increases on welfare, with the following equation:

$$EV = -\sum_k xk\Delta pk - \frac{1}{2\sum_{kj}\frac{\partial xk}{\partial pj}}\Delta pk\Delta pj + 1/2\sum_k xk\Delta pk\sum\frac{\partial xk}{\partial m}\Delta pk \quad (22)$$

EV rules are the same as the CV if positive, EV means an increase in interest (welfare gain/better off), whereas if negative, there is a decrease in welfare (welfare loss/worse off) due to price increases (Varian, 2010).

2.4. Data

The data used in this research is secondary data conducted by the Central Bureau of Statistics in the form of a household survey, called Susenas (Survai Sosial Ekonomi Nasional/National Socio-economics Survey) data (March 2018). The data analyzed were socio-demographic data (household residence status, total household member (HHsize), household consumption and spending, and total expenditure. The animal foods observed in this study were eggs (chicken eggs, local chicken eggs, and duck eggs), chicken meat (local chicken meat and chicken meat), beef, fresh fish (fresh fish and shrimp including fish, shrimp, squid, and shellfish) as well as milk powdered (milk powder and infant milk). The sample of this research is 133,873 households.

3. Results and Discussion

3.1 Parameter estimates of animal food demand in urban Indonesia

It is crucial to estimate the parameters of all animal food prices, income, and household size (HH). These parameters serve as the basis for calculating price and income elasticity. Price elasticity includes the price elasticity of the goods themselves and the costs of other goods. The calculated price elasticity includes Marshallian and Hicksian price elasticities. Table 1 is the result of estimating animal food parameters using the LA-AIDS approach. These parameters have also met the three restriction tests and the demand system restrictions. The three restrictions are adding up, homogeneity, and symmetry.

All parameters of animal food prices, namely sea fish price, chicken meat price, beef price, egg price, and milk price, are very significant to demand. It can be interpreted that an increase in animal food prices reduces demand. This is to the economic theory that there is a negative relationship between price and need for a good. Household income, as measured by total household expenditure, is only significant for milk. At the same time, for other animal foods, it is not substantial. The parameters for the number of household members were important for chicken, beef, and eggs. At the same time, sea fish and milk were not substantial. In general, it can be concluded that the AIDS model for animal food in urban households in Indonesia can explain the animal food demand model in almost all of them. Virtually all parameters of price, income and household size members are very significant.

Table 1: AIDS estimated parameters for animal food in the urban of Indonesia

Variable	Sea fish	Chicken meat	Beef	Eggs	Milk
Intercept	2,598*	1.297*	1.487*	1.460*	1.289
Price of sea fish	-0.052*	-0.0002*	-0.002	-0.0029	-0.00005
Price of chicken meat	-0.026*	-0.0001*	-0.0007	-0.0008	0.00002
Price of beef	-0.024*	0.0002	-0.0024*	-0.0009	-0.00002
Price of eggs	-0.009*	-0.00002	-0.00007	-0.0003*	-0.00003*
Price of milk	0.007*	-0.00004	-0.00019	-0.0002	-0.00001*
Total expenditure	0.028	0.00003	0.00067	-0.0001	-0.00001*
Household size	-0.081	-0.00003*	-0.0002*	-0.0005*	-0.00003
β	-1.880*	-0.00001*	-0.0005*	-0.0005*	-0.00002*
R^2	0.014*	-1.627	-0.055*	0.081*	-1.616
Intercept	0.998				

Source: Author's computations based on Susenas, 2018

*) significant 99%

3.2 Marshallian (uncompensated): own and cross-price elasticity

Price elasticity describes the relationship between the percentage change in the number of goods ordered due to the price change. Price elasticity consists of Marshallian and Hicksian price elasticities. Price elasticity includes own-price elasticity and cross-price elasticity. The own-price elasticity of animal food is the percentage change in the amount of animal food demanded due to the percentage change in the price of the animal food item. Meanwhile, cross-price elasticity is the percentage change in the quantity of animal food demanded due to changes in the price of other animal foods. Table 2 results from calculating the own-price elasticity and the cross-price elasticity of the Marshallian. All animal food self-price elasticities are negative. This is in line with the economic theory that price and market have a negative relationship. Alternatively, in other words, if the price goes up, the market goes down.

In urban Indonesia, all animal foods are inelastic except beef, which are highly elastic. This is indicated by all the elasticities of demand for animal food less than one, except beef more than one (absolute). The meat group is the most elastic animal food with a demand elasticity of 13,936%, followed by milk (0.991%), sea fish (0.649%), eggs (0.284%), and chicken (0.057%). The 1% increase in beef prices reduced demand by 13,936%. Chicken meat is an animal food with the most minor demand elasticity. It can be interpreted that changes in demand for chicken meat are more minor than changes in chicken prices. This confirms with the findings of Mwenjeri et al. (2016), who found that food spending elasticity in Laikipia City, Kenya, is positive. Marshallian price elasticity is greater (absolute) than Hicksian because in Marshallian price elasticity, besides there is a substitution effect, there is also an income effect. In contrast, in Hicksian, there is only a substitution effect.

Table 2 also shows the cross-price elasticity of animal foods. It can be seen that almost all animal foods have substitute or complementary goods. This is indicated

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by the analysis results that part of the cross elasticity is positive, and part of the cross elasticity is negative. Positive cross-price elasticity means that animal food is a substitution. Meanwhile, negative cross-price elasticity means that animal food is complimentary. Substitution is an increase in the price of animal food to increase the demand for other animal foods. Complementary is that the rise in animal food prices reduces the need for other animal foods. Sea fish is a substitute for chicken, eggs, and milk. Sea fish was complementary to beef. Indonesian urban households consume seafood and beef at the same time. In other words, beef and sea fish complement each other.

Sea fish is substituted for chicken, eggs, and milk, while with beef, sea fish is a substitute. Chicken meat substitutes sea fish and eggs, while beef and milk are complimentary. Beef is a substitute for sea fish and eggs. Beef with chicken and milk is complimentary. Eggs with sea fish and chicken are substitutes. Eggs with beef and milk are complimentary. Milk with beef is complimentary. Milk with sea fish, chicken, and eggs is a substitute. An increase followed the 1% increase in milk prices in demand for marine fish, chicken meat, and eggs by 0.277%, 0.053%, and 0.733%. Indonesian urban households consume milk along with beef. This is indicated by the negative sign in the cross-price elasticity of beef and milk. In other words, beef and milk are complimentary. An exciting finding on the animal food consumption of urban Indonesian households is the increase in beef prices a decrease in chicken meat consumption and the rise in demand for eggs. This means that the rise in beef prices decreases the consumption of animal food directly to eggs instead of chicken. Therefore, beef price stability is essential to prevent a drastic decrease in beef consumption. This reduction in protein consumption can be one of the drivers of increased stunting both in Indonesia (Sari et al., 2017), (Hoddinott et al., 2013), (Mahmudiono et al., 2016), as well as in other countries (Headey & Martin, 2016), (Jain, 2018), (Béné et al., 2015).

3.3 Hicksian (compensated): own and cross-price elasticity

Hicksian price elasticity reflects the percentage change in the quantity of animal food demanded due to the percentage change in the price of animal food. Table 3 presents the own-price elasticities and the Hicksian cross-price elasticities. All animal foods are inelastic, meaning that a 1% price increase causes a decrease in less than 1% demand unless beef is very elastic. The 1% increase in beef prices caused demand to fall by 4,145%. Compared to other animal foods, the 1% price increase for sea fish, chicken meat, eggs, and decrease in milk demand are by 0.058%, 0.387%, 0.902%, and 0.384%, respectively.

Table 3 also presents the cross-price elasticity of Hicksian animal food in urban households in Indonesia. The finding is that all animal foods are substitutes, as indicated by the positive cross-price elasticity. This means that an increase in the price of one animal food causes a decrease in animal food itself and an increase in demand for other animal food. Beef is a substitute for chicken, milk, sea fish, and eggs. The 1% increase in beef price increases the demand for chicken meat by 0.632%, milk by 0.538%, sea fish by 0.293%, and eggs by 0.053%.

Referring to the results of the analysis of own and cross-price Marshallian and Hicksian elasticity as in Tables 2 and 3, it can be concluded that the difference in the value of the two elasticities is slight. This means that the substitution effect is much more significant

Table 2: Marshallian (uncompensated) own and cross-price elasticities

Animal food groups	Sea fish	Chicken meat	Beef	Eggs	Milk
	Uncompensated				
Sea fish	-0.649	0.265	0.267	0.273	0.277
Chicken meat	0.029	-0.057	-0.944	0.055	0.053
Beef	-2.464	-15.277	-13.936	-13.145	-12.567
Eggs	0.590	0.729	0.725	-0.284	0.733
Milk	0.013	-0.009	-0.008	-0.007	-0.991

Source: Author's computations based on Susenas, 2018

than the income impact. Price changes have a profound effect on the consumption of animal foods. A price increase in price reduces the consumption of animal foods (all price elasticities were negative). In Hicksian terms, all animal foods are substitutes. It can be concluded that the consumption of animal food in Indonesian urban households is a mutual substitution.

3.4 Income elasticity and marginal expenditure share

Income elasticity often uses the household expenditure elasticity approach. Income elasticity describes the percentage change in animal food demanded due to a percentage change in household income. Meanwhile, the Marginal Expenditure Share (MES) shows the additional demand for animal food due to extra income in the long run. Table 4 is the result of calculating income elasticity and MES of Indonesian urban households. Beef is very elastic with an income elasticity of 3,418%, followed by milk, chicken, eggs, and sea fish with income elasticities of 1,145%, 1,122%, 1,017%, and 0.872%, respectively. The 1% increase in income increased the demand for beef by 3,418%. The rise in revenue has been responded to very well by Indonesian urban households by increasing beef consumption.

On the other hand, the decrease in income has also been responded to very strongly because beef demand has been significantly reduced. Milk is an animal food with the second-largest income elasticity after beef. The 1% rise in income increased the demand for milk by 1,145%. Likewise, for chicken and eggs, the rise in demand was also more significant than the increase in prices. Beef is the most luxurious animal food, followed by milk, chicken, and eggs. This is indicated by an income elasticity of more than one. The findings of this study are consistent with those of several other studies conducted in various countries. The income elasticity value is positive, according to Abdulai & Aubert (2004), who used cross-sectional data on six food groups. In addition, Erhabor & Ojogho (2011) conducted a study in Nigeria, and the findings revealed that as income climbed, so did food spending. Similarly, Mwenjeri et al. (2016) found that a rise in household income increased consumption in Kenya.'

Table 3. Hicksian (compensated) own and cross-price elasticities

Animal food groups	Sea fish	Chicken meat	Beef	Eggs	Milk
	Compensated				
Sea fish	-0.058	0.274	0.293	0.338	0.371
Chicken meat	1.281	-0.387	0.632	0.677	0.709
Beef	5.791	5.123	-4.145	5.187	5.219
Eggs	0.701	0.034	0.053	-0.902	0.130
Milk	1.187	0.519	0.538	0.583	-0.384

Source: Author's computations based on Susenas, 2018

Table 4. Expenditure elasticity and marginal expenditure share

Animal food group	Expenditure elasticity	Marginal expenditure share
Ikan Laut	0.872	0.592
Ayam	1.122	0.012
Daging Sapi	3.418	0.102
Telur	1.017	0.078
Susu	1.145	0.123

Source: Author's computations based on Susenas, 2018

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Meanwhile, sea fish are everyday goods because the income elasticity is less than one. All animal food is a luxury item except sea fish, an everyday item. This is evidenced by the income elasticity of more for luxury goods and less than one for standard items.

MES shows the effect of changes in income on changes in demand in the long run. The highest MES was sea fish at 0.592%, followed by milk (0.123%), beef (0.102%), and eggs (0.078%), and the lowest was chicken meat at 0.012%. Beef has MES number three, but it is pretty big too. This means that the increase in income has a significant enough effect on the demand for meat. Following the research of Nendissa et al. (2019), the rise in beef prices in the last five years is relatively high. The increase in beef prices should be followed by an increase in income to impact increasing demand for beef and increasing household consumption of beef.

3.5 Welfare analysis

3.5.1 Compensating Variation

Scenarios of increasing prices, either simultaneously or partially, have been carried out to analyse welfare changes due to price changes. The scenario for an increase in food prices for this analysis includes a 10% increase in the price of marine fish, 10% chicken, 10% beef, 20% eggs, 5% milk, 5% other protein, 5% other food, and 5% non-food. The results of the data analysis show that the increase in prices causes households to experience worse off. This is shown by CV. Mostly negative. The increase in all prices for both food and non-food items simultaneously requires a total variation of compensation (CV) that must be given to households of Rp. 244,830/HH/month (Table 5). The partial price increase for one food shows that the largest CV is the price increase in the non-food group, namely Rp. 129,138. The price increase in this non-food group was only 5%. A 5% increase in food prices other than protein requires a CV of Rp.90,545/HH/month. Meanwhile, a 5% increase in the price of protein food in addition to animal protein requires a CV of Rp.1,724/HH/month.

Regardless of the substitution, the compensation required for CV and EV is the same, namely Rp. 245,532/HH/month (Table 4 and 5). The compensation needs to be given so that households return to their welfare level with a 5% increase in non-food prices

Table 5. Compensating Variation of animal food, other food and non-food

Food & Non-food Items	W/O Subst*	Subst Only**	W/ Subst***	Price changes (%)
	Rp/Household/month			
ALL Items	-245,532	**702.45**	**-244,830**	
Sea fish	-858	-1.05	-859	10
Chicken meat	-7,014	161.7	-6,852	10
Beef	-2,381	54.6	-2,328	10
Eggs	-10,876	792.75	-10,083	20
Milk	-3,296	-4	-3,301	5
Other Protein	-1,721	-3	-1,724	5
Other Food	-90,411	-127	-90,545	5
Non Food	-128,975	-156	-129,138	5
TOTAL (Household)	**-245,532**	**702.45**	**-244,830**	

Source: Author's computations based on Susenas 2018
Note: *W/O subts = without substitution
**Subst Only = substitution only
***W/ subts = with substitution

is Rp.128,975 / HH/month. Compensation for food other than all protein is Rp.90,411/HH/month and for other proteins Rp.1,721 / HH/month. Particularly for the five animal food groups, the largest compensation was the increase in egg prices by 20%, requiring Rp's compensation are 10,876/HH/month, followed by chicken, milk, beef, and sea fish with Rp's consecutive compensation are Rp.7,014. Rp. 3,296, Rp. 2,381 and Rp. 858 per HH (household) per month.

Considering the substitution, the price increase simultaneously requires CV compensation of Rp. 244,830/HH/month. This CV compensation is smaller than without considering substitution. The largest CV compensation remains at the 5% increase in non-food prices, requiring Rp's CV compensation by Rp.129,138/HH/month. The second-largest compensation is the increase in other food prices by 5%, requiring CV compensation of Rp. 90,545/HH/month. Meanwhile, specifically in the animal food group, the largest compensation was for eggs, which increased by 20%, so it requires Rp's CV compensation is Rp. 10,083/HH/month. Then chicken meat, which has experienced a price increase of 10%, requires Rp's CV compensation is Rp.6,852/HH/month. The 5% increase in milk prices requires CV compensation of Rp. 3,301/HH/month. Beef requires compensation of Rp. 6,852/HH/month and the smallest compensation is for sea fish. The 10% increase in the price of sea fish requires CV compensation of Rp. 859/HH/month.

3.5.2 Equivalent Variation

Table 6 results from the analysis of changes in welfare using the Equivalent Variation (EV) approach. The scenario of a price increase is the same as an analysis of changes in CV welfare. Regardless of substitution, the amount of compensation given to households is the same between CV and EV, as presented in Tables 4 and 5. Without substitution, the amount of compensation that must be given if all food and non-food items simultaneously increase is Rp. 245,532/HH/month. An increase in egg price of 20% requires the highest compensation, namely Rp. 10,876/HH/month (without substitution), Rp. 9,493 (with substitution), and Rp 1,384 (substitution only). Chicken meat is the animal food that requires the second-largest compensation after eggs, followed by milk, beef, and sea fish.

With the substitution, the EV compensation required if the price increases simultaneously are Rp. 231,858/HH/month. This amount of EV compensation is smaller than CV compensation. A 20% increase in egg prices requires EV compensation of Rp. 9,493/HH/month. A 10% increase in chicken meat price requires compensation of Rp. 6,473/HH/month and a 5% increase in milk price require compensation of 3,127/HH/month. The animal food that requires the lowest EV compensation is marine fish. An increase in the price of marine fish by 10% requires an EV compensation of Rp.815/HH/month.

Other food is food that requires the largest EV compensation, namely Rp. 122,362 / HH/month. This is following the research results by Khoiriyah (2019) expenditure on other food is the second largest after grains if there is a 5% increase in other food prices. A large EV compensation is needed because the calculation of welfare changes refers to the share of household expenditure. They were judging from the results of data analysis, between CV and EV results in different values. CV is more than EV in absolute terms. So it can be concluded that EV compensation is more efficient for urban households in Indonesia than CV compensation. The smaller EV compensation indicates this compared to CV. One example of an EV policy is direct cash assistance (BLT). BLT is direct cash assistance provided to households. Through BLT, it is hoped that the target will be more accurate because the animal protein food aid is received directly by households. EV compensation helps households to return to their original income. This EV compensation replaces the income that is reduced as a result of an increase in price.

4. Conclusion

This research describes the impact of animal food prices on demand and consumer welfare in Indonesia's urban. The total sample is 133,873 households. The research data used the 2016 Household National Socio-Economic Survey (Susenas) data on household consumption and expenditure data collected by the Central Statistics Agency (BPS). Data analysis for the demand system uses the Linear-Approximation: Almost Ideal Demand System (LA-AIDS) approach and the study of changes in prices for changes in household welfare uses the Compensating Variation (CV) and Equivalent Variation (EV) approaches. The

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Table 6: Equivalent Variation of animal food, other food and non-food

Food & Non-food Items	W/O Subst*	Subst Only**	W/ Subst***	Price changes (%)
	Rp/household/month			
ALL Items	**-245,532**	**13,676**	**-231,858**	
Sea fish	-858	44	-815	10
Chicken meat	-7,015	540	-6,473	10
Beef	-2,382	184	-2,198	10
Eggs	-10,876	1,384	-9,493	20
Milk	-3,296	169	-3,127	5
Other Protein	-1,721	90	-1,633	5
Other Food	-90,411	4,654	-85,759	5
Non Food	-128,974	6,614	-122,362	5
TOTAL (household)	**-245,532**	**13,676**	**-231,858**	

Source: Author's computations based on Susenas 2018
Note: *=w/o subts = without substitution
**=Subst Only = substitution only
***=w/ subts = with substitution

results showed that the meat group was the most elastic animal food with a demand elasticity of 13,936%, followed by milk (0.991%), sea fish (0.649%), eggs (0.284%), and chicken meat (0.057%) in Indonesian urban households. Beef is a substitute for sea fish and eggs. Beef with chicken and milk is complimentary. In the substitution effect shown by the Hicksian price elasticity, the result shows that all animal food is inelastic, meaning that a 1% price increase causes a decrease in demand of less than 1% unless beef is very elastic. The 1% increase in beef prices caused demand to fall by 4.145%. Compared to other animal foods, the 1% price increase for marine fish, chicken meat, eggs, and milk causes a decrease in demand by 0.058%, 0.387%, 0.902%, and 0.384%, respectively. All animal food is a luxury item except sea fish, a standard item. In the long term, the highest marginal expenditure share is sea fish at 0.592%, followed by milk (0.123%), beef (0.102%), eggs (0.078%), and the lowest is chicken meat at 0.012%. Beef has MES number three, but it is pretty big too.

Considering the substitution, the price increase simultaneously requires CV compensation of Rp. 244,830/HH/month. This CV compensation is smaller than without considering substitution. The largest CV compensation remains at the 5% increase in non-food prices, requiring Rp's CV compensation is Rp.129,138/HH/month. The second-largest compensation is the increase in other food prices by 5%, requiring CV compensation of Rp. 90,545/HH/month. Meanwhile, specifically in the animal food group, the largest compensation was for eggs, which increased by 20%, requiring Rp's CV compensation. 10,083 / HH / month. Then chicken meat, which has experienced a price increase of 10%, requires Rp's CV compensation is Rp. 6,852/HH/month. The 5% increase in milk prices requires CV compensation of Rp. 3,301/HH/month. Beef requires compensation of Rp. 6,852/HH/month and the smallest compensation is for marine fish. The 10% increase in the price of marine fish requires CV compensation of Rp. 859/HH/month.

In EV compensation, considering the substitution, the EV compensation required if the price increases simultaneously are Rp.231,858/HH/month. This amount of EV compensation is smaller than CV compensation. A 20% increase in egg prices requires an EV compensation of Rp.9,493/HH/month. A 10% increase in chicken meat price requires payment of Rp.6,473/HH/month, and a 5% increase in milk price requires payment of Rp.3,127/HH/month. The animal food that requires the lowest EV compensation is

sea fish. An increase in the price of marine fish by 10% requires an EV compensation of Rp. 815/HH/month. EV compensation is more effective than CV compensation.

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Author contributions

Ratya Anindita was responsible for data collection, literature review, forecasting analysis, and drafting the manuscript. Ana Arifatus Sa'diyah was responsible for translating the manuscript. Nikmatul Khoiriyah was responsible for editing the manuscript.

Conflict of interest:

The authors declare no conflict of interest.

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