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Estimating Household Price and Income Elasticities for Animal-Sourced Food: The Case of Bengkulu Province, Indonesia

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Abstract

Bengkulu is one of the provinces in Indonesia where household protein consumption is still below the national protein recommended allowance. This paper examines the effect of price, income and socio-demographic factors on household demand using the Quadratic Almost Ideal Demand System (QUAIDS) model and data from the Indonesian National Socio-Economic Survey (Susenas) in March 2021, which includes 5,079 households. The QUADS parameters were estimated using the Iterated Nonlinear Seemingly Unrelated Regression technique with theoretical restrictions imposed. The estimated parameters from the model were utilized to derive price and income elasticities for animal-derived foods. Empirically, it was found that fish is the most elastic animal-sourced food with a demand elasticity of 4.44%, followed by beef (2.78%), milk (1.94%), poultry (1.54%), and eggs (0.82%). Fish substitutes for beef, chicken, and eggs when prices increase but is complementary to milk. Four animal-sourced food groups, namely fish, beef, milk, and poultry, are luxury items, with income elasticities of 2.57%, 2.39%, 2.22%, and 1.36%, respectively. In contrast, eggs were found to be a normal good with an income elasticity of 0.53%. Fish and beef are very elastic; thus, the government can use pricing strategies and implement policy to increase poultry and eggs production so that daily protein requirements of 57 grams per capita per day are reached in Bengkulu province.

Keywords

Animal sourced food, Bengkulu Province, elasticity, QUAIDS.

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Introduction

The pattern of household consumption of animal-derived protein foods can be seen as one indicator that can be used to measure the level of household welfare (Tiberti and Tiberti (2018); Giwa and Choga (2020)). According to Jackson and Marks (1999) and Donkoh et al. (2014), households with high-income levels tend to have smaller food expenditures than those with lower levels. This generally confirms Engle's (1857) law, which notes an inversed relationship between income and the amount of expenditure on food. In addition, Khoiriyah et al. (2020) assert that households with higher income levels tend to have higher economic welfare, which leads to higher levels of non-food consumption, assuming that the nutrition and dietary requirements of the household are met. Prior to the COVID-19 pandemic, Indonesia was experiencing rapid economic growth; however, recent statistics reveal that GDP in the first quarter of 2020 slowed to around 3% (Paramashanti, 2020). According to the Asian Development Bank (2019), around 22 million Indonesians had already experienced hunger between 2016-2018. The decline in GDP growth and the shock placed on the global food system due to the COVID-19 pandemic could increase the prevalence of hunger in Indonesia in the future.

One of the key objectives of the Sustainable Development Goals (SDG) is to eradicate hunger and foster food and nutrition security in developing countries. Adequate protein consumption can be used to assess a community's nutritional status and the success of government policy regarding food, agriculture, and health (Ariani, 2010; Salvia

et al., 2019). However, studies focusing on household consumption patterns of animal-sourced food, specifically animal protein in Bengkulu province, are rare but can provide vital information regarding welfare and consumer response to price changes.

Efficient and reliable food elasticity estimates are essential tools used in developing policies geared toward improving consumer welfare and overall well-being, especially in developing nations. This is because elasticities offer an opportunity to study and understand consumer consumption behavior. For example, according to Singh et al. (2011) and Lokuge and Edirisinghe (2015), reliable price and income elasticities help to understand the relationship between prices and income as it relates to consumer demand. In addition, it can also be used to develop effective campaigns and marketing strategies to improve consumer welfare. Therefore, calculating elasticities for various animal-sourced food groups for Bengkulu province could help better understand consumer behavior and can be used as tools to develop effective policies that will help improve the well-being of households in the region.

The law of demand ascertains that there exists an inversed relationship between the price and quantity demanded of a good. The lower the price of an item, the more quantity demanded of those goods increases, and vice versa (Anindita, 2008; Akram, 2020). Apart from price, the demand for goods by consumers is influenced by many other factors, such as income, the price of other goods, tastes and preferences, and future expectations (Ackah and Appleton, 2007; Martin and Ivanic, 2016; Giwa and Choga, 2020). According to Wahyuni et al. (2016), three factors are most important in influencing household consumption: prices, income, and preferences. In addition, other demographic factors such as the area of residence, education level of household members, household size, habits, and culture are all determinants of household demand (Abramovsky et al., 2012; Giwa and Choga, 2020; Negi, 2018).

Research on food demand systems using the Quadratic Almost Ideal Demand System (QUAIDS) approach has been carried out in various countries, such as Italy (Jones and Mazzi, 1996), Brazil (Coelho and Aguiar, 2007), Nigeria (Elijah Obayelu et al., 2009), Kenya (Korir et al., 2018), Saudi Arabia (Al-Shuaibi, 2011; Alnafissa and Alderiny, 2019), Pakistan (Akram, 2020), and Indonesia (Umaroh and Pangaribowo, 2007; Anindita et al., 2019). Demand system studies have also been carried out by Anderson and Blundell (1983) in Canada, Hayes et al. (1990) in Japan, Henneberry and Hwang (2007) in South Korea, Ravikumar et al. (2000), Roley (1983) and Haag et al., (2009). However, similar studies are rarely found in Indonesia, especially in the Bengkulu province. Therefore, this study seeks to analyze the effect of prices, income and socio-demographic factors on animal-sourced food demand using the QUAIDS model. This study uses data on household consumption and expenditure on animal-sourced food. Data was collected by the Central Bureau of Statistics (BPS) from the 2021 Indonesian National Socio-Economic Survey (Susenas) of 5,037 households. Parameter estimates of the QUAIDS model with theoretical restrictions imposed were obtained using Iterated Nonlinear Seemingly Unrelated Regression (ITNL-SUR). Post-estimation, the parameter estimates of the QUAIDS are used to compute price and income elasticities. The estimated parameters will be used to calculate and interpret the animal-sourced food groups' own-price, cross-price, and income elasticities. Showing whether animal-sourced food is elastic, inelastic, or unitary elastic. The study results can be used to develop a policy geared towards improving animal protein consumption and food and nutrition security in Bengkulu province, Indonesia.

Materials and methods

Model specification: Quadratic Almost Ideal Demand System (QUAIDS)

The empirical literature is proliferated with studies regarding demand analysis. Over the last two decades, the almost ideal demand system (AIDS) model developed by Deaton and Muellbauer (1980) is one of the most widely used demand models. Although there are other functional forms in the empirical literature that can be used in demand analysis, the AIDS model remains popular among scholars due to it having many favorable properties. Such properties include aggregating perfectly over consumers, having a functional form consistent with available data, satisfying the axiom of choice exactly, and being relatively easy to estimate (Barnett and Seck, 2008). Additionally, the AIDS model allows for the theoretical restrictions of homogeneity and symmetry to be imposed on the parameters and tests empirically. Although many of the existing functional forms in the literature

possess many of the desirable properties noted above, only the AIDS model possesses all of them at the same time. However, demand analysis studies regarding households tend to favor the quadratic version of the AIDS model (QUAIDS) put forward by Banks et al. (1997). According to Banks et al. (1997), some consumer preferences are quadratic contrary to the linear form of the AIDS; therefore, the QUAIDS specification is more appropriate, especially when studying household demand. In addition, the QUAIDS is a theoretically consistent model and possesses all of the favourable demand properties of the traditional AIDS model.

Formally, the share equations of the QUAIDS model, according to Banks et al. (1997), are as follows:

$$\boldsymbol{w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} ln p_j + \beta_i ln \left[\frac{m}{a(p)}\right] + \frac{\lambda_i}{b(p)} \left\{ln \left[\frac{m}{a(p)}\right]\right\}^2 + \varepsilon_i} \quad (1)$$

Where:

w_i = a household's expenditure share for commodity i, and it is defined as

$$\boldsymbol{w_i \equiv \frac{p_i q_i}{m} and \sum_{i=1}^{n} w_i = 1} \quad (2)$$

q_i = the quantity of each commodity consumed

lnp_j = is the natural logarithm of the price of the j^{th} animal-sourced food commodity group

m = is the total household expenditure for animal-sourced food consumption

ln a(p) = is a price index given in natural logarithm, usually the stone price index given as $\ln p_j = \Sigma_{j=1} w_i \ln p_j$

b(p) = is a price aggregator, which is given as

$$b(p) = \prod_{t=1}^{k} p_i^{\beta_i}$$

ε_i = is a white noise error term

α_i, γ_{ij}, β_I and λ_i = are all parameters to be estimated in each share equation

In order to be consistent with demand theory, the theoretical restrictions of adding-up, homogeneity, and symmetry are imposed during estimation as follows:

- Adding-up: $\sum_{i=1}^{n} \boldsymbol{\alpha_1 = 1, \sum_{i=1}^{n} \beta_1 = 0}$, $\sum_{i=1}^{n} \boldsymbol{y_{ij} = 0, \sum_{i=1}^{n} \lambda_i = 0}$ (3)
- Homogeneity: $\sum_{i=1}^{n} \boldsymbol{y_{ij} = 0}$ (4)
- Symmetry: $\boldsymbol{\gamma_{ij} = \gamma_{ji}}$ (5)

Where i is for the i^{th} share equation and j is for the j^{th} commodity. Equation (1) highlights the traditional QUAIDS model. However, this specification does not consider any of the socio-demographic factors that might have an impact on household animal-sourced food demand. Socio-demographic factors can affect household behavior regarding demand and expenditure allocation among goods (Alboghdady and Alashry, 2010; Tefera et al., 2018). Therefore, they should be included and accounted for in the QUAIDS model highlighted in the equation (1). The 'demographic scaling' method was used to consider the effect of socio-demographic factors that might affect household demand for animal-sourced food in this study, as Poi (2012) suggested. In this approach, the effects of a change on the demographics are close to the effect of the price change of animal-sourced foods. Considering z as a vector of S household characteristics, z is a scalar representing the household size in the simplest case. Let $e^R(p,u)$ represent the expenditure function of a reference household with just a single adult. For each household, Ray's (1983) method uses an expenditure function of household characteristics without controlling for changes in consumption patterns. The second term control for a change in relative prices and actual goods consumed. Following Ray (1983) and Poi (2012), QUAIDS is parameterized as:

$$\boldsymbol{\overline{m_o}(z) \text{ as } \overline{m_o}(z) = 1 + \rho z} \quad (6)$$

Where $\overline{m_o}$ is income deflated by the equivalence scale and ρ is a vector of household characteristics parameters to be estimated. The expenditure share expenditure equation highlighted in equation (1) now takes the following form:

$$\boldsymbol{w_i = \alpha_i + \sum_{j=1}^{K} \gamma_{ij} ln p_j + (\beta_i + \eta_i' z) ln \left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\} + + \frac{\lambda_i}{b(p)c(p,z)} \left[ln \left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right]^2} \quad (7)$$

Where $\boldsymbol{c(p,z) = \prod_{j=1}^{k} p_j^{\eta_i' z}}$ (8)

Moreover, $\boldsymbol{\eta_i'}$ represents the j^{th} column of the s x k parameter matrix $\boldsymbol{\eta_i'}$ (Poi, 2012)[1].

The adding-up condition requires that $\boldsymbol{\sum_{j=1}^{K} \eta_i' = 0}$ for i = 1,….,s. (9)

The parameters are estimated by Iterated Nonlinear Seemingly Unrelated Regression (ITNL-SUR)

[1] Full details of how demographic parameters are incorporated into the QAIDS model is outline in Poi (2012) and Ray (1983).

technique in Stata 17. In order to avoid singularity of the variance co-variance matrix, one of the share equations for animal goods is excluded during estimation and then obtained using the adding-up restriction.

Now that a theoretically consistent and viable model is specified for estimating parameters, price and income elasticities can be calculated. Marshallian own-price and cross-price elasticities for each animal-sourced food group are derived using equations (10) and (11), respectively.

$$\varepsilon_{ii}^{M} = -\delta_{ij} + \frac{1}{w_i}\left(\gamma_{ij}\left[\beta_i + \eta_i' z + \frac{2\lambda_i}{b(p)c(p,z)} ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right] * \right.$$
$$\left. * \left(\alpha_j + \sum_1 \gamma_{ij} lnp_j\right) - \frac{(\beta_i+\eta_i' z)\lambda_i}{b(p)c(p,z)}\left[ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right]^2\right) \quad (10)$$

$$\varepsilon_{ij}^{M} = -\delta_{ij} + \frac{1}{w_i}\left(\gamma_{ij}\left[\beta_i + \eta_i' z + \frac{2\lambda_i}{b(p)c(p,z)} ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right] * \right.$$
$$\left. * \left(\alpha_j + \sum_1 \gamma_{ij} lnp_j\right) - \frac{(\beta_i+\eta_i' z)\lambda_i}{b(p)c(p,z)}\left[ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right]^2\right) \quad (11)$$

All of the parameters in equations (10) and (11) are previously defined, except ε_{ii}^{M} and ε_{ij}^{M} which are own- and cross-price elasticities, respectively. Delta (δ_{ij}) is the Kronecker delta which takes the value of 1 if we are calculating own-price elasticity and zero otherwise. Marshallian own-price elasticities measure the changes in quantity demanded of a particular animal-sourced food group due to changes in its price. In contrast, cross-price measures the changes in quantity demanded of a particular animal-sourced food group due to changes in the price of another animal-sourced food group. The expenditure or income elasticity for each animal-sourced food group is also calculated by using the formula highlighted in equation (12) below:

$$\varepsilon_{ii}^{c} = \varepsilon_{ii} + \mu_i w_i \quad (13)$$

$$\varepsilon_{ij}^{c} = \varepsilon_{ij} + \mu_i w_j \quad (14)$$

All parameters are defined in equations (13) and (14) previously, except ε_{ii}^{c} and ε_{ij}^{c} which are Hicksian own- and cross-prices elasticities.

Data and source

The data used in this article is secondary data from the National Socio-economic Survey (Susenas) in March 2021. The data analyzed were household consumption and expenditure on animal-sourced food groups, region (urban and rural), the number of household members or household size, and total expenditure on all animal-sourced food groups. The approach used to obtain data on animal-sourced food prices is the ratio of the amount of animal-sourced food consumed by households divided by the price paid by households. This is because price data are not available on household consumption and expenditure. The animal-sourced food groups included in this study were eggs (chicken eggs, local chicken eggs, and duck eggs), poultry (local chicken meat and chicken meat), beef, fish (fresh fish and shrimp including fish, shrimp, squid, and shellfish) as well as milk (milk powder and infant milk). The sample of this research is 5,079 households. All estimation was done in STATA 17.

Results and discussion

Estimated parameters of animal-sourced food demand system models

The results of the QUAIDS model with socio-demographic factors and theoretical restrictions imposed for the five animal-sourced food groups are presented in Table 1, which was derived using equation (7). From Table 1, it can be observed that most of the estimated parameters are highly statistically significant. The effect of the own-price variables in each of the respective share equations was found to be positive and highly statistically significant, except for the fish share equation, which was found to be negative. Furthermore, ceteris paribus, it is suggested that a 1% increase in the price of eggs, poultry, beef, and milk is expected to, on average, bring about a 0.389%, 0.568%, 0.060%, and 0.146% increase in expenditure share, respectively. These results are similar to those found by Kharisma et al. (2020), who note that own-price tends to have a direct relationship with expenditure share. However, for the fish share equation, it is suggested that a 1% increase in the price of fish is expected to bring about, on average, a 0.052% decrease in expenditure share, ceteris paribus. Similar results for fish were found by Nendissa et al. (2021). Poultry share had the most responsiveness to changes in price with respect to expenditure share, while beef had the least response.

Table 1 also highlights the income variable for each animal-sourced food share equation. The parameters associated with income in each share equation were found to be highly statistically significant. It was discovered that an increase in household income is expected to increase the expenditure shares of eggs, beef, and milk but a decrease in the expenditure share of poultry and fish. According to Hayat et al. (2016), an increase in the income of households

is expected to increase the demand for dairy and meat products. Regarding the negative relationship between income, poultry and fish, similar results were also found by Kharisma et al. (2020), who notes that this is likely to occur when household income shifts the demand towards more expensive sources of animal-sourced food such as meat and milk. In addition, the results for poultry and fish validate Bennet's Law in Bengkulu province, Indonesia, which states that higher household income levels tend to shift consumption towards better quality foods. According to Rathnayaka (2019), a negative sign attached to the income variable usually means the good is a necessity, while a positive sign means that the good is a luxury good. Hence, the negative sign attached to the income variable in both the poultry and fish share equation suggests that these foods are necessities. In contrast, other animal-sourced food groups are luxuries.

The study also investigated the impact of socio-demographic factors on animal-sourced food expenditure share, which is presented in Table 1. A regional dummy variable was added to each expenditure share equation to determine if there is any difference in animal-sourced food expenditure share between households living in rural areas and those living in urban areas. It was found that households living in urban areas have a higher expenditure share on eggs, beef, and fish than those in rural areas. However, households living in urban areas have less poultry and milk expenditure compared to rural households. The results for poultry and milk show that these animal-sourced food groups play a significant role in fulfilling nutritional requirements in rural areas in Bengkulu. The other socio-demographic factor added to each share equation was the household size which was defined as the number of persons living in the home of each household. It was found that household size statistically impacted the expenditure share of each animal-sourced food group. However, the effect size based on the magnitude of the estimated parameter was relatively small. In addition, it was found that household size negatively affected expenditure shares for eggs and milk. This suggests that expenditure on eggs and milk decreases as household size increases. Deaton and Paxson (1998) note that households with more members consume less food. Abdulai (2002) notes that household parameters negatively affect consumption as large families are often forced to adjust consumption patterns and purchase relatively cheaper foods. This could be because households with more people have more diverse diets and are less likely to purchase eggs and milk as income is allocated toward purchasing

Parameter	Animal Sourced Food Share Equation				
	Eggs Share	Poultry Share	Beef Share	Fish Share	Milk Share
Constant	0.566*** (0.017)	-1.341*** (0.022)	0.728*** (0.011)	0.018 (0.013)	1.028*** (0.014)
Eggs Price	0.398*** (0.003)	-0.259*** (0.003)	-0.006*** (0.005)	-0.039*** (0.001)	-0.095*** (0.011)
Poultry Price	-0.259*** (0.005)	0.568*** (0.011)	-0.192*** (0.005)	0.070*** (0.005)	-0.187*** (0.007)
Beef Price	-0.006** (0.005)	-0.192*** (0.005)	0.060*** (0.003)	0.012*** (0.002)	0.127*** (0.003)
Fish Price	-0.039*** (0.001)	0.070*** (0.005)	0.012*** (0.002)	-0.052*** (0.001)	0.009*** (0.002)
Milk Price	-0.095*** (0.011)	-0.187*** (0.007)	0.127*** (0.003)	0.009*** (0.002)	0.146*** (0.006)
Expenditure	0.045*** (0.003)	-0.318*** (0.003)	0.122*** (0.002)	-0.012*** (0.002)	0.162*** (0.003)
Expenditure2	0.015*** (0.000)	-0.021*** (0.000)	0.005*** (0.000)	-0.002*** (0.000)	0.003*** (0.000)
Region (Urban =1)	0.002*** (0.000)	-0.004*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	-0.001*** (0.000)
Household Size	-0.001*** (0.000)	0.001*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	-0.001*** (0.000)

Note: *** p <0.01, ** p <0.05, * p <0.1. Standard errors in parentheses
Source: Own calculation based on data from Susenas, March 2021

Table 1: Parameter estimates of QUAIDS models for animal sourced food demand.

other preferred foods or affordable items. It was also found that household size positively affected poultry, beef, and fish expenditure share. These results are not surprising as poultry, beef, and fish are significant protein sources in Bengkulu; therefore, having more household members would mean that expenditure would increase on these animal-sourced foods.

Marshallian price elasticities

Having reliable price and income elasticities available can help to understand household consumption patterns and behavior. This can then help develop and implement an effective policy geared towards improving household welfare and overall well-being. Using the estimated parameters in Table 1, we calculate price and income elasticities for a household in Bengkulu province. Marshallian or uncompensated price elasticity has a price and income effect. It measures the degree of responsiveness of the quantity demand and demand due to changes in prices and income. Table 2 presents the Marshallian own-price and cross-price elasticities for animal-sourced foods in Bengkulu province. In Table 2, Marshallian own-prices elasticities are given on the diagonal. All own-price elasticities for animal-source food groups are statistically significant at the 1% level and carry the expected negative sign, which is consistent with the law of demand, which states that there is an inversed relationship between prices and quantity demanded. It must be noted that although there is a negative sign attached to the own-price elasticities, interpretation ignores this negative sign and considers the elasticity value in absolute terms. In addition, an elasticity value greater than one in absolute terms would mean that the good in question has elastic demand or is very responsive to changes in its price. In contrast, a good with an elasticity value less than one in absolute terms would suggest that the good has inelastic demand or is less responsive to changes in its price. Elasticity values are also interpreted with the ceteris paribus assumption. For instance, in Bengkulu province, the own-price elasticity for eggs was found to be 0.82. Therefore, ceteris paribus, a 1% change (increase or decrease) in the price of eggs is expected to bring about, on average, a 0.82% change (decrease or increase) in the number of eggs demanded by households in Bengkulu province.

In Bengkulu province, all animal-sourced food groups were found to have elastic demand, or they are highly responsive to changes in prices, except for eggs which were found to have inelastic demand. Fish was found to be the most elastic animal-sourced food among all animal-sourced foods, with a demand elasticity of 4.44, which means that a 1% change in fish prices is expected to bring about, on average a 4.44% change in the quantity of fish demanded by households in Bengkulu province. This result is similar to those found by Nendissa et al. (2021) and Rianti and Khoiriyah (2021), who notes that fish had highly elastic demand. However, finding fish to be the most elastic among all other animal-sourced food groups is interesting for Bengkulu province since previous studies were done in different parts of Indonesia, see Rianti and Khoiriyah (2021), Khoiriyah et al., (2019), Khoiriyah et al., (2020) and Maula et al., (2019), found beef to be most elastic animal-sourced food group among other sources of animal-sourced food. This result for Bengkulu might be explained by the fact that the monthly per capita expenditure of fish/shrimp/shellfish/squid is Rp. 36,238, meat

Food Group	Eggs	Poultry	Beef	Fish	Milk
Eggs	**-0.816**	0.162	0.026	0.032	0.064
	(0.003)	(0.003)	(0.001)	(0.002)	(0.002)
Poultry	-0.155	**-1.539**	0.080	0.091	0.159
	(0.006)	**(0.007)**	(0.003)	(0.003)	(0.004)
Beef	-0.327	0.826	**-2.778**	0.544	-0.655
	(0.038)	(0.039)	**(0.044)**	(0.028)	(0.035)
Fish	-0.516	1.564	0.779	**-4.444**	0.047
	(0.055)	(0.057)	(0.037)	**(0.050)**	(0.047)
Milk	-0.511	0.424	-0.177	-0.015	**-1.941**
	(0.016)	(0.017)	(0.010)	(0.010)	**(0.018)**

Note: Standard errors in parentheses.
Source: Own calculation based on data from Susenas, March 2021.

Table 2: Marshallian own-price and cross-price elasticities.

group of Rp. 16,594, eggs, and milk Rp. 25,428. Bengkulu fish group expenditure is far higher than the average national expenditure of only Rp. 33,620 (BPS, 2019). Whereas the consumption of some animal-sourced foods in Indonesia is Rp. 67,237. Beef was also found to have high responsiveness to changes in price, followed by milk and poultry, which have own-price elasticities of 2.78%, 1.94%, and 1.54%, respectively.

Table 2 also shows the cross-price elasticity of animal-sourced food. Cross-price elasticity is used to explain the relationship that exists between two goods. It looks at how changes in the price of one good affect the demand for another good. It speaks to whether the relationship between two goods is substitution or complementary. A positive cross-price elasticity would suggest that both goods are substitutes. However, a negative cross-price elasticity would suggest that both goods might be complements. Substitute good tend to have inversed relationships; that is, changes (increase or decrease) in the price of one good is expected to bring about changes (decrease or increase) in demand for another. Complementary goods, on the other hand, tend to have a direct relationship in that a change (increase or decrease) in the price of one good is expected to bring about a change (increase or decrease) in demand for another good. For Bengkulu province, cross-price elasticities were primarily positive, suggesting that substitution relationships existed among various animal good groups. For instance, fish has substitution relationships with beef, poultry, and eggs but is complementary with milk. A 1% increase in the price of fish is expected to increase the household demand for beef by around 0.54%, while a 1% increase in the price of fish is expected to decrease household milk demand by around 0.01% on average. A 1% increase in beef price increases household demand for fish by around 0.78%. It means the substitute for beef is fish in Bengkulu province. Poultry meat was found to have substitution relationship with all other animal-sourced food sources. An increase in the price of poultry meat by 1% increased household demand for fish by 1.56%, beef by 0.83%, milk by 0.42%, and egg by 0.16%.

Hicksian price elasticities

Hicksian or compensated price elasticity are elasticities when there is only the effect of price changes. Hence, they are often referred to as elasticity of substitution. In addition, unlike Marshallian elasticities, which have both price and income effects, Hicksian price elasticities only have price effects which means that their magnitude tends to be smaller than Marshallian elasticities. Table 3 presents Hicksian own-price and cross-price elasticities. All calculated Hicksian own-price elasticities were statistically significant and possessed the appropriate negative sign. For Bengkulu province, it was discovered that fish had the greatest response to price changes, as a 1% increase in prices, for instance, is expected to bring about, on average, a 4.40% decrease in the quantity of fish consumed by households. Beef had the second highest own-price elasticity, followed by milk and poultry. The four aforementioned animal-sourced food groups were found to have elastic demand since the elasticity values were greater than unity. However, eggs were found to have the smallest Hicksian own-price elasticity, which was 0.51. Therefore, a 1% increase in the price of eggs is expected to, on average, bring about a 0.51% decrease in household consumption. Furthermore, in Bengkulu province, eggs were

Food Group	Eggs	Poultry	Beef	Fish	Milk
Eggs	**-0.514**	0.330	0.038	0.041	0.106
	(0.003)	(0.003)	(0.001)	(0.002)	(0.002)
Poultry	0.620	**-1.110**	0.111	0.114	0.265
	(0.006)	**(0.007)**	(0.003)	(0.003)	(0.004)
Beef	1.032	1.579	**-2.724**	0.584	-0.470
	(0.038)	(0.039)	**(0.044)**	(0.028)	(0.035)
Fish	0.946	2.373	0.836	**-4.401**	0.246
	(0.054)	(0.057)	(0.037)	**(0.050)**	(0.047)
Milk	0.751	1.123	-0.127	0.022	**-1.769**
	(0.015)	(0.017)	(0.010)	(0.010)	**(0.018)**

Note: Standard errors in parentheses.
Source: Own calculation based on data from Susenas, March 2021.

Table 3: Hicksian own-price and cross-price elasticities.

found to have inelastic demand.

Table 3 also presents Hicksian cross-price elasticities for animal-sourced food in Bengkulu province. The results show that there exist mainly substitution relationships between pairs of animal-sourced food. Most cross-price elasticities are positive, which means that an increase in the price of a particular animal-sourced food group would experience a decrease in household consumption in Bengkulu province as households would substitute that particular animal-sourced food with other relatively cheaper sources of animal-sourced. In addition, the results suggest that the price of a particular animal-sourced food strongly influences household consumption demand for other animal-sourced food in Bengkulu. For instance, it was found that beef and poultry are substitutes which means that a 1% increase in the price of beef is expected to bring about, on average, a 0.11% increase in household consumption demand for poultry because as the price of beef increases and poultry prices remains unchanged, poultry becomes relatively cheaper than beef, and so households would substitute beef for poultry. In addition, fish is substituted with all other animal-sourced foods. Therefore, an increase in fish prices by 1% increases household consumption of beef, eggs, poultry, and milk by about 0.58%, 0.41%, 0.11%, and 0.02%, respectively. However, it must be noted that beef and milk were found to be complements in Bengkulu province. This is because an increase in household consumption of beef would mean that more cattle would be produced, which would mean more milk would also be produced. Therefore, an increase in milk production might cause the price of milk to decrease, which makes it more affordable to Bengkulu households, thereby increasing the consumption demand for milk.

Income elasticity and marginal expenditure share

Income is an important factor in the demand for goods and services. Income elasticity measures how demand changes as income changes. Generally speaking, it is expected that when income increases, consumer welfare improves so that they will demand more of a good. For instance, if the good is normal, there is a direct relationship between income and consumption. The income elasticity, therefore, is expected to be positive. This means that if income increases, demand for that product also increases. However, if a good is an inferior good, then there is usually an inversed relationship between income and consumption of that particular good. Hence, the income elasticity is expected to be negative because an increase in income is expected to decrease the demand for that particular good. Therefore, when it comes to Bengkulu province, all sources of animal-sourced food can be classified as normal goods as the income elasticity values are positive. Furthermore, income elasticity values greater than one would signify that the good in question is a luxury good. Income elasticity results presented in Table 4 show that fish, beef, milk, and poultry are luxuries as their income elasticities are all greater than one. For instance, fish had the highest income elasticity value, which was 2.57. This means that a 1% increase in household income is expected to bring about, on average, a 2.57% increase in household consumption demand for fish products. This result is similar to what was found by Nendissa et al. (2021) in their study of household animal-sourced food consumption in East Nusa Tenggara, Indonesia. Regarding beef, milk, poultry, and eggs, a 1% increase in household income is expected to bring about a 2.39%, 2.22%, 1.36%, and 0.53% increase in household consumption expenditure on those food groups, respectively.

Table 4 also presents the value of marginal expenditure shares (MES). The MES is used to see the long-term effects of changes in income on household expenditure for animal-sourced food (Barigozzi et al., 2012). The MES multiplies expenditure elasticity and budget share for each animal-sourced food. The results of the calculation of MES show that households in Bengkulu province allocate their income more proportionally to beef and milk. Since beef is an animal-sourced food that is luxurious and highly elastic, the local government needs to work to reduce the price of beef so that consumption increases.

Food Group	Income Elasticity	Marginal Expenditure Share
Eggs	0.532	0.474
Poultry	1.364	0.301
Beef	2.393	0.076
Fish	2.574	0.643
Milk	2.219	0.071

Source: Own calculation based on data from Susenas, March 2021.

Table 4: income elasticity and marginal expenditure share of animal sourced food.

Policy discussion

Price elasticity of demand reveals that household fish consumption has elastic demand, which means

that consumption is highly responsive to price changes. Fish makes up a large portion of household protein consumption. According to Kharisma et al. (2020), fish consumption contributes to around 26.8% of calories derived from animal sources daily and around 2.1% of total daily calorie intake. Regarding protein consumption derived from animal-sources, in 2017, fish accounted for more than 50% of daily protein consumption. Therefore, price increases for this animal-sourced protein food group have severe implications for household food and nutrition security, especially for individuals living in rural areas. Cross-price elasticities reveal that when fish prices increase, households will substitute other sources of animal-derived proteins such as eggs, poultry, and beef. Results suggest that households' demand for poultry products will increase significantly when fish prices increase. However, if poultry supply cannot accommodate the demand increase, protein deficiency in households can be a severe problem.

Eggs were found to be least responsive to price changes, supported by price inelastic demand. Therefore, changes in egg prices lead to a less than proportionate change in the quantity demanded. Eggs are also found to be substitutes for all other animal sources of protein. According to Vanany et al. (2019), eggs are more regularly consumed than other sources of animal-derived proteins in Indonesia. This could be due to eggs being much cheaper than commodities like fish and beef in Indonesia; hence, it is expected that price increases of other animal-derived protein groups will lead to increased consumption of eggs as a source of protein. In addition, a policy to increase egg production would also aid in increasing poultry production, which has also been found to have a substation relationship with protein sources such as beef and fish. Therefore, policy regarding poultry and egg production must be developed and put in place to ensure that demand can be met since achieving daily protein dietary requirements is paramount. Shaffer (2015) notes that broiler and egg production has increased over the last few years; however, avian influenza has negatively affected production in 2015 and 2016. In order to aid domestic production of poultry and eggs, reliable biosecurity and hygiene concepts should be established to avoid severe outbreaks of diseases and to ensure good performance conditions (Ali, 2014).

In general, the own-price elasticity values were greater than income elasticities, especially for fish, beef, and eggs. This means that the most effective policy to help improve household consumption of these animal-sourced food groups would be to lower the price of these items. Government and policy officials in Bengkulu can offer subsidies to producers of fish, beef, and eggs to help cover production costs, incentivizing them to sell these animal-sourced foods at lower prices to consumers. Fish and beef had the highest own-price elasticities, which means that they are very responsive to price changes. Therefore, to foster increased consumption levels of these two animal-sourced food groups among households, the government and policy officials can use pricing strategies such as a price ceiling to set a maximum price at which these goods can be sold to help households attain higher levels of consumption. Regarding poultry and milk, income elasticities are generally larger in magnitude than own-price elasticities; hence, in order to increase consumption of these two animal-sourced food groups, it is suggested that household income should be increased. This can be done through social welfare programs and maybe food grants which would help improve household welfare in Bengkulu province. In addition, households with more individuals can be given food grants to help improve animal-sourced food consumption. These schemes can help to improve animal protein food and nutrition security and help to foster community resilience in Bengkulu province.

Conclusion

This paper focused on analyzing animal-sourced food demand in Bengkulu province, Indonesia. This study aims to analyze the impact of changes in prices, incomes, and socio-demographic factors on animal-sourced food demand. The study utilized the Quadratic Almost Ideal Demand System (QUAIDS) model with theoretical restrictions imposed and estimated using the ITNL-SUR technique. The data used was BPS data from the 2021 Susenas data of 5,079 households. Data were analyzed using Stata 17 software. The QUAIDS model results reveal that prices, income, region of residence and household size all affected household consumption expenditure share of various animal-sourced foods. It was discovered that urban households consume more eggs, fish, and beef than rural households. However, urban households' consumption expenditure on poultry and milk is less than that of rural households. It was also discovered that household size positively affects poultry, beef and fish expenditure share while negatively impacting the expenditure

shares of eggs and milk in Bengkulu province. The study also calculated price and income elasticities for various animal-sourced foods. The results showed that in Bengkulu province, fish is the most elastic animal-sourced food among all animal-sourced foods, with an own-price demand elasticity of 4.44%. This was then followed by beef (2.78%), milk (1.94%), poultry (1.54%), and eggs (0.82%). All animal-sourced food groups were found to have elastic demand except for eggs which were found to have inelastic demand. Based on Marshallian cross-price elasticities, various substitution and complementary relationships were found to exist among animal-sourced food groups. For instance, fish is a substitute for beef, poultry, and eggs but is complementary to milk. Hicksian elasticities highlighted that most substitution relationships existed among various animal-sourced food groups. However, it was found that beef and milk were complementary goods. Income elasticity estimates reveal that all animal-sourced food groups in Bengkulu province are normal goods. However, beef, fish, poultry, and milk were found to be luxury goods. Fish were the most responsive to changes in income, with an income elasticity of 2.57%, while eggs were the least responsive to changes in income, with an elasticity of 0.53%. Finally, the study also calculated MES, which showed that households in Bengkulu province allocate their income more proportionally to beef and milk.

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References

[1] Ali, D. O. (2014) "Biosecurity in Layer Farms", *Zootechnica International*, Vol. 2. ISSN 0392-0593.

[2] Asian Development Bank (2019) "*Policies to Support Investment Requirements of Indonesia's Food and Agriculture Development during 2020-2045*", Asian Development Bank. DOI 10.22617/TCS190447-2.

[3] Abramovsky, L., Attanasio, O. and Phillips, D. (2012) "Demand responses to changes in consumer prices in Mexico: Lessons for policy and an application to the 2010 Mexican tax reforms", Royal Economic Society Conference Paper.

[4] Abdulai, A. (2002) "Household Demand for Food in Switzerland. A Quadratic Almost Ideal Demand System", *Swiss Journal of Economics and Statistics (SJES)*, Vol. 138, No. 1, pp. 1-18. ISSN 2235-6282.

[5] Ackah, C. and Appleton, S. (2007) "Food price changes and consumer welfare in Ghana in the 1990s", CREDIT Research Paper.

[6] Akram, N. (2020) "Household's demand for Food Commodities in Pakistan: Issues and Empirical Evidence", *Estudios de Economía*, Vol. 47, No. 1, pp. 127-145. ISSN 0304-2758. DOI 10.4067/S0718-52862020000100127.

[7] Alboghdady, M. A. and Alashry, M. K. (2010) "The demand for meat in Egypt: An almost ideal estimation", *African Journal of Agricultural and Resource Economics*, Vol. 4, No. 1, pp. 70-81. ISSN 1993-3738. DOI 10.22004/ag.econ.93884.

[8] Alnafissa, M. and Alderiny, M. (2019) "Analysis of Saudi demand for imported honey using an Almost Ideal Demand System (AIDS)", *Journal of the Saudi Society of Agricultural Sciences*, Vol. 19, No. 4, pp. 293-298. ISSN 1658-077X. DOI 10.1016/j.jssas.2019.05.001.

[9] Al-Shuaibi, A. M. (2011) "An Economic Study of the Demand for Red meat in the Kingdom of Saudi Arabia using almost Ideal demand system", *Trends in Agricultural Economics*, Vol. 4, No. 1, pp. 30-40. ISSN 1994-7933. DOI 10.3923/tae.2011.30.40.

[10] Anderson, G. and Blundell, R. (1983) "Testing restrictions in a flexible dynamic demand system: An application to consumers' expenditure in Canada", *The Review of Economic Studies*, Vol. 50, No. 4, pp. 397-410. E-ISSN 1467-937X, ISSN 0034-6527.

[11] Anindita, R. (2008) "Pendekatan Ekonomi Untuk Analisis Harga", Prenada Media Group, Jakarta. 117 p. ISBN 9789791486453. (In Indonesian).

[12] Anindita, R., Sadiyah, A. A., Khoiriyah, N. and Nendyssa, D. R. (2020) "The demand for beef in Indonesian urban", In *IOP Conference Series: Earth and Environmental Science*, Vol. 411, No. 1. ISSN 1755-1307. DOI 10.1088/1755-1315/411/1/012057.

[13] Banks, J., Blundell, R. and Lewbel, A. (1997) "Quadratic Engel curves and consumer demand", *Review of Economics and Statistics*, Vol. 79, No. 4, pp. 527-539. E-ISSN 1530-9142, ISSN 0034-6535. DOI 10.1162/003465397557015.

[14] Barnett, W. A. and Seck, O. (2008) "Rotterdam model versus almost ideal demand system: will the best specification please stand up?", *Journal of Applied Econometrics*, Vol. 23, N0. 6, pp.795 -824. E-ISSN 1099-1255. DOI 10.1002/jae.1009.

[15] Barigozzi, M., Alessi, L., Capasso, M. and Fagiolo, G. (2012) "The distribution of household consumption-expenditure budget shares", S*tructural Change and Economic Dynamics*, Vol. 23, No. 1, pp. 69-91. ISSN 0954-349X. DOI 10.1016/j.strueco.2011.09.003.

[16] Coelho, A. B. and de Aguiar, D. (2007) "O modelo quadratic almost ideal demand system (quaids): Uma aplicação para o brasil", In: *Gasto e Consumo Das Famílias Brasileiras Contemporâneas*, Vol. 2, Brasilia, book, pp. 485-514. ISBN 10 85-86170-85-2. (In Portuguese).

[17] Deaton, A. and Muellbauer, J. (1980) "An almost ideal demand system", *The American Economic Review*, Vol. 70, No. 3, pp. 312-326. ISSN 0002-8282.

[18] Deaton, A. and Paxson, C. (1998) "Economies of Scale, Household Size, and The Demand for Food", *Journal of Political Economy*, Vol. 106, No. 5, pp. 897-930. ISSN 0022-3808. DOI 10.1086/250035.

[19] Donkoh, S. A., Alhassan, H. and Nkegbe, P. K. (2014) "Food expenditure and household welfare in Ghana", *African Journal of Food Science*, Vol. 8, No. 3, pp. 164-175. ISSN 1996-0794. DOI 10.5897/AFSF2013.1120.

[20] Elijah Obayelu, A., Okoruwa, V. O., and Ajani, O. I. Y. (2009) "Cross-sectional analysis of food demand in the North Central, Nigeria: The quadratic almost ideal demand system (QUAIDS) approach", *China Agricultural Economic Review*, Vol. 1. No. 2, pp. 173-193. ISSN 1756-137X. DOI 10.1108/17561370910927426.

[21] Engel, E. (1857) "*Die Productions-und Consumptions verhaltnisse des Konigreichs Sachsen*. [The Production and Consumption Conditions of the Kingdom of Saxony], reprinted, 1895. Engel's Die Lebenskosten belgischer Atbeiter-Familien.

[22] Giwa, F. and Choga, I. (2020) "The Impact of Food Price Changes and Food Insecurity on Economic Welfare: A Case of Selected Southern African Countries", *Journal of Reviews on Global Economics*, Vol. 9, pp. 77-93. ISSN 1929-7092. DOI 10.6000/1929-7092.2020.09.08.

[23] Haag, B. R., Hoderlein, S. and Pendakur, K. (2009) "Testing and imposing Slutsky symmetry in nonparametric demand systems", *Journal of Econometrics*, Vol. 153, No. 1, pp. 33-50. ISSN 0304-4076. DOI 10.1016/j.jeconom.2009.04.003.

[24] Hayat, N., Hussain, A. and Yousaf, H. (2016) "Food demand in Pakistan: Analysis and projections", *South Asia Economic Journal*, Vol. 17, No. 1, pp. 94-113. ISSN 0973-077X. DOI 10.1177/1391561415621.

[25] Hayes, D. J., Wahl, T. I. and Williams, G. W. (1990) "Testing restrictions on a model of Japanese meat demand", *American Journal of Agricultural Economics*, Vol. 72, No. 3, pp. 556-566. ISSN 0002-9092. DOI 10.2307/1243024.

[26] Henneberry, S. R. and Hwang, S. (2007) "Meat demand in South Korea: An application of the restricted source-differentiated almost ideal demand system model", *Journal of Agricultural and Applied Economics*, Vol. 39, No. 1, pp. 47-60. ISSN 1074-0708. DOI 10.1017/S1074070800022744.

[27] Jackson, T. and Marks, N. (1999) "Consumption, sustainable welfare and human needs - with reference to UK expenditure patterns between 1954 and 1994", *Ecological Economics*, Vol. 28, No. 3, pp. 421-441. ISSN 0921-8009. DOI 10.1016/S0921-8009(98)00108-6.

[28] Jones, A. and Mazzi, M. G. (1996) "Tobacco consumption and taxation in Italy: An application of the QUAIDS model", *Applied Economics*, Vol. 28, No. 5, pp. 595-603. E-ISSN 0003-6846, ISSN 1466-4283. DOI 10.1080/00036849600000039.

[29] Kharisma, B., Alisjahbana, A. S., Remi, S. S. and Praditya, P. (2020) "Application of the Quadratic Almost Ideal Demand System (QUAIDS) Model in the Demand of the Household Animal Sourced Food in West Java", *AGRIS on-line Papers in Economics and Informatics*, Vol. 12, No. 1, pp. 23-35. ISSN 1804-1930. DOI 10.7160/aol.2020.120103.

[30] Khoiriyah, N., Anindita, R., Hanani, N., and Muhaimin, A. W. (2018) "Permintaan Pangan Hewani Di Pedesaan Jawa Timur, Indonesia", *Jurnal Ketahanan Pangan*, Vol. 2, No. 2, pp. 198-207. ISSN 2654-2811. (In Idonesian).

[31] Khoiriyah, N., Anindita, R., Hanani, N., and Muhaimin, A. W. (2019) "Animal Food Demand in Indonesian Rural: A Quadratic Almost Ideal Demand System Approach", *WACANA: Jurnal Sosial dan Humaniora*, Vol. 22, No. 2. E-ISSN 2338-1884, ISSN 1411-0199.

[32] Khoiriyah, N., Anindita, R., Hanani, N., and Muhaimin, A. W. (2020) "Impacts of Rising Animal Food Prices on Demand and Poverty in Indonesia", Agricultural Socio-Economics Journal, Vol. 20, No. 1, pp. 65-76. E-ISSN 2252-6757, ISSN 1412-1425. DOI 10.21776/ub.agrise.2020.20.1.9.

[33] Korir, L., Rizov, M. and Ruto, E. (2018) "Analysis of household food demand and its implications on food security in Kenya: An application of QUAIDS model", *92nd annual conference, April 16-18, 2018*, Warwick University, Coventry, UK. 20 p. DOI 10.22004/ag.econ.273474.

[34] Lokuge, L. D. M. N. and Edirisinghe, J. C. (2015) "Econometric analysis of the demand for pulses in Sri Lanka: an almost ideal estimation with a censored regression", *Journal of Agriculture and Environment for International Development (JAEID)*, Vol. 109, No. 1, pp. 41-53. E-ISSN 2240-2802. DOI 10.12895/jaeid.20151.225.

[35] Martin, W. and Ivanic, M. (2016) "Food Price Changes, Price Insulation, and Their Impacts on Global and Domestic Poverty", chapter, In: Food Price Volatility and Its Implications for Food Security and Policy, pp. 101-113. E-ISBN 978-3-319-28201-5, ISBN 978-3-319-28199-5. DOI 10.1007/978-3-319-28201-5_5.

[36] Maula, L. R., Anindita, R., Rianti, T. S. M., Pratama, A. R. and Khoiriyah, N. (2019) "Demand for Animal Food in The Rural and Urban of Maluku, Indonesia", *Proceeding of the 2nd International Conference on Food and Agriculture*, Vol. 2, No. 1. ISBN 9786021491799.

[37] Paramashanti, B. A. (2020) "Challenges for Indonesia zero hunger agenda in the context of COVID-19 pandemic", *Kesmas: Jurnal Kesehatan Masyarakat Nasional (National Public Health Journal)*. E-ISSN 2460-0601, ISSN 1907-7505. DOI 10.21109/kesmas.v15i2.3934.

[38] Negi, D. S. (2018) "*The Welfare Impacts of High Food Prices: Resource Endowments and Spill-Over Effects*". [Online]. Available: https://www.isid.ac.in/~epu/acegd2018/papers/DigvijayNegi.pdf [Accessed: Sept. 25, 2022].

[39] Nendissa, D. R., Anindita, R., Khoiriyah, N. and Sa'diyah A. A. (2021) "Consumption and Beef Price Changes on Demand in East Nusa Tenggara, Indonesia", *AGRIS on-line Papers in Economics and Informatics*, Vol. 13, No. 2, pp. 97-107. ISSN 1804-1930. DOI 10.7160/aol.2021.130208.

[40] Poi, B. P. (2012) "Easy demand-system estimation with quaids.", *Stata Journal*, Vol. 12, No. 3, pp. 433-446. ISSN 1536867X. DOI 10.1177/1536867X1201200306.

[41] Ray, R. (1983) "Measuring the costs of children: an alternative approach", *Journal of Public Economics*, Vol. 22, No. 1, pp. 89-102. ISSN 0047-2727. DOI 10.1016/0047-2727(83)90058-0.

[42] Rathnayaka, S. D., Selvanathan, S., Selvanathan, E. A. and Kler, P. (2019) "Modelling Sri Lankan consumption patterns using error corrected LA-AIDS", *Economic Modelling*, Vol. 80, pp. 185-191. ISSN 0264-9993. DOI 10.1016/j.econmod.2018.11.006.

[43] Ravikumar, B., Ray, S. and Savin, N. E. (2000) "Robust wald tests in sur systems with adding-up restrictions", *Econometrica*, Vol. 63, No. 3, pp. 715-719. E-ISSN 1468-026, ISSN 0012-9682. DOI 10.1111/1468-0262.00129.

[44] Roley, V. V. (1983) "Symmetry restrictions in a system of financial asset demands: Theoretical and empirical results", *The Review of Economics and Statistics*, Vol. 65, No. 1, pp. 124-130. E-ISSN 1530-9142, ISSN 0034-6535. DOI 10.2307/1924416.

[45] Salvia, A. L., Leal Filho, W., Brandli, L. L. and Griebeler, J. S. (2019) "Assessing research trends related to Sustainable Development Goals: Local and global issues", *Journal of Cleaner Production*, Vol. 208, pp. 841-849. ISSN 0959-6526. DOI 10.1016/j.jclepro.2018.09.242.

[46] Singh, K., Dey, M. M. and Thapa, G. (2011) "An error corrected almost ideal demand system for crustaceans in the United States", *Journal of international food & agribusiness marketing*, Vol. 23, No. 3, pp. 271-284. ISSN 0897-4438.

[47] Shaffer, E. (2015) "*WASDE: World meat production to rise in 2016*", June 11, 2015. [Online]. Available: https://www.meatpoultry.com/articles/13089-wasde-world-meat-production-to-rise-in-2016 [Accessed: Sept. 25, 2022].

[48] Tefera, N. U., Desta, M. D. and Rashid, S. (2018) "A Dynamic analysis of food demand patterns and habit effects: Panel evidence from rural households in Ethiopia", *Journal of Agricultural Economics*, Vol. 1, No. 1, pp. 1-13. E-ISSN 1477-9552.

[49] Tiberti, L. and Tiberti, M. (2018) "Food price changes and household welfare: What do we learn from two different approaches?", *The Journal of Development Studies*, Vol. 54, No. 1, pp. 72-92. ISSN 0022-0388. DOI 10.1080/00220388.2016.1269888.

[50] Umaroh, R. and Pangaribowo, E. H. (2020) "Welfare Impact of High-Nutrient Foods'price Increase on Indonesian Households: Is There a Role for Own-Farm Production?", *Journal of Indonesian Economy and Business (JIEB)*, Vol. 35, No. 1, pp. 17-29. E-ISSN 2338-584, ISSN 2085-8272. DOI 10.22146/jieb.50424.

[51] Vanany, I., Maftuhah, D. I., Jaelani, L. M., Hajar, G. and Utami, N. M. C. (2019) "Modeling of chicken production for food security in Indonesia", *2019 International Conference on Industrial Engineering and Engineering Management (IEEM)*, pp. 627-631. ISSN 2157-3611. DOI 10.1109/IEEM44572.2019.8978877.

[52] Wahyuni, D., Purnastuti, L. and Mustofa, M. (2016) "Analisis Elastisitas Tiga Bahan Pangan Sumber Protein Hewani di Indonesia", *Jurnal Economia*, Vol. 12, No. 1, pp. 43-53. ISSN 1858-2648. DOI 10.21831/economia.v12i1.9544. (In Indonesian).