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DEMAND ELASTICITIES OF ANIMAL-SOURCED FOOD: EMPIRICAL STUDY IN YOGYAKARTA, INDONESIA

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Abstract

The rise in prices and income levels significantly impact the demand for animal-sourced protein in Indonesia. The research aimed to analyze the consumption patterns of animal-source food and their impact on demand in Yogyakarta, Indonesia. The study utilized secondary data from the 2021 National Socioeconomic Survey (Susenas), collected by the Central Bureau of Statistics (BPS) Indonesia, which involved a sample of 3,227 households. The research approach was based on the Quadratic Almost Ideal Demand Systems (QUAIDS) method. The results showed that the most elastic animal-sourced food was beef, with a demand elasticity of -2.661, followed by fish (-2.229), poultry (-1.581), milk (-1.541), and eggs (-0.669). All animal-sourced food were found to be luxury goods, except for eggs, which were considered normal goods. Beef is also the most luxurious good (2.359), followed by fish (2.191), milk (2.001), poultry (1.183), and eggs (0.507). The findings indicated that a price policy was more effective than an income policy in affecting the demand for animal-sourced food in Yogyakarta. In conclusion, the study highlights the importance of considering animal-sourced food's price and income elasticity in formulating effective demand-influencing policies.

Keywords: *Demand system, animal-sourced food, price policy, income policy, QUAIDS.*
JELCodes: *Q18, L66, Q11, C31, B23.*

1. Introduction

Indonesia already has a Nutrition Slogan called "*Healthy Four*, *Perfect Five*" (Anyanwu et al., 2022; Rachmi et al., 2017; Rokx et al., 2018; Soekirman, 2011). This arrangement of four words has been tested for decades, is easy to express, easy to understand, and has the meaning that consuming four food groups every day can meet the nutritional needs of the body

so that it contributes to a healthy life. However, when households consume the fifth food group, the fulfilment of nutritional needs and the degree of health achieved will be perfect in Indonesia. Milk is one of the most important food sources of animal-protein consumed by the entire population of Indonesia (Diana et al., 2022; Khusun et al., 2022), especially during the early period of children's growth. However, milk is still a commodity where consumption is relatively low as the price is quite expensive in Indonesia (Anindita et al., 2022; Anindita et al., 2020; Nikmatul et al., 2020; Khoiriyah et al., 2023).

The rise in prices and income levels has a significant impact on the demand for animal-sourced protein in Indonesia, and by extension in Jogjakarta. As income levels increase, people tend to shift their dietary patterns towards more animal-based protein sources, such as meat, eggs, fish, and dairy products, as these food items are seen as a symbol of higher status and prosperity. However, at the same time, the rise in prices of these animal-based protein sources also affects their demand, as they become more expensive and less accessible to low-income households (Arwanto et al., 2022; Bekele et al., 2023; Roosen et al., 2003; Wang, 2020).

In Jogjakarta, the demand for animal-protein sources has been on the rise in recent years, driven by the increasing urbanization and standard of living of the region. The increasing middle class and the growing awareness of the health benefits of animal-protein have also contributed to this trend. Despite this growth in demand, the rising prices of these food items have become a challenge for many low-income households, who struggle to afford these protein sources in their diets (De Cianni et al., 2023; Tziva et al., 2023).

The impact of rising prices on the demand for animal-protein can be seen in the recent trends in Jogjakarta. The price of meat, for example, has increased significantly in recent years, making it more expensive and less accessible to low-income households (Khoiriyah el. al., 2023). The same trend can be seen with eggs and dairy products, which have also become more expensive due to the rising costs of production and the increasing demand for these food items. To tackle this challenge, many households have been forced to reduce their consumption of animal-based protein sources or switch to cheaper alternatives, such as plant-based protein sources. This shift in consumer behavior has been particularly noticeable among low-income households, who have limited access to these food items and are more likely to opt for cheaper alternatives.

In addition to the rising prices, income levels have also had a significant impact on the demand for animal-based protein sources in Jogjakarta. This trend has been observed in many developed countries, where the increasing prosperity of the population has led to a rise in the consumption of animal-based protein sources. However, it is important to note that the rise in income levels and the accompanying shift towards animal-based protein sources is not without its challenges (Arwanto et al., 2022; Partelow et al., 2023). This trend has had a significant impact on the environment, as the increased demand for animal-based protein sources has led to an increase in the production of these food items, resulting in increased greenhouse gas emissions and deforestation.

The rise in prices and income levels has had a significant impact on the demand for food sources of animal-protein in Jogjakarta. The increasing demand for these food items, coupled with the rising prices, has made it more difficult for low-income households to access these protein sources (Fainguersch et al., 2023; Hearst et al., 2023; Laila et al., 2023; Madlala et al., 2023). To address this challenge, households have been forced to reduce their consumption of animal-based protein sources or switch to cheaper alternatives. The rise in income levels and the accompanying shift towards animal-based protein sources has also had a significant impact on the environment, highlighting the need for more sustainable and environmentally friendly food production practices in Jogjakarta. The average monthly consumption and expenditure per capita of commodities that are widely consumed by urban-rural classification, in March 2021 for Indonesia are shown in Table 1.

Table 1. Average Monthly Consumption and Expenditure per Capita of Commodities that are Widely Consumed by Urban Rural Classification, March 2021 for Indonesia

Type of Food Commodity	Unit of Quantity	Urban		Rural		Urban+Rural	
		Quantity	Value (Rupiahs)	Quantity	Value (Rupiahs)	Quantity	Value (Rupiahs)
Fresh fish and shrimp	Kg	1.485	45.764	1.554	38.734	1.514	42.729
Preserve fish and shrimp	Ons/0.1Kg	1.652	8.795	1.973	8.771	1.791	8.785
Beef	Kg	0.053	6.340	0.019	2.122	0.038	4.519
Broiler/local chicken meat	Kg	0.689	23.630	0.500	17.635	0.608	21.042
Chicken eggs	Unit	10.746	16.882	8.493	14.121	9.773	15.690
Sweetened condensed ilk	397 grams	0.313	3.255	0.299	3.261	0.307	3.257

Source: Central Bureau of Statistic Indonesia, 2021.

Referring to Table 1, food sources of animal-protein for households in Indonesia consist of six food groups, namely fresh fish and shrimp, preserved fish and shrimp, beef, broiler and local chicken meat, chicken eggs, and sweetened condensed milk. Rural households consume more fresh fish and shrimp than urban households, but the quality of fresh fish and shrimp consumed by urban households is better than urban households. This can be seen from the higher prices in urban areas compared to rural, likewise with preserved fish and shrimp. The highest share of expenditure on animal-source food protein is fresh fish and shrimp in Indonesia, both in urban and rural areas. The average monthly consumption and expenditure per capita of commodities that are widely consumed by urban-rural classification, March 2021 for Yogyakarta are shown in Table 2.

Table 2. Average Monthly Consumption and Expenditure per Capita of Commodities that are Widely Consumed by Urban Rural Classification, March 2021 for Yogyakarta

Type of Food Commodity	Unit of Quantity	Urban		Rural		Urban+Rural	
		Quantity	Value (Rupiahs)	Quantity	Value (Rupiahs)	Quantity	Value (Rupiahs)
Fresh fish and shrimp	Kg	0.733	23.769	0.673	16.974	0.717	21.011
Preserve fish and shrimp	Ons/0.1Kg	1.298	4.852	1.080	3.561	1.241	4.518
Beef	Kg	0.042	5.371	0.011	1.298	0.034	4.317
Broiler and local chicken meat	Kg	0.665	23.675	0.574	21.189	0.641	23.032
Chicken eggs	Butir or Unit	11.341	17.803	9.815	14.915	10.946	17.056
Sweetened condensed milk	397 grams	0.332	3.497	0.294	3.194	0.322	3.418

Source: Central Bureau of Statistic Indonesia, 2021.

In Yogyakarta, as shown in Table 2, in contrast to Indonesia, the dominant protein food consumed by urban households is fresh fish and shrimp, but with almost the same amount as broiler and local chicken meat, while rural households consume broiler and chicken meat dominantly. Then fresh fish and shrimp, preserved fish and shrimp, sweetened condensed milk, and beef consumption is the lowest. If we look at the provincial data which consists of urban

and rural areas, it can be seen that the main protein food sources for households in Yogyakarta are broiler and local chicken. Milk is the lowest consumption for households in Yogyakarta. This is supported by data that Yogyakarta province is the lowest province in Indonesia for milk consumption. Household consumption of beef is also low, namely 4.317 kg per capita per month.

2. Literature Review

Food demand systems refer to the various factors that influence consumers' decisions to purchase certain food items in each market. Research on food demand systems has been conducted in many countries around the world and has helped to shed light on the factors that drive food consumption patterns. In the United States, research has shown that income, prices, and demographics play a significant role in determining food demand. Higher incomes tend to lead to increased demand for higher quality and more diverse food items, while lower incomes are associated with a higher demand for staple foods such as rice and potatoes. Prices also play a major role in food demand, with consumers being more likely to purchase cheaper items when prices are high. Demographic factors, such as age, race, and education level, also influence food demand, with younger, more educated consumers tending to demand more diverse and high-quality food items. The demand for organic and health-conscious food products has also been increasing in the United States, reflecting a growing awareness of the health benefits associated with consuming these types of products.

Similar patterns have been observed in Europe, where research has shown that income and prices are also key drivers of food demand. Additionally, cultural, and social factors, such as culinary traditions and preferences, play a significant role in determining food demand in Europe. For example, traditional cuisines in Italy, France, and Spain are highly valued and have a significant influence on food demand in these countries (Albagli et al., 2023; Petrontino et al., 2023). European consumers are also known for their interest in local and regional food products, with many consumers seeking out products that are produced close to their home and have a strong connection to their local food culture. Traditional cuisines in Italy, France, and Spain are highly valued and have a significant influence on food demand in these countries (Robu et al., 2023; Sogari et al., 2023). This trend is often referred to as the "locavore" movement.

In developing countries, food demand is influenced by a variety of factors, including income, prices, cultural and social factors, and the availability of food. In many cases, low incomes and high food prices make it difficult for consumers to access diverse and high-quality food items, leading to a higher demand for staple foods (Ahn et al., 2020; Anindita et al., 2022; Bai et al., 2020; Bharumshah & Mohamed, 1993; Nikmatul et al., 2020; Forgenie et al., 2023; Khoiriyah et al., 2023). Cultural and social factors, such as traditional diets and food preparation methods, also play a significant role in shaping food demand in these countries. For example, in many African countries, traditional diets are based on staple foods such as cassava and maize, and these foods play a central role in shaping food demand in these countries. In addition, the availability of food is often limited in developing countries, which can make it difficult for consumers to access the foods they want and need.

In China, food demand has changed significantly in recent years, as the country's economy has grown and incomes have risen. Research has shown that consumers in China are becoming more interested in high-quality and diverse food items, with a growing demand for imported foods and specialty products. Prices and cultural factors, such as the importance of food in social and cultural events, also play a role in shaping food demand in China (Li et al., 2023; Sarfraz et al., 2023). For example, traditional Chinese dishes are often served during important social and cultural events, such as weddings and festivals, and these dishes play a significant role in shaping food demand in China. Additionally, the growing middle class in China is

increasingly interested in health and wellness, which has led to a growing demand for healthy and organic food products.

In India, food demand is influenced by a variety of factors, including income, prices, cultural and social factors, and the availability of food (Hosseini et al., 2017; Kabir et al., 2023; Khoiriyah et. al., 2023). Like many developing countries, low incomes and high food prices can make it difficult for consumers to access diverse and high-quality food items, leading to a higher demand for staple foods. Cultural and social factors, such as traditional diets and food preparation methods, also play a significant role in shaping food demand in India. For example, traditional Indian diets are often based on vegetarianism and a strong emphasis on spices and herbs, which has led to a growing demand for products that are aligned with these dietary preferences. Additionally, the importance of food in social and cultural events, such as weddings and festivals, also plays a role in shaping food demand in India. However, the increasing urbanization and growth of the middle class in India is leading to a growing demand for more diverse and high-quality food items, including imported foods and specialty products (Akter et al., 2023).

Food demand systems vary widely across countries and are influenced by a complex interplay of factors, including income, prices, cultural and social factors, and the availability of food. Understanding these demand systems is important for food producers, retailers, and policymakers, as it can help to guide decision-making and investment in the food sector. By continuing to study food demand systems in different countries, we can gain a deeper understanding of the factors that drive food consumption patterns and work to improve access to diverse and high-quality food for consumers around the world.

3. Methods and Materials

3.1. Model Specification: The QUAIDS Model

The empirical literature on-demand analysis is extensive. The Almost Ideal Demand System (AIDS) model, introduced by Deaton and Muellbauer (1980), has become one of the most widely utilized models in consumer demand analysis. Despite numerous functional forms available for demand analysis, researchers favor the AIDS model due to several advantageous properties. These include perfect aggregation over consumers, a functional form that aligns well with available data, adherence to the axiom of choice, and ease of estimation (Barnett and Seck, 2008). Additionally, the AIDS model allows for the imposition and empirical testing of theoretical restrictions such as homogeneity and symmetry on the parameters. While several functional forms in the literature share some of these desirable characteristics, the AIDS model uniquely encompasses all of them simultaneously.

However, for household demand analysis, the Quadratic AIDS (QUAIDS) model proposed by Banks et al. (1997) is often preferred. Banks et al. (1997) argue that consumer preferences can exhibit quadratic relationships, rather than the linear form assumed in the AIDS model, making the QUAIDS specification more suitable, particularly for studies of household demand. Furthermore, the QUAIDS model maintains theoretical consistency and preserves all the favorable properties of the traditional AIDS model. The share equations of the QUAIDS model are formally expressed as follows (Poi, 2012):

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

Where:

w_i = is the expenditure share of the ith commodity group, derived as follows:

$$w_i \equiv \frac{p_i q_i}{m} \; and \; \sum_{i=1}^{n} w_i = 1 \tag{2}$$

q_i = is the quantity of the i[th] commodity consumed.
lnp_j = is defined as the natural logarithm of price for the j[th] commodity group.
m = is the total household expenditure for on all commodities in question.
ln $a(p)$ = is a price index, usually the stone price index given as

$$ln\, p_j = \Sigma_{j=1} w_i lnp_j$$

$b(p)$ = is a price aggregator, which is given as b(p) = $\prod \prod_{t=1}^{k} p_t^{\beta_i}$
ε_i = is a white noise error term.
α_i, γ_{ij}, β_1 and λ_i = are parameters to be estimated.
To align with demand theory, the theoretical constraints of adding-up, homogeneity, and symmetry are imposed during the estimation process as follows:

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

Equation (1) depicts the traditional QUAIDS model, which does not account for socio-demographic factors influencing household demand for animal-sourced foods. These factors, as highlighted by Alboghdady and Alashry (2010) and Tefera et al. (2018), can significantly shape household behavior in terms of demand and expenditure distribution across goods. Therefore, it is essential to integrate these factors into the QUAIDS model presented in Equation (1). To address this, we employ the 'demographic scaling' method, as suggested by Poi (2012), to capture socio-demographic influences on household demand for animal-sourced food. This method posits that the impact of demographic changes parallels the effect of price changes in animal-sourced foods. Here, *z* represents a vector of S household characteristics, where *z* can be a scalar representing household size in its simplest form. Let $e^R(p,u)$ denote the expenditure function of a reference household comprising a single adult. Ray's (1983) method utilizes an expenditure function tailored to household characteristics, without adjusting for shifts in consumption patterns. The second term in the equation controls for changes in relative prices and the actual goods consumed. Following the parameterization approach of Ray (1983) and Poi (2012), QUAIDS is formulated as follows:

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

Where ρ is a vector of parameters to be estimated, the expenditure share equation presented in Equation (1) is now expressed in the following form:

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

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

Moreover, η_i represents the *j*th column of the *s x k* parameter matrix η (Poi, 2012).

The adding-up condition requires that $\sum_{j=1}^{K} \eta_{rj} = 0$ for $r = 1, \ldots, s$. (9)

The parameters are estimated using the Iterated Nonlinear Seemingly Unrelated Regression (ITNL-SUR) technique in Stata 17. To avoid singularity in the variance-covariance matrix, one of the share equations for animal goods is excluded during estimation and subsequently recovered using the adding-up restriction. With a theoretically consistent and viable model now specified for parameter estimation, 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.

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

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

Equations (10) and (11) use previously stated parameters, except δ_{ij}, which is set to 1 when computing own-price elasticity and zero otherwise. Marshallian own-price elasticities measure how much demand varies for a certain animal-sourced food category in response to price changes. Cross-price elasticities, on the other hand, quantify variations in the amount demanded of one animal-sourced food group when the price of another animal-sourced food group changes. Furthermore, the spending or income elasticity for each animal-based food category is computed using the formula noted in Equation (12) below.

$$\mu_i = 1 + \frac{1}{w_i}\left[\beta_i + \acute{\eta}_i z + \frac{2\lambda_i}{b(p)c(p,z)} ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right] \quad (12)$$

Income elasticity measures the extent of demand responsiveness resulting from changes in income. Classical Keynesian theory indicates a positive correlation between income and demand. This is because as income rises, consumer welfare improves, leading to increased demand for goods and services, and vice versa. Additionally, this study computes Hicksian price elasticity for each animal-sourced food group. Hicksian own-price elasticities are derived from the Slutsky equation, as noted in Equation (13), while cross-price elasticities are derived from Equation (14) as follows:

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

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

3.2 Data and Source

The study utilizes secondary data from the Central Bureau of Statistics (Badan Pusat Statistik or BPS) of Indonesia, specifically from household surveys known as Susenas (National Socioeconomic Survey) conducted in March 2021. This dataset includes socio-demographic details such as household region status, household size (number of members), household consumption and expenditure, and total expenditure. The study examines the prices and consumption of five animal food categories: eggs, chicken meat, beef, fresh fish, and powdered milk. Price variables are calculated by dividing the total expenditure on each type of animal-sourced food by the quantity consumed. The consumption variables encompass egg consumption, chicken meat consumption, beef consumption, fresh fish consumption, and powdered milk consumption. The analysis includes various types of eggs (chicken, local chicken, and duck eggs), chicken meat (both local and regular chicken), beef, fresh fish (including shrimp, squid, and shellfish), and powdered milk (including infant milk). The sample for this research comprises data from 3,227 households.

4. Results and Discussion

4.1 Factors Affecting Animal Food Demand

The QUAIDS analysis results provide several parameters, including the constant parameter (α), price parameters for the five animal food groups (γ), income parameters for the five animal food groups (β), income square parameter (λ), region status parameter (η), and household size parameter (ρ). The parameters for prices, expenditure (income), the square of income, and demographic factors such as household size and region status (urban or rural) are mostly significant at the 1% to 5% level (see Table 3). All constant (α) parameters are significant, except for those related to egg consumption. The prices of beef, eggs, and powdered milk are highly significant (at the 1% level), while the prices of chicken meat and fresh fish are not significant. The estimated QUAIDS model meets the three theoretical restrictions: adding-up, homogeneity, and symmetry.

All quadratic expenditures significantly impact animal-sourced food demand, except for fish. The quadratic income coefficient is positive for eggs and fish but negative for poultry, beef, and powdered milk. This suggests that if household income doubles, the demand for eggs and fresh fish increases, while the demand for chicken meat, beef, and powdered milk decreases. Negative coefficients imply these goods are inferior, whereas positive coefficients indicate they are superior. Therefore, eggs and fish are classified as normal goods, while poultry, beef, and powdered milk are considered luxury goods. The positive coefficient for beef quadratic income indicates that increasing household income significantly boosts beef consumption.

Eta represents the settlement type or household residence status (region), and HHm denotes the total household members for each animal-sourced food. Almost all animal food prices, in both urban and rural areas, significantly affect demand. For the HHm variable, significant effects are seen in egg, poultry, and beef consumption, while for fish and powdered milk, the effects are not significant. This implies that an increase in household size decreases egg demand (negative coefficient) and increases the demand for poultry and beef (positive coefficient).

Households in Yogyakarta province consumed the lowest fish/shrimp/squid/shellfish, namely 0.717 kg. Meanwhile, Southeast Sulawesi province is the province with the highest consumption of fresh fish and shrimp per capita per month, which is 3,171 kg. The highest expenditure share is in North Kalimantan Province, which is 92,809 rupiah per capita per

month, while the lowest is in Central Java Province, which is 20,580 rupiah per capita per month.

Table 3. QUAIDS Parameter Estimates.

Parameter	Coefficient	Std. Err.	z	P>|z|
Alpha (constant)				
alpha_1	2.094	0.098	21.430	0.000
alpha_2	-3.765	0.141	-26.660	0.000
alpha_3	0.751	0.086	8.690	0.000
alpha_4	0.363	0.054	6.710	0.000
alpha_5	1.557	0.127	12.280	0.000
Beta				
beta_1	0.238	0.015	16.190	0.000
beta_2	-0.694	0.019	-36.360	0.000
beta_3	0.124	0.013	9.360	0.000
beta_4	0.057	0.008	6.720	0.000
beta_5	0.275	0.019	14.260	0.000
Gamma				
gamma_1_1	0.584	0.021	27.570	0.000
gamma_2_1	-0.837	0.043	-19.480	0.000
gamma_3_1	0.097	0.018	5.280	0.000
gamma_4_1	0.049	0.011	4.420	0.000
gamma_5_1	0.107	0.029	3.670	0.000
gamma_2_2	2.092	0.121	17.290	0.000
gamma_3_2	-0.344	0.049	-7.090	0.000
gamma_4_2	-0.157	0.028	-5.520	0.000
gamma_5_2	-0.754	0.083	-9.050	0.000
gamma_3_3	0.035	0.022	1.630	0.103
gamma_4_3	0.019	0.010	1.810	0.070
gamma_5_3	0.193	0.020	9.430	0.000
gamma_4_4	0.000	0.009	-0.010	0.996
gamma_5_4	0.089	0.013	7.100	0.000
gamma_5_5	0.365	0.056	6.480	0.000
lambda_1	0.022	0.001	36.790	0.000
lambda_2	-0.034	0.001	-28.610	0.000
lambda_3	0.004	0.001	7.100	0.000
lambda_4	0.002	0.000	5.160	0.000
lambda_5	0.006	0.001	7.200	0.000

Etha				
eta_urban_1	0.004	0.003	1.290	0.196
eta_urban_2	-0.012	0.004	-2.730	0.006
eta_urban_3	0.001	0.001	1.550	0.122
eta_urban_4	0.001	0.000	2.040	0.042
eta_urban_5	0.005	0.001	5.260	0.000
eta_hhm_tot_1	0.003	0.001	3.230	0.001
eta_hhm_tot_2	-0.005	0.001	-3.600	0.000
eta_hhm_tot_3	0.001	0.000	4.380	0.000
eta_hhm_tot_4	0.000	0.000	2.360	0.018
eta_hhm_tot_5	0.000	0.000	1.100	0.272
Rho				
rho_urban	0.141	0.085	1.670	0.096
rho_hhm_tot	0.293	0.051	5.770	0.000

Source: March 2021 Susenas; 1=eggs, 2=poultry, 3=beef, 4=fish, 5=milk, hhm=household member

4.2 Marshallian Own- and Cross-price Elasticities

Consumption or demand for fresh milk and its derivatives is expected to continue to increase in line with the growth of Indonesia's population, economic growth, improved education levels, awareness of nutrition, and lifestyle changes (Ministry of Agriculture, 2022). So national milk consumption is expected to continue to grow positively in line with the increase in population. In general, daily milk needs are related to three types of milk, namely factory liquid milk, sweetened condensed milk, and powdered milk. However, milk is one of the most popular nutritional intakes. Not only is it served as a healthy drink, but milk can be processed with other food ingredients, therefore milk is very popular. Milk is sourced from cow's milk, goat's milk, horse's milk, and soy milk.

For factory liquid milk commodities, nationally, the monthly average consumption per capita of factory liquid milk by Province (grams), March 2021) is 118 grams. When viewed by province, the most consumed factory liquid milk is DKI Jakarta (427 grams), followed by DI Yogyakarta (254 grams), West Java (199 grams), and Riau Islands (193 grams). There are 8 provinces with a lot of factory liquid milk consumed above the national figure, including Jogjakarta which is the second largest.

The results of the QUAIDS model analysis yield parameters that are utilized to compute price and income elasticities. Price elasticity includes own and cross-price elasticities, while income elasticity measures the responsiveness of demand to changes in income. Table 4 presents the own-price elasticities and Marshallian cross-price elasticities. All Marshallian own-price elasticities are negative, consistent with economic theory, indicating that higher prices of animal-sourced foods reduce demand. In other words, increases in prices for eggs, poultry, beef, fish, and milk powder lead to decreased consumption of animal-source foods. Households tend to decrease their consumption of animal-source foods in response to price increases.

The own-price elasticity of demand measures the responsiveness of the quantity demanded of a product to changes in its price. The Marshallian own-price elasticity of eggs, poultry, beef,

fish, and milk are 0.669%, 1.581%, 2.661%, 2.229%, and 1.541% respectively. A positive own-price elasticity of demand implies that an increase in the price of a product leads to an increase in the quantity demanded of that product. Conversely, a negative own-price elasticity of demand implies that an increase in the price of a product leads to a decrease in the quantity demanded of that product. The own-price elasticity of demand for eggs (0.669%) is relatively inelastic, implying that a small increase in the price of eggs will not lead to a significant decrease in the quantity demanded. On the other hand, the own-price elasticity of demand for beef (2.661%) is relatively elastic, implying that an increase in the price of beef leads to a relatively larger decrease in the quantity demanded.

The own-price elasticities of demand for poultry (1.581%), fish (2.229%), and milk (1.541%) are in between the elasticities of demand for eggs and beef, implying that an increase in the price of these products lead to a moderate decrease in the quantity demanded. It is important to note that the own-price elasticities of demand for these animal-based protein sources are likely to vary across different regions and demographic groups, depending on factors such as income levels, cultural preferences, and availability of substitute products.

The own-price elasticity of demand for beef is 2.661%, making it the most elastic among the animal-based protein sources discussed. This implies that a small increase in the price of beef leads to a relatively larger decrease in the quantity demanded, as consumers are more responsive to changes in the price of beef compared to the other food items. This high elasticity of demand for beef highlights the importance of considering the own-price elasticities of demand when setting prices for beef and the potential for price changes to significantly affect demand. Additionally, it emphasizes the need for businesses and policymakers to monitor the market dynamics affecting beef demand, such as changes in consumer preferences, the availability of substitute products, and fluctuations in income levels.

In conclusion, the own-price elasticities of demand for eggs, poultry, beef, fish, and milk provide insight into the responsiveness of the quantity demanded of these food items to changes in their own prices. Understanding the own-price elasticities of demand is important for policymakers and businesses, as it can inform pricing strategies and help ensure that the supply of these food items is in line with the changing demand patterns of consumers.

Table 4: Marshallian Own- and Cross-price Elasticities

Animal food group	Eggs	Poultry	Beef	Fish	Milk
Eggs	**-0.669**	**0.207**	**-0.005**	**0.008**	**-0.048**
	0.038	*0.035*	*0.017*	*0.011*	*0.027*
Poultry	**-0.043**	**-1.581**	**0.136**	**0.066**	**0.239**
	0.054	*0.074*	*0.029*	*0.019*	*0.048*
Beef	**-0.957**	**1.369**	**-2.661**	**-0.658**	**0.547**
	0.363	*0.395*	*0.577*	*0.341*	*0.412*
Fish	**-0.475**	**1.258**	**-1.223**	**-2.229**	**0.478**
	0.427	*0.468*	*0.636*	*0.634*	*0.483*
Milk	**-0.884**	**0.264**	**0.110**	**0.050**	**-1.541**
	0.102	*0.116*	*0.074*	*0.046*	*0.134*

Source: March 2021 Susenas, standard errors in italics.

Table 4 also presents the Marshallian cross-price elasticities, which illuminate the relationships between different animal-sourced foods. A positive cross-price elasticity indicates substitution, while a negative one suggests complementarity. The analysis reveals predominantly positive cross-price elasticities, indicating substitution effects among animal foods. Specifically, fish substitutes for all other animal-sourced foods.

Beef, known for its high elasticity as a protein source, shows sensitivity to changes in price and availability compared to other proteins like poultry or milk. The cross-price elasticity of beef with poultry and milk substitutes is 0.135% and 0.110%, respectively. This means that for every 1% increase in beef price, there is a 0.135% increase in poultry demand and a 0.110% increase in milk demand as alternative protein sources. Understanding this elasticity is crucial for farmers, processors, and retailers to adjust pricing strategies and manage profitability. For instance, higher beef prices might lead consumers to switch to poultry or milk products, impacting beef sales and profit margins. Conversely, lower beef prices could increase demand and profitability, depending on consumer preferences and market dynamics.

Beef, eggs, and fish are often consumed together as complementary foods, enhancing taste and nutritional value. The cross-price elasticity of beef with eggs and fish is 0.005% and 0.233%, respectively. A low cross-price elasticity between beef and eggs suggests that changes in beef price have minimal impact on egg demand, likely due to eggs' affordability and versatility in various dishes. In contrast, a higher cross-price elasticity between beef and fish indicates that beef price changes significantly influence fish demand as a complementary protein source. This suggests consumers may switch to fish if beef prices rise, affecting market dynamics for both products.

Consumer preferences and cultural attitudes also influence the demand for complementary protein sources. Some consumers prefer combinations like beef, eggs, and fish in meals, while others may choose these proteins separately based on taste or dietary preferences. Additionally, preferences for specific fish types (e.g., salmon or cod) can further influence demand patterns. Understanding these relationships helps stakeholders in agriculture and retail make informed decisions on pricing, marketing, and product offerings to meet diverse consumer needs effectively.

4.3 Hicksian Own- and Cross-price Elasticities

Table 5 presents the own and cross-price elasticity of Hicksian. The Hicksian own-price elasticity of demand measures the responsiveness of the quantity demanded of a good to changes in its price, holding all other factors constant. The results of the data analysis show that the Hicksian beef own-price elasticity is the highest at 2.603%, followed by poultry (1.195%), milk (1.266%), fish (0.341%), and eggs (0.416%).

The high Hicksian beef own-price elasticity of 2.603% indicates that changes in the price of beef have a significant impact on the quantity demanded. If the price of beef increases, consumers may switch to other protein sources, resulting in a decrease in demand for beef. Conversely, if the price of beef decreases, consumers may increase their consumption of beef, resulting in an increase in demand. The Hicksian own-price elasticities of poultry, milk, fish, and eggs are lower than that of beef, but still significant. A Hicksian own-price elasticity of 1.195% for poultry indicates that changes in the price of poultry also have an impact on the quantity demanded, although not as much as changes in the price of beef. Similarly, the Hicksian own-price elasticities of milk, fish, and eggs also suggest that changes in their prices can impact their respective demand, although to a lesser extent compared to beef.

It is important to note that the Hicksian own-price elasticities of protein sources may also be influenced by other factors such as consumer preferences and cultural attitudes, availability, and advertising. For example, if consumers become more health-conscious and demand healthier protein sources, the Hicksian own-price elasticity of demand for poultry and

fish may increase, while that of beef and milk may decrease. The results of the data analysis show that the Hicksian own-price elasticity of demand for beef is the highest at 2.603%, followed by poultry, milk, fish, and eggs, indicating that changes in their prices can have a significant impact on their respective demand. This information is useful for farmers, processors, and retailers to make informed pricing and marketing decisions and remain competitive in the market.

Table 5. Hicksian Own- and Cross-price Elasticities

Animal food group	Eggs	Poultry	Beef	Fish	Milk
Eggs	**-0.416**	**0.373**	**0.007**	**0.015**	**0.022**
	0.037	*0.034*	*0.017*	*0.011*	*0.027*
Poultry	**0.547**	**-1.195**	**0.165**	**0.082**	**0.401**
	0.053	*0.073*	*0.030*	*0.019*	*0.048*
Beef	**0.220**	**2.139**	**-2.603**	**-0.627**	**0.870**
	0.351	*0.393*	*0.577*	*0.341*	*0.413*
Fish	**0.351**	**0.393**	**0.577**	**0.341**	**0.413**
	0.351	*0.393*	*0.577*	*0.341*	*0.413*
Milk	**0.114**	**0.917**	**0.159**	**0.076**	**-1.266**
	0.098	*0.115*	*0.074*	*0.046*	*0.135*

Source: March 2021 Susenas, standard errors in italics.

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In Yogyakarta, all animal-source food, including beef, poultry, milk, fish, and eggs, are considered substitutes. This means that if the price of one animal-source food increases, consumers may switch to another animal-source food that is more affordable, resulting in a decrease in demand for the more expensive product. For example, if the price of beef increases, consumers in Yogyakarta may choose to purchase poultry instead, as it may be more affordable. This will result in an increase in demand for poultry and a decrease in demand for beef. The same can be said for other animal-source food such as milk, fish, and eggs. If the price of one of these products increases, consumers may switch to another animal-source food that is more affordable and accessible, resulting in a decrease in demand for the more expensive product. It is important to note that consumer preferences and cultural attitudes also play a role in determining the demand for animal-source food in Yogyakarta. For example, some consumers may prefer beef over poultry, while others may prefer poultry over beef. Additionally, consumers may have different preferences for specific types of fish, such as salmon or cod, or for specific types of eggs, such as organic or free-range eggs.

All animal-source foods are considered substitutes. This means that changes in the price of one animal-based food source can impact the demand for another animal-based food source. Understanding the relationship between these food sources is important for farmers, processors, and retailers in Yogyakarta to make informed pricing and marketing decisions and meet consumer demands. By considering consumer preferences and cultural attitudes, they can effectively target their marketing efforts and increase demand for their products.

Milk is also highly elastic. In Yogyakarta, all animal-sourced food, including beef, poultry, milk, fish, and eggs, are considered substitutes. This means that if the price of one animal-based food source increases, consumers may switch to another animal-based food source that

is more affordable, resulting in a decrease in demand for the more expensive product. If the price of beef increases, consumers in Yogyakarta may choose to purchase poultry instead, as it may be more affordable. This will increase demand for poultry and a decrease in demand for beef. The same can be said for other animal-based food sources such as milk, fish, and eggs. If the price of one of these products increases, consumers may switch to another animal-based food source that is more affordable and accessible, resulting in a decrease in demand for the more expensive product. It is important to note that consumer preferences and cultural attitudes also play a role in determining the demand for animal-sourced food in Yogyakarta. For example, some consumers may prefer beef over poultry, while others may prefer poultry over beef. Additionally, consumers may have different preferences for specific types of fish, such as salmon or cod, or specific types of eggs, such as organic or free-range eggs.

In conclusion, in Yogyakarta, all animal-sourced food is considered a substitute. This means that changes in the price of one animal-source food can impact the demand for another animal- source food. Understanding the relationship between these food sources is important for farmers, processors, and retailers in Yogyakarta to make informed pricing and marketing decisions and meet consumer demands. By considering consumer preferences and cultural attitudes, they can effectively target their marketing efforts and increase demand for their products.

4.4 Expenditure Elasticity

The demand for goods and services is influenced by household income. Income elasticity measures the percentage change in demand resulting from a percentage change in income. Table 5 presents the results of the analysis of income elasticity and Marginal Expenditure Share (MES). Beef shows the highest elasticity among all animal-sourced foods, with an income elasticity of 2.359%. This means that a 1% increase in income leads to a 2.36% increase in demand for beef. Fish, milk, and poultry also exhibit elasticity, with values of 2.191%, 2.001%, and 1.183%, respectively. Since the income elasticity of beef, fish, poultry, and milk is greater than one, these four animal-sourced food groups are classified as luxury goods. In contrast, eggs are categorized as normal goods because the income elasticity is less than one, at 0.507%. This finding aligns with research conducted in various countries indicating that beef is also considered a luxury item (Acar et al., 2016; Aftab et al., 2017; Abegaz et al., 2018; Pangaribowo, 2010).

Table 5: Expenditure Elasticities and Marginal Expenditure Shares.

Animal Food Groups	Expenditure Elasticity	Marginal Expenditure Share
Eggs	0.507 (0.009)	0.067 (0.003)
Poultry	1.183 (0.015)	0.054 (0.001)
Beef	2.359 (0.087)	0.266 (0.054)
Fish	2.191 (0.100)	0.140 (0.034)
Milk	2.001 (0.091)	0.217 (0.022)

Source: Author's calculations from Susenas 2021.

The income elasticity of demand for animal-sourced food sources, such as beef, poultry, milk, fish, and eggs, is an important factor to consider when analyzing consumer behavior and market trends. The results of the data analysis show that beef has the highest income elasticity of demand at 2.359%, followed by poultry at 2.191%, milk at 2.001%, fish at 1.183%, and eggs at 0.507%. This means that as consumer income increases, the demand for beef, poultry, milk, fish, and eggs will increase at different rates. For example, as consumer income increases, the demand for beef is expected to increase by a greater amount compared to the demand for eggs. This suggests that beef is a more luxurious animal-based food source compared to eggs. It is important to note that the income elasticity of demand for animal-based food sources is influenced by various factors, such as consumer preferences and cultural attitudes, availability, and advertising. For example, if consumers become more health-conscious and demand lower-fat animal-based food sources, the income elasticity of demand for animal-based food sources may decrease. On the other hand, if consumers become more environmentally conscious and demand more sustainable animal-based food sources, such as organic and free-range products, the income elasticity of demand for animal-based food sources may increase.

The results of the data analysis show that beef is the most elastic in income elasticity, followed by poultry, milk, fish, and eggs. This information is useful for farmers, processors, and retailers to make informed pricing and marketing decisions and remain competitive in the market. By considering consumer preferences and cultural attitudes, they can effectively target their marketing efforts and increase demand for their products. It is also important to note that consumer income and consumer attitudes towards animal-based food sources can significantly impact the demand for these products and must be continuously monitored and evaluated.

Table 5 also presents the marginal expenditure share (MES). MES describes the additional changes in the quantity demanded resulting from changes in income over the long run (Anindita et al., 2020; Sa'diyah et al., 2019). Analyzing MES is crucial because it can be utilized, among other things, to devise price or income policy scenarios to achieve recommended dietary allowances (RDA) aligned with national guidelines, which is 57 grams per capita per day. MES for beef is the highest. This implies that in the long run, households in Yogyakarta increase beef consumption with an increase in income. Similarly, milk also experiences increased demand with an increase in income. The order of increasing demand (MES) from highest to lowest is beef, milk powder, fresh fish, eggs, and poultry, with values of 0.266%, 0.217%, 0.14%, 0.067%, and 0.054% respectively. Although fish is more elastic than beef, the MES for beef is greater than the MES for fish. This suggests that an increase in income encourages households to increase beef consumption more than fish consumption over the long run.

5. Conclusion

In Yogyakarta, beef is the most elastic in terms of demand elasticity, with a value of 2.661%. This means that changes in price, consumer income, and consumer preferences can significantly impact the demand for beef. As consumer income and preferences increase, the demand for beef is expected to increase, making it a luxury good in the region. Similarly, all animal-sourced food, including poultry, milk, and fish are considered luxury goods in Yogyakarta, except for eggs, which have a lower income elasticity of 0.507%. This suggests that changes in consumer income and preferences may not have as significant an impact on the demand for eggs compared to other animal-sourced food.

The results of the data analysis suggest that price policy may be more effective than income policy in Yogyakarta for increasing demand for animal-sourced food. By implementing price policies that make animal-sourced food more affordable, farmers, processors, and retailers can increase demand for their products and remain competitive in the

market. It is important to note that consumer attitudes towards animal-sourced food can significantly impact the demand for these products. As consumers become more health-conscious and environmentally conscious, they may demand more sustainable animal-sourced food, such as organic and free-range products, which can impact the demand elasticity of animal-sourced food.

The high demand elasticity of beef in Yogyakarta suggests that changes in price, consumer income, and consumer preferences can significantly impact the demand for beef in the region. While all animal-sourced food, except for eggs, are considered luxury goods in Yogyakarta, price policy may be more effective than income policy for increasing demand for animal-sourced food. It is important to continuously monitor and evaluate consumer attitudes towards animal-sourced food and implement appropriate price and marketing policies to remain competitive in the market.

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