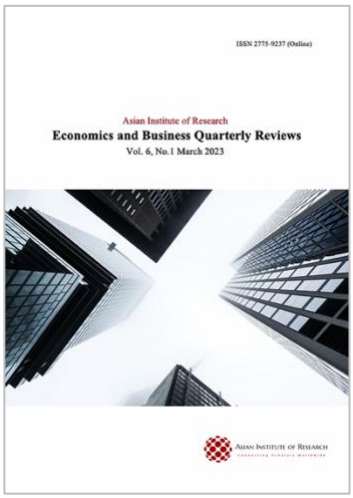

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Assessing the Welfare Effects of Rising Prices of Animal-Derived Sources of Food on Urban Households in Indonesia

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Abstract
Animal-derived food is a major source of protein for urban households in Indonesia. Rise in animal-derived food prices reduces consumption, causing households to consume less food than the recommended amount which can lead to serious health deficiencies that has serious implications for health and well-being in the long-run. The effects of rising prices of animal-derived protein source on urban households' welfare is examined in this study. The Quadratic Almost Ideal Demand System model is used to analyze household consumption patterns, while the welfare effects of rising prices is measured using compensating and equivalent variation. The data for this study came from the 2021 National Socio-Economic Survey (Susenas), which included 112,569 households. Price elasticity of demand reveals that fish was the most responsive to changes in price while eggs were the least. Based on income elasticity of demand, all animal-derived sources of protein were found to be luxurious except for eggs which were found to be a normal good. The welfare exercise found that increase in prices resulted in approximately Rp. 23,262 per month in welfare loss when there is no substitution. However, when there is substitution, welfare loss as measured by CV was Rp. 22,308 and EV was Rp. 21,052 per month. Urban households were found to experience the most welfare loss from price increase of eggs but the least from fish. It was also found that when urban households are able to substitute when prices increase, the welfare impact is smaller than when they are not able to do so. Hence, policy aimed at diversifying urban households' consumption patterns when it comes to protein consumption is suggested as a means of attaining protein food and nutrition security.

Keywords: Food Price, Indonesia, QUAIDS, Urban, Welfare

1. Introduction

Food is one of the most basic and essential needs of an individual or household. However, over the last two decades, there have been substantial increases in global food prices, especially between 2006 and 2008 where the global food price crisis has led to international food price index nearly doubling (Nguyen and Jolly 2013, Azzam and Rettab 2012, Warr and Yusuf 2014). According to data from the Food and Agriculture Organization (2022), in 2006 the world food price index was 72.6 but increased to around 117.5 in 2008, or by around 61.9%. There was major increase in the global price of cereals (93.3%), vegetable oils (100.1%), dairy (93.3%), and meat

(17.3%) between 2006 and 2008 (FAO 2022). Over the last five years, 2018 to 2022, world food prices have continued to show positive increases annually. In 2018, the world food price index was reported to be 95.9 and increased to 145.8 in 2022 (FAO 2022). This represents a more than 55% increase in global food prices between 2018 and 2022. Two core mandates of the Sustainable Development Goals (SDGs) are to eliminate hunger and poverty; hence, it is of paramount importance that safe, nutritious, and affordable foods are available for consumption by the populace in order to foster food sovereignty and food and nutrition security. In addition, Azzam and Rettab (2012) ascertain that consumers are entitled to a maintained level of food welfare even when prices increase, hence, they must be compensated for any lost welfare brought about by increasing food prices.

Food price increase has serious implications towards food and nutrition security and poverty in the developing world, hence, there must be policy interventions by governments and policymakers with the primary goal of safeguarding consumer welfare. According to Attanasio *et al.* (2013), rising food prices has serious implication regarding the welfare of poor households since their food consumption level might have already be at subsistence level. Increase in food prices also put extra strain on poor households and increases their vulnerability to food insecurity (Gregory and Coleman-Jensen 2013, Amolegbe *et al.* 2021). Increases in food prices also increase poverty in various countries in the world (Headey and Martin 2016, Warr *et al.* 2014, Vu and Glewwe 2011, Dhahri and Omri 2020). Warr and Yusuf (2014) notes that food price increase affects poverty in two opposing instances. Firstly, when food prices increase poor households in both rural and urban areas are affected negatively since a large portion of their income is allocated towards food expenditure. Secondly, in developing nations, many poor farmers and non-farmers live in rural areas and benefit from price increases. This is because most of the poor residing in rural areas engage mainly in agriculture which means that they directly benefit from higher prices for agricultural products. However, it is not easily determined which of these two competing effects dominates (Warr and Yusuf 2014).

Indonesia is a developing country that depends heavily on international trade of agricultural products to meet the nutritional demands of its population (Forgenie and Khoiriyah 2023). Major staple food items such as cereals, cassava, soybean, sugar, and beef are imported (Hadi and Chung 2022, Warr and Yusuf 2014). Major staple food items such as cereals, cassava, soybean, sugar, and beef are imported (Hadi and Chung 2022, Warr and Yusuf 2014). Prior to the COVID-19 pandemic, Indonesia was experiencing rapid economic growth, however, recent statistics reveal that GDP in the first quarter of 2020 has slowed down to around 3% (Paramashanti 2020). Recent data from the Asian Development Bank suggest that around 22 million Indonesians had already experienced hunger between 2016 and 2018. Decline in GDP growth and shock placed on the global food system as a result of the COVID-19 pandemic could result in an increase in the prevalence of hunger in Indonesia in the future. This can be amplified by volatile food prices in Indonesia which would negatively affect household welfare in urban areas.

Households with higher income levels tend to have smaller food expenditures than those with lower levels (Regmi and Meade 2013, Baker *et al.* 2020). According to Khoiriyah *et al.* (2020), household food expenditure makes up a significant portion of total household expenditure in both rural (55.8%) and urban (44.2%) households. Over the last two decades, global animal protein consumption has increased by around 58% (Whitnall and Pitts 2019). In 2018, Indonesia accounted for 3% of global protein consumption, which has more than doubled between 1998 and 2018 (Whitnall and Pitts 2019). However, the Central Statistics Agency in 2021 reports that expenditure on animal protein in Indonesia is quite low due to low income and high animal protein prices. According to Ariningsih (2004), animal protein play a significant role in the development of a nations. Hence, it is of paramount importance that animal protein consumption increase in Indonesia as it is essential in improving health and productivity of Indonesians in the long-term (Kharisma *et al.* 2020).

Studies focused on assessing the welfare impacts of rising prices of food on households have been carried out in several countries i.e. Groom and Tak (2015) and De Janvry and Sadoulet (2009) for India; Azzam and Rettab (2012) for the United Arab Emirates; Aftab *et al.* (2015) for Pakistan; Attanasio *et al.* (2013) and Avalos (2016) for Mexico; Allo *et al.* (2018) and Sa'diyah *et al.* for Indonesia; Ferreira *et al.* (2013) for Brazil; Tefera *et al.* (2012) and Shimeles and Woldemichael (2013) for Ethiopia; Dimova (2015) for Sub-Saharan Africa; Aftab *et al.* (2017) for South Asian Countries; Anríquez *et al.* (2013) for various countries; Cudjoe *et al.* (2010) for Ghana;

Layani *et al.* (2020) for Iran; Adoho and Gansey (2019) for Congo; Aghabeygi and Arfini (2020) for Italy; and De Janvry and Sadoulet (2010) for Guatemala. However, few studies have been done for Indonesia urban households regarding food price increases and changes in welfare. Thus, a study that focuses on assessing the welfare consequences associated with animal-derived protein price changes is essential to formulate policy strategies centered around improving household consumption, especially in urban areas.

This study aims to analyze prices and income and their effects on welfare in urban Indonesian households using the Quadratic Almost Ideal Demand System (QUAIDS) model and data from the National Socio-Economic Survey (Susenas) in March 2021. Compensating Variation (CV) and Equivalent Variation (EV) is used to analyze changes in welfare. The study will determine the amount of monetary compensation that must be given to households to negate the negative effects of price increases. Finally, the results are expected to be used as valuable information that can aid in improving urban household's animal-derived protein consumption to correspond with the national food sufficiency figure of 57 grams per day, especially for poor and almost-poor households in urban Indonesia.

2. Materials and Method

2.1. Model Specification: The Quadratic Almost Ideal Demand System Model

Studies on demand analysis are widely published in the empirical literature. Ever since Deaton and Muellbauer (1980) proposed the almost ideal demand system (AIDS) model, researchers have widely favored the specification over other functional forms due to the many attractive properties it possesses. Barnett and Seck (2008) highlights that the AIDS model aggregates perfectly over consumers, has a functional form which is consistent with known data, satisfies the axiom of choice, is rather easy to estimate, and allow the theoretical restrictions of homogeneity and symmetry to be imposed and tested empirically. Although many of the existing functionals forms in the literature possess many of the desirable properties noted above, only the AIDS model possess all of them at them same time (Barnett and Seck 2008, Deaton and Muellbauer 1980).

Despite the popularity of the traditional AIDS model in the empirical literature, researcher have proposed alternative specifications. Banks *et al.* (1997) added a quadratic expenditure term to the AIDS model which yielded a quadratic almost ideal demand system (QUAIDS) model. According to Banks *et al.* (1997), some preferences are quadratic in nature, therefore, the QUAIDS specification is more appropriate. The QUAIDS model is also theoretically consistent and possesses all of the desirable properties of the traditional AIDS model. This specification is widely used in household demand analysis studies, see Kharisma *et al.* (2020), Lakkakula *et al.* (2016), Khoiriyah *et al.* (2020), Layani *et al.* (2020), Tefera *et al.* (2012), Korir *et al.* (2018), Mustafa *et al.* (2022), Dybczak *et al.* (2014), Bronnmann *et al.* (2016), Rasyid (2022), Suárez-Varela (2020), Obisesan (2021), Guerrero-López *et al.* (2017). This study utilized the QUAIDS model to estimate demand for various animal protein source by urban households in Indonesia.

According to Banks *et al.* (1997), the share equation of the QUAIDS model is specified as follows:

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

Where:
w_i is the household expenditure share of the *ith* animal-derived food group, given as follow:

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

lnp_j = is the price of the j[th] animal food commodity group
m = is the household total expenditure for animal food
$ln(a(p))$ = is a price index, i.e., stone price index
$b(p)$ = price aggregator
ε_i = is a white noise error term

$\alpha_i, \gamma_{ij}, \beta_i$ and λ_i = are all parameters to be estimated in each share equation

To be consistent with classical demand theory, the theoretical restrictions of adding-up, homogeneity and symmetry are imposed during estimation 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: $\sum_{i=1}^{n} y_{ji} = 0$ (4)

Symmetry: $\gamma_{ji} = \gamma_{ij}$ (5)

The parameters of the QUAIDS model are estimated by iterated nonlinearly seemingly unrelated regression (ITNL-SUR) in Stata 17. To ensure that the variance-covariance matrix is not singular, one of the share equations is omitted during estimation, then the parameters of the omitted share equation are recovered using the adding-up restriction. Now that a theoretically consistent model is specified to estimate the demand parameters, price and income elasticities can be derived for protein derived from various animal foods. Marshallian or uncompensated price elasticities for each animal-derived food group are calculated using the formula

$$\varepsilon_{ii}^{M} = -\delta_{ii} + \frac{1}{w_i}\left(\gamma_{ij}\left[\beta_i + \acute{\eta}_i z + \frac{2\lambda_i}{b(p)c(p,z)} ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right] * \left(\alpha_j + \sum_{1} \gamma_{ij} lnp_j\right) - \frac{(\beta_i + \acute{\eta}_i z)\lambda_i}{b(p)c(p,z)}\left[ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right]^2\right) \quad (6)$$

Marshallian own-price elasticities generally measure changes in the quantity demanded as a result of changes in prices. Income elasticity of demand which measures the changes in demand brought about by changes in income is derived using the formula as follows:

$$\eta_i = 1 + \frac{1}{w_i}\left[\beta_i + \acute{\eta}_i z + \frac{2\lambda_i}{b(p)c(p,z)} ln\left\{\frac{m}{\overline{m_o}(z)\alpha(p)}\right\}\right] \quad (7)$$

Hicksian own-price elasticities are derived from the Slutsky equation using the formula below:

$$\varepsilon_{ii}^{H} = \varepsilon_{ii} + \eta_i w_i \quad (8)$$

2.2. Measuring Welfare Impact of Price Change: CV and EV

The concept of welfare is widely studied in the empirical literature; however, it has varying definition across disciplines. According to Greve (2008), in order to properly measure the state of welfare it is of paramount importance that a proper definition is established. From an economic perspective, welfare is defined as the contribution to consumer well-being that is derived from the consumption of goods and services that the income available can buy (Van Praag and Frijters 1999). Generally, welfare is linked to consumer's perception and utility they obtain from the use of income. Changes in the economic environment such as price increase or income reduction have serious implications towards consumer welfare, hence, must be studied.

In principle, consumer welfare can be measured in five ways - 1) Consumer's Surplus variation (CS); 2) Compensating Variation (CV); 3) Equivalent Variation (EV); 4) Laspeyres Variation (LV); and 5) Paasche Variation (PV). However, this study utilizes CV and EV to assess the welfare impact of rising food prices on urban households in Indonesia. Compensating variation is the adjustment in income that returns the household to the status quo level of utility after an economic change transpired. If the economic change is positive, for instance the price of a good decreases, CV is commonly regarded as the maximum a consumer or household is willing to pay in order to tolerate that economic change. However, when the economic change is negative, for instance the prices of a good increases, CV is the minimum amount of monetary compensation requires in order to tolerate the economic change. On the other hand, equivalent variation is the adjustment in income that changes the consumer or household's level of satisfaction equal to the status quo level of satisfaction that would occur if the economic change did not happen. When the economic change is positive, EV is regarded as the increase in income that would yield the same additional utility that would have happened if a price fall did not occur. Additionally, when there

is a negative economic change, EV is regarded as the amount of income that would be taken from the consumer to lower utility to the level that would happen if the change did not occur.

The exact measure of the change in welfare can be described in terms of the cost function based on price differences. To measure changes in welfare related to price changes, a measure of CV can be attained by using Hicksian elasticities derived from QUAIDS model (Luong and Vu 2020, Vu and Glewwe 2011, De Janvry and Sadoulet 2009). According to Tefera *et al.* (2012), CV can be completely defined via the indirect utility function V as follows:

$$V(\, m^0 + CV, p_c^1 = V(m^0, p_c^0) \tag{9}$$

Where *m* is household expenditure or income, *CV* is the compensating variation and p_c is defined as a vector of prices for animal foods. The superscript 0 and 1 refers to before and after price changes, respectively. The representation of *CV* in equation (9) can be re-expressed using the expenditure or cost function, $e(u, p)$ where u is utility, as outlined below:

$$CV = e(u, p_i^1) - \, e(u_i^0, p_i^0) \tag{10}$$

If welfare after the price change is lower than before, then CV will be positive, however, if it is greater than before the price changes, then CV is negative. Since utility cannot be directly measured, the CV can be approximated using a second order Taylor expansion (Tefera *et al.* 2012, Luong and Vu 2020, Vu and Glewwe 2011) of the minimum expenditure function as follow:

$$\Delta \ln e = \sum_{i=1} w_i \, \Delta lnp_i \, + \, \frac{1}{2} \sum_{i=1} \sum_{j=1} w_i \, \varepsilon_{ij}^H \, \Delta lnp_i \Delta lnp_j \tag{11}$$

Where ε_{ij}^H is the compensated or Hicksian price elasticity of good *i* with respect to the price of good *j*. Equation (11) signifies that the impact that price change has upon a household is a function of the magnitude of the price change and also the relative importance of other food items (Luong and Vu 2020). A positive CV means an increase in the level of welfare (welfare gain); however, a negative value means a decrease in welfare (welfare loss) due to changes in prices. EV is also used to assess the impact of price increases on welfare using the following equation:

$$EV = \, - \sum_k x_k \Delta p_k - \frac{1}{2 \sum_{kj} \frac{\partial x_k}{\partial p_j}} \Delta p_k \Delta p_j + \frac{1}{2} \sum_k x_k \Delta p_k \sum \frac{\partial x_k}{\partial m} \Delta p_k \tag{12}$$

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

2.3. Data and Source

This study utilizes secondary data collected by BPS (Badan Pusat Statistik) in the form of household surveys, called Susenas (National Socio-economic Survey) for March 2021. The data is in the form of household consumption and expenditure on food and non-food items. The data is grouped into various food categories: cereals, tubers, fish/shrimp, meat, eggs and milk, vegetables, legumes, fruits, oil and coconut, beverage stuff, spices, miscellaneous food item, prepared food, and beverages. Food from animal source of protein were grouped into five categories - eggs (chicken eggs, local chicken eggs, and duck eggs), chicken (chicken meat), beef, fish (fish, shrimp, squid, and shellfish), and milk (milk powder and infant milk). The sample of this research is 112,569 households.

3. Results and Discussion

3.1. Household Protein Consumption Patterns in Urban Indonesia

All foods include protein, however the quality and amount of protein from animal and plant sources, such as fruit, varies. Urban households in Indonesia consumes a variety of protein-containing foods. The government in Indonesia has mandated that the minimum protein consumption per capita daily should be around 57 grams. This has been done in an effort to promote food and nutrition security of households in an effort to eradicate hunger and malnutrition as many households do not meet the daily required amount (Khoiriyah *et al.* 2020). Recent statistics ascertain that around 32% of households in Indonesia are regarded as food insecure since their caloric intake is below the recommended 2100 kcal daily. In addition, Karima and Achadi (2012) notes that around 44.1% of pregnant women lack adequate daily food consumption while 48.1% lack adequate protein consumption. Having adequate food for consumption plays a significant role in economic growth and development as the quality of labour diminishes as food quality and consumption patterns declines (Kearney 2010).

Based on per capita daily consumption of protein, cereals, prepared food and beverages, fish and shrimp, and legumes account for more than 75% of total protein consumption. According to Table 1, cereals were the primary source of protein in urban Indonesia where daily per capita consumption was around 18.91 grams followed by prepared foods and beverages (14.08 grams), fish and shrimp (7.03 grams), and legumes (5.44 grams). Protein from animal source such as meat accounted for around 7.24% of total daily consumption or 4.28 grams, while protein from milk and eggs was 4.18 grams or 7.07% of total daily consumption. All other foods consumed daily by urban households in Indonesia accounted small portions of total protein consumption. From Table 1, it is observed that oils and coconut account for only 0.25% or 0.15 grams per capita daily followed by fruits which was only 0.40 grams daily. Khoiriyah *et al.* (2020) notes that the lack of adequate protein consumption, especially from animal sources, has been exacerbated by rising food prices over the last five years. Price increase directly leads to changes in consumption patterns as the purchasing power of households diminish (Sa'diyah *et al.* 2019, Tefera *et al.* 2012).

Table 1: Protein Food Source and Gap to a Minimum Daily Requirement in Urban Indonesia

Food Groups	**Urban Households Income Group**			
	Low	**Middle**	**High**	**National**
	gram/cap/day			
Cereals	18.29	18.45	19.11	18.91
Tubers	0.17	0.22	0.36	0.31
Fish	3.70	4.99	7.99	7.03
Meat	1.03	2.04	5.29	4.28
Eggs and Milk	1.65	2.52	4.94	4.18
Vegetables	1.43	1.60	1.97	1.85
Legumes	4.15	4.82	5.76	5.44
Fruits	0.13	0.21	0.49	0.40
Oil and Coconut	0.12	0.13	0.16	0.15
Beverage Stuff	0.58	0.64	0.78	0.74
Spices	0.32	0.39	0.52	0.47
Miscellaneous Food Item	0.77	1.06	1.43	1.30
Prepared Foods and Beverages	5.68	8.38	16.65	14.08
Total Protein Consumption	38.00	45.44	65.43	59.14
Total Population (millions)	10.34	27.53	94.78	132.65
Min. Protein Requirement	57.00	57.00	57.00	57.00
Gap to Min. Protein Requirement	-19.00	-11.56	8.43	2.14
Gap to Min. Protein Requirement (%)	-33.33	-20.28	14.79	3.75

Source: Authors calculations based on Susenas, 2021

Table 1 also outlines protein consumption among three types of households based on income level in urban Indonesia – low, medium, and high. It can be observed that total protein consumption was relatively low in households with lower levels of income than those with medium and higher levels. Total daily per capita protein consumption by households with low levels of income was around 38 grams, 33.33% short of the recommend 57 grams. Households with medium levels of income consumed on average around 45.44 grams of protein daily

which was around 20.28% less than the national recommended amount. In contrast, total per capita daily protein consumption among urban household with high levels of income was 65.43 grams, which was around 14.79% greater than the daily recommended amount. It is interesting to note that households with higher levels of income tend to consume more animal sources of protein than those with lower levels of income. For instance, households with low and medium levels of income consumer around 6.38 grams and 9.55 grams of protein from animal sources daily per capita whist households with lower levels of income consumes around 18.22 grams.

The data in Table 1 shows that protein from animal sources vary significantly among households in urban Indonesia with different levels of income as households with higher income levels consumes almost three times more protein from animal sources than households with lower levels of income. This reinforces the point by Sa'diyah *et al.* (2019) and Tefera *et al.* (2012) that households with higher levels of income are more likely to consume animal protein as they have the mean to do so. The data suggest that around 71% of the population in urban Indonesia can be considered to be food secure when it comes to protein consumption. When viewed nationally, Indonesian households consume more protein than the National Protein Recommended Dietary Allowance (RDA) of 57 gram per capita daily. The excess protein consumption of urban Indonesian households is 2.14 grams or about 3.75% above the RDA. That sounds so blissful. However, there is still around 29% of the population in urban Indonesia who do not meet the RDA currently which can have serious implications towards health, the labour force welfare and also economic growth and development.

3.2. Household Protein Expenditure Share

Table 2 highlights urban household in Indonesia tend to consume protein, especially those from animal sources after the consumption of cereals is fulfilled. Nationally, households in urban Indonesia allocate around 37.21% of their income towards cereal consumption. Households with low levels of income allocate most of their food expenditure, around 52.73%, towards cereal consumption while households with medium and high levels allocate around 45.32% and 33.60%, respectively. Protein from prepared foods and beverages account for almost 20% of national consumption, followed by fish and shrimp which was around 12.66%. On a national level, protein consumption from animal food sources accounts from around 24.47% of total urban household protein expenditure share. For low, medium, and high-income households, protein consumption expenditure share was around 16.33%, 19.95%, and 26.43%, respectively. Households with higher income tend to allocate more of their budget toward animal foods such as meat, fish and shrimp, and milk and eggs. This indicates that when household income increases, the household reduces cereal consumption and increases consumption of other foods, namely food/beverage and protein, especially animal sources of protein.

Table 2: Food Expenditure Share to Total Food

Food Groups	**Urban Households Income Group**			
	Low	**Medium**	**High**	**National**
	Proportion of Total Food (%)			
Cereals	52.73	45.32	33.60	37.21
Tubers	0.90	0.59	0.62	0.63
Fish	10.93	11.99	13.00	12.66
Meat	2.02	3.47	6.92	5.91
Eggs and milk	3.38	4.49	6.51	5.90
Vegetables	4.40	4.07	3.41	3.61
Legumes	9.06	9.38	8.58	8.77
Fruits	0.39	0.47	0.72	0.65
Oil and coconut	0.52	0.48	0.39	0.41
Beverage stuff	1.72	1.64	1.42	1.48
Spices	0.75	0.84	0.84	0.83
Miscellaneous food item	1.67	2.01	2.13	2.08
Prepared food and beverages	11.52	15.26	21.86	19.86
Total Food	100.00	100.00	100.00	100.00

Source: Authors calculations based on Susenas, 2021

Interestingly, the allocation of expenditure towards legumes such as beans and nuts was around 8.77% nationally. However, consumption expenditure allocation for legumes was greater in lower-income households than those with hight levels of income. For instance, for the study period, legumes accounted for around 9.06% of consumption expenditure share by low-income households while in high-income households' expenditure share was 8.58%, or 0.48% lower than poorer households. According to Huebbe and Rimbach (2020) and Kebede (2020), legumes are a cheap source of proteins, therefore, consumption tend to be higher in lower-income household than those with higher level.

3.3. Protein Prices in Urban Indonesia

In Indonesia, there is usually a direct relationship between price and quality of goods. Higher prices for an item most often suggest better quality. This assumption is used to discuss food quality, especially the quality of protein consumed by households in urban Indonesia. Table 3 presents the price per gram of protein paid by urban households at various income levels in Indonesia. In the cereal's food group, the difference in prices paid by households does not differ greatly between low, and medium households. However, it is suggested that households with higher income levels consume better quality cereals based on price paid. Likewise, with the legumes and other groups. However, for the meat group, high-income households consume meat that is almost double the quality paid by low-income households. Likewise, for fish and shrimp, and the egg and milk group. Thus, it can be suggested that the lower the poverty level of the households the better the quality of animal source of protein consumed. Poor households consume lower quality protein than non-poor households. Oil and coconut food group are the food with the highest price paid by households in urban Indonesia, followed by fruit groups which might be the reason for low consumption of these groups by households, especially in poor households.

Table 3: The Price of Protein for Indonesian Urban Households

Food Groups	**Urban Households Income Group**			
	Low	**Medium**	**High**	**National**
	Price per gram per capita (*Rp.)			
Cereals	2,397.11	2,514.72	3,302.12	3,074.45
Tubers	8,793.61	10,031.44	15,314.99	14,286.40
Fish	3,064.16	3,468.70	5,490.46	5,093.70
Meat	3,579.01	3,860.17	6,610.80	6,282.66
Eggs and milk	5,440.66	5,810.55	9,075.06	8,554.35
Vegetables	11,502.01	13,325.87	20,988.59	19,033.82
Legumes	1,560.59	1,617.92	2,243.17	2,087.82
Fruits	29,819.64	35,743.89	63,473.38	59,573.69
Oil and coconut	53,651.87	60,222.02	87,797.87	81,124.72
Beverage stuff	13,451.16	15,529.04	23,353.75	21,343.66
Spices	13,456.16	14,653.46	21,004.72	19,544.94
Miscellaneous food item	58,26.12	6,146.90	8,494.40	7,973.37
Prepared food and beverages	7,063.03	8,197.59	13,479.54	12,626.07

*Source: Authors calculations based on Susenas, 2021. *Indonesian Rupiah*

3.4. Own-price and Income Elasticities

Reliable price and income elasticities are vital for effective policy development as it can be used to understand the relationship between consumer demand and its determinants (Lokuge and Edirisinghe 2015). Demand elasticities can be used to facilitate the development of effective campaigns and marketing strategies that can help to improve consumer welfare or improve the firm's profits. Elasticity of demand measures the degree of responsiveness of

demand due brought about by changes in one of its major determinants such as price or income. This only calculated price and income elasticities for animal food as a source of protein for urban households in Indonesia.

Price elasticity of demand looks at the relationship that exist been quantity demanded and the price of the good. Economic theory dictates that there is an inversed relationship between the quantity of a good demanded and its price, hence, it the own-price elasticity of demand is expected to be negative. However, economist usually interpret own-price elasticities in their absolute form whereby the negative sign is ignored and the ceteris paribus assumption is imposed. In classical economic theory, there are two types of price elasticities – Marshallian and Hicksian price elasticities. Marshallian or uncompensated price elasticities which has a price and income effect and measures the degree of responsiveness of the quantity demand and demand as a result of changes in prices and income, respectively. Hicksian or compensated elasticities 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 effect which means that their magnitude tends to be smaller than Marshallian elasticities. In terms of magnitude, an own-price elasticity value that is greater than unity is usually described as an elastic good while a good which an elasticity value less than unity is inelastic. For goods that are elastic, the quantity demanded tend to be very responsive to changes in price, however, the opposite is true for inelastic goods.

Table 4 presents Marshallian and Hicksian own-price elasticities for animal foods consumed as a source of protein by urban households in Indonesia. As expected, all calculated own-price elasticities are negative. This is in line with economic theory that price increase reduces demand or consumption. The analysis results also show that the Marshallian price elasticity is greater than the Hicksian. This is because as stated prior, Marshallian elasticities contain both price and income effects while Hicksian elasticities only contain a price effect. In the interest of brevity, only Marshallian own-price elasticities are interpreted since both Marshallian and Hicksian own-price elasticities have similar interpretations. In urban areas, the most elastic animal food is fish, followed by beef, milk, and chicken. For fish, it was found that a 1% increase in its price is expected to bring about a 1.979% decrease in the quantity of fish demanded by urban households on average. For beef, milk, and chicken, Marshallian elasticities suggest that a 1% increase in prices is expected to bring about on average a 1.975%, 1.561%, and 1.402% decrease in quantity demanded, respectively. The results show that for all animal sources of protein except eggs, quantity demand is highly responsive to price increases. Eggs were found to have inelastic demand since the Marshallian own-price elasticity was 0.749, which is interpreted as a 1% increase in egg price brings about a 0.749% decrease in quantity consumed on average. Eggs demand is not as responsive to price changes compared to other animal foods.

Table 4: Own-Price and Income Elasticities for Urban Households in Indonesia

Animal Food Groups	**Own-price Elasticity**		**Income Elasticity**
	Marshallian	**Hicksian**	
Eggs	-0.749	-0.518	0.476
Chicken	-1.402	-1.016	1.346
Beef	-1.975	-1.842	1.885
Fish	-1.979	-1.897	1.411
Milk	-1.561	-1.335	1.749

Source: Authors calculations based on Susenas, 2021

Table 4 also presented income elasticities for various animal foods. Income elasticities measures the degree of responsiveness of demand for a good which is brought about by changes in household income. If the calculated income elasticity is positive, then the good is said to be a normal good where increase in income brings about increase in consumption. However, if the income elasticity is negative then the good is inferior and increase in income brings about decrease in consumption as consumers substitute it for goods that are of higher quality. Furthermore, for normal goods, if the calculated income elasticity is greater than unity, then the good is said to be a luxury. The income elasticity of all animal food groups were found to be positive which means that they are all normal goods. Additionally, income elasticity suggest that all animal food is are luxuries except for eggs since

their values are greater than unity. Beef was found to have an income elasticity of 1.885 which means that a 1% increase in household income is expected to bring about a 1.885% increase beef consumption. For milk, fish, chicken, and eggs, it was found that a 1% increase in household income is expected that a 1% increase in household income will bring about a 1.749%, 1.411%, 1.346%, and 0.476%, respectively. Therefore, it can be suggested that policies geared towards improve household income can prove to be beneficial in the long term with respects to improving household animal protein consumption so that the national daily requirement of 57 grams per capita is met in urban households.

3.5. Welfare Analysis

In several countries around the world, rising food prices reduce household welfare. Protein fulfilment is often used to measure the household welfare of a country. This paper analyses the impact of price increases on household welfare using CV and EV. The scenario of an increase in food prices used to see changes in welfare is an increase in the price of eggs by 20%, chicken, beef, and fresh fish by 10% each, and milk by 5%. The study looked at three scenarios – CV and EV without substitution, with substitution only and with substitution.

Table 5 presents changes in the CV and EV welfare for urban Indonesian households caused by increase in food prices. Firstly, it can be seen that when there are no substitutions, the cost of animal-derived protein food combined is Rp. 23,262 per month per household. The CV and EV value for this scenario is identical, Rp. 23,262. From a CV perspective, this means that households would need to receive this Rp. 23,262 per month of additional income to maintain their original level of welfare after a price increase. This suggests that a price increase in all animal-derived proteins would have a negative impact on household welfare, as they would need to spend more money to maintain their original level of consumption.

Table 5: CV and EV for urban household of Indonesia

Food Groups	**CV**			**EV**		
	W/O Subst.	**Subst. Only**	**W/ Subst.**	**W/O Subst.**	**Subst. Only**	**W/ Subst.**
	Rp. per month per household					
Eggs	-10,358	755	-9,603	-10,358	1,317	-9,041
Chicken	-6,680	154	-6,526	-6,680	514	-6,165
Beef	-2,268	52	-2,217	-2,268	175	-2,093
Fish	-817	-1	-818	-817	42	-775
Milk	-3,139	-4	-3,144	-3,139	161	-2,978
All Items	**-23, 262**	**956**	**-22,308**	**-23,262**	**22,029**	**-21,052**

Source: Authors calculations based on Susenas, 2021. W/O subst.=without substitution, W/subst.= with substitution

The results in table 5 show that for all five animal-derived food groups, households without a substitution option experience a larger welfare loss compared to households with substitution options. When substitutions are made, we can see that the CV of all food groups combined is reduced to Rp. 22,308 per month per household. This means that households would need to receive this amount of additional income to maintain their original level of utility after a price increase. Compared to the scenario where no substitutions were made, the CV value is smaller, which suggests that households are more resilient to price increases when substitutions are possible. This can also be seen by the fact that for most animal-derived food, CV was smaller when there was substitution. For example, for eggs, the CV for households without a substitution option is Rp. 10,358 per month per household, indicating that these households need to be compensated with this amount of extra income to maintain their pre-price welfare level. On the other hand, households with a substitution option experience a smaller levels of welfare loss, with a CV of Rp. 9,603 per month for eggs. This suggests that the ability to substitute for other food items reduces the negative impact of a price increase.

Similarly, the results show that for all animal-derived food groups, households with a substitution option experience a higher EV compared to households without a substitution option. The EV value for the scenario with substitutions is larger than the one without substitutions, with a value of Rp. 21,052 per month. This means that

households could have the same level of utility with Rp. 21,052 per month less income if prices were reduced. This suggests that the impact of a price decrease is greater when substitutions are possible, as households can switch to cheaper alternatives to maintain their level of consumption. For instance, for eggs, the EV for households with a substitution option is around Rp. 1,317 per month, indicating that these households are willing to pay this amount to maintain their current consumption level of eggs despite the price increase. On the other hand, households without a substitution option experience a lower EV of Rp. -9,041 per month, suggesting that they are not willing to pay this amount to maintain their consumption level of eggs.

The results also show that the impact of a price increase varies across food groups. The highest welfare loss is for eggs, followed by chicken, beef, milk, and fish. This can be attributed to the different levels of substitutability between food items. Eggs, chicken, and beef are relatively close substitutes, while milk and fish are less substitutable. Therefore, the welfare loss for households with a substitution option is lower for eggs, chicken, and beef compared to milk and fish. The study's findings are consistent with the theory of demand, which states that the demand for a good depends on its price and the prices of other goods. In the case of animal-derived food, households have a substitution option between different food items, and a price increase in one food item will lead to a decrease in demand for that item and an increase in demand for substitutes. The results also suggest that households with a substitution option are more resilient to a price increase compared to households without a substitution option, highlighting the importance of promoting food diversification and increasing access to different food items.

The policy implications of the study are significant for Indonesia, where the majority of the population still relies on animal-derived food as a primary source of protein. The results suggest that a price increase in animal-derived food can have a significant negative impact on household welfare, especially for households without a substitution option. Therefore, policies aimed at stabilizing food prices and increasing the availability of different food items can help mitigate the negative impact of a price increase. One possible policy recommendation is to promote the diversification of food sources by promoting the consumption of plant-based protein sources, such as legumes and beans. This can reduce the reliance on animal-derived food and increase the availability of different food items. Additionally, policies aimed at increasing agricultural productivity can help reduce the cost of production and stabilize food prices. This can be achieved through investments in research and development, improving access to credit, and promoting the adoption of modern agricultural practices.

4. Concluding Remarks

This paper assessed the welfare impact of rising price of animal-derived food on urban Indonesian households using compensating and equivalent variation. The research data used secondary data in the form of the National Socio-Economic Survey (Susenas) data collected by the Central Bureau of Statistics (BPS), in 2021, totaling 112,569 households. The study calculated price and expenditure elasticities for various animal-derived foods. It was found that the most elastic animal-derived food in urban Indonesia was fish, followed by chicken, milk, beef, and eggs with demand elasticities of 1.979%, 1.975%, 1.561%, 1.402%, and 0.749%, respectively. Beef was the most income elastic with an income elasticity of 1.885%, followed by milk, fish, chicken, and eggs with income elasticities of 1.749%, 1.411%, 1.346%, and 0.476%, respectively. Estimation of CV and EV found that increase in animal-derived food prices reduces household welfare. In general, when prices increase and there is no substitution, household lose about Rp. 23,262 per month on average. However, when there is substitution, welfare loss based on CV is around Rp. 22, 308 while based on EV was around Rp. 21,052. In general, urban welfare loss was greater when there was substitution. Urban households experienced the most welfare loss from eggs which is plausible since eggs are widely consumed as it is a relatively cheap source of animal-derived protein. Fish saw the least welfare loss due to price increase as fish is already a relatively expensive commodity and is not as abundantly consumed as eggs for example. Considering that protein deficiency is permanent and has an impact on long-term mental decline, efforts are needed to stabilize the price of protein food so that the fulfilment of protein consumption according to the RDA is immediately met and protein food and nutrition security is achieved in urban households.

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