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ANIMAL FOOD DEMAND IN JAKARTA, INDONESIA: USING QUADRATIC ALMOST IDEAL DEMAND SYSTEM

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ABSTRACT
All of the households in Jakarta are urban households, but when viewed from the income elasticity of animal food, all animal food is still a luxury item except eggs. This study aims to analyze the influence of socio-demographic variables, price, and income on animal food demand in Jakarta. The estimation of demand system using Quadratic Almost Ideal Demand System model with the application of Iterated Non-Linear Seemingly Unrelated Regression. Research data using Susenas 2016 is 4,298 households. The results showed that a 1% increase in income would increase demand for eggs, chicken, beef, fish and milk by 0.38%, 1.07%, 2.19%, 1.44%, and 1.84%. Eggs are normal goods while chicken, beef, fish, and milk are luxury items. Beef is most sensitive to income changes. Beef is a substitute for eggs and chicken. The increase in household members of 1 person decreased the consumption of beef by 0.07%. Households in Jakarta are very sensitive to changes in the price of chicken, beef, and fish. To meet protein consumption according to national standards, the stability of beef prices needs to be maintained. In Jakarta, pricing policies are more effective than income policies.

KEY WORDS
Animal food, protein, demand system, urban household.

Three provinces with the lowest share of food expenditure is Yogjakarta (43.00%), Bali (42.73%) and Jakarta (39.94%) (BPS, 2016). Monthly expenditure per Capita in Jakarta by Rp. 1,997,446,-. Percentage of Monthly average expenditure per capita in the food and non-food by Jakarta by 39.94 and 60.06%. The monthly share of food expenditure per capita in Jakarta in March 2017 by 39.94%, East Java and Bali is 50.79 and 42.73% (Suhariyanto, 2017). Monthly average expenditure per capita of food items in Jakarta for fresh fish and shrimp by 1.48 kg (Rp. 45,638), beef by 0.12 kg (Rp. 12,317), broiler and local chicken meat by 0.76 kg (Rp. 23,158), chicken eggs by 10.57 unit (Rp. 13,511), duck eggs by 0.01 unit (Rp. 23), infant formula by 0.1 kg (Rp. 8,805). Along with increasing income and public awareness of nutrition and food quality, there has been a change in consumption patterns including increased consumption of animal foods (Bharumshah & Mohamed, 1993). Furthermore, Fabiosa (2005) said that income growth would shift the consumption of high-carbohydrate staple foods into more expensive foods such as meat and milk.

The increase in income will increase the demand for animal food (Bharumshah & Mohamed, 1993, Wood, Nelson, & Nogueira, 2012). Increasing demand for Indonesian animal food in the future requires adequate, quality and safe supply readiness. It is consistent with the goal of self-sufficiency, self-reliance, sovereignty, and resilience in food development. Indonesia was targeting self-sufficiency for animal food in 2010, but until now domestic animal food availability has not been sufficient, so imports are still being carried out, except for fish whose needs are met by domestic production. Weber (2015) also explained that if only relying on domestic production, it would be difficult for Indonesia to be self-sufficient in meat. Meat imports in 2010 amounted to 28% and in 2015 imports were still quite high at 37%. During this time the highest imports occurred in 2014, amounting to 246,509 tons. Domestic supply instability and import dependence often result in very volatile market prices.

Research on the demand for animal food using the QUAIDS approach has previously been carried out in various cities in various countries, both developed and developing countries (Elijah Obayelu, Okoruwa, & Ajani, 2009) in Nigeria, (Mittal, 2010) in India, and (Korir, Rizov, & Ruto, 2018) in Kenya. However, similar research is still rarely found especially in Jakarta. Therefore, this study wants to analyze the impact of price changes on demand for animal food in urban areas in Jakarta. Through this research we will obtain price elasticity and animal food income, whether animal food is normal or luxury goods, whether animal food is a substitute or complementary. This illustrates the consumption behavior and purchasing power of households for animal foods so that these results can be used to develop a protein fulfillment policy in Jakarta.

METHODS OF RESEARCH

Quadratic Almost Ideal Demand System. Estimating demand impact of rising food prices requires reliable price and income elasticities that could be commonly derived from utility-based demand models. The (Okrent & Alston, 2011), Linear Expenditure System (LES) and Theil (1965) Rotterdam model are among the first attempts to derive utility-based demand models. The AIDS model has been the most commonly used spesification in applied demand analysis for more than two decades as it satisfies a number of desirable demand properties. Moreover, it allows a linear approximation at estimation stage and has budget shares as dependent variables and logarithm of prices and real expenditure/income as regressors. (Banks, Blundell, & Lewbel, 1997), however, observed the existense of nonlinearity in the budget shares for some, if not all, commodities and subsequently introduced an extension to permit non-linear Engle Curves. They proposed a generalized Quadratic Almost Ideal System (QUAIDS) model which has budget shares that are quadratic in log total expenditure.

The AIDS as well as QUAIDS models are derived from indirect utility function (V) of the consumer given by:

$$1nV = \left\{\left[\frac{1nx - 1n\alpha\,(p)}{b(p)}\right]^{-1} + \lambda(p)\right\}^{-1} \quad (1)$$

Where x is total food expenditure, p is a vector a prices, a(p) is a function that is homogenous of degree one in prices, and b(p) and λ(p) are function that are homogenous of degree zero in prices; In a(p) and In b(p) are specified as translog and Cobb-Douglass equations as originally specified in Deaton and Muellbauer’s AIDS model. Note also that λ(p) is set to zero in Deaton and Muellbauer’s AIDS model.

$$1n\alpha(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_1 1np_1 + \frac{1}{2}\sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij}\, 1np_i 1np_j \quad (2)$$
$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i} \quad (3)$$
$$\lambda(p) = \sum_{i=1}^{n} \lambda_i 1np_i \quad (4)$$

Where = 1,.., n represent commodities.

After application of the Roy’s identity to equation [1], the QUAIDS expressed in budget shares form is given by (Banks, et al., 1997):

$$w_i = \alpha_1 + \sum_{j=1}^{n} \gamma_{ij}\, 1np_j + \beta_i 1n\left(\frac{x}{a(p)}\right) + \frac{\lambda_i}{b(p)}\left[1n\left(\frac{x}{a(p)}\right)\right]^2 + \varepsilon_i,\ i = 1, \dots, n \quad (5)$$

Where w_i is budget share for good i, α_1, γ_{ij} and β_i are the parameters to be estimated, ε_i is error term.

The demand theory requires that the above system to be estimated under restrictions of adding up, homogeneity and symmetry.

The adding up is satisfied if $\sum_{i}^{n} w = 1$ for all x and p which requires.

$$\sum_{i=1}^{n} \alpha_1 = 1, \sum_{i=1}^{n} \beta_1 = 0, \sum_{i=1}^{n} \gamma_{ij} = 0, \sum_{i=1}^{n} \lambda_i = 0 \text{ (Adding-up)} \quad (6)$$
$$\sum_{j=1}^{n} \gamma_{ij} = 0 \text{ (Homogeneity)} \quad (7)$$
$$\gamma_{ij} = \gamma_{ji} \text{ (Slutsky symmetry)} \quad (8)$$

These conditions are satisfied by dropping one of the n demand equations from the system and recovering parameters of the omitted equations from the estimated equations. Household demand for animal food consumption depends not only on their income and product prices but also on household preferences as well as socio-demographic characteristics (Banks, et al., 1997, Poi, 2012). Household demographic factors can be incorporated (in the demand model) using demographic transition method (Pollak and Wales, 1981). The QUAIDS can then be modeled after specifying the constant terms,s, α_1, as follows:

$$\alpha_i = \delta_i + \sum_{j=1}^{s} \delta_{ij} D_j, \& \sum_{j=1}^{s} \delta_{ij} = 0 \; i = 1, \ldots, n \quad (9)$$

Where δ_i and δ_{ij}'s are parameters to be estimated and D_j are demographic attributes including household size. In the letter approaches, zero consumption is modeled in the following system of demand equation with limited dependent variables.

$$w_i^* = f(x_i, u_i) + u_i, d_i^* = z_i^{'} \partial_i + v_i, \quad (10)$$

Where is budget share of good i (as specified above) and d_i is a binary outcomes that take one if household consumes food item of the considers aggregate, and zero otherwise, and w_i^* and d_i^* are the corresponding unobserved (latent) variables, x_i are household expenditure (income) and prices and$z_i^{'}$ are household demographic and related variables; $u_i$and ∂_i vectors of parameters to be estimated u_i and v_i are the random errors.

Assuming error terms (u_i and v_i) have bivariate normal distribution with cov $(u_i, v_i) = \emptyset$, for each commodity, Shonkwiller and Yen (1999) correct for inconsistency in the demand system by defining the second-stage regression as;

$$w_i^* = \phi(z_i^{'} \partial_i) f(x_i, u_i) + \delta_i \emptyset(z_i^{'} \partial_i) + e_i \quad (11)$$

Where $\phi(z_i^{'} \partial_i)$ and $\emptyset(z_i^{'} \partial_i)$ are the probability density function (PDF) and the cumulative distribution function, respectively, which are obtained, in theory, from a probit model using equation (10) in the first step for each of food commodity.

The QUAIDS model for animal food demand with household demographic in the second-step in then modified as (Poi, 2012):

$$w_i^* = \alpha_i \, \phi(z_i^{'} \partial_i) + \sum_{i=1}^{n} \gamma_{ij} 1np_j \; \phi(z_i^{'} \partial_i) + \beta_i \, \phi(z_i^{'} \partial_i) 1n\left(\frac{x}{a(p)}\right) + \frac{\lambda_i}{b(p)} \, \phi(z_i^{'} \partial_i) \left[1n\left(\frac{x}{a(p)}\right)\right]^2 + \sum_{j=1}^{s} \delta_{ij} D_j \, \phi(z_i^{'} \partial_i) + \delta_i \emptyset(z_i^{'} \partial_i) + \varepsilon_i, \text{ i=1,...,n} \quad (12)$$

In order to derive conditional expenditure on food prices elaticities, equation (12) is differentiated with respect to lnm and lnp, such that:

$$\Psi_i = \frac{\partial_i^*}{\partial 1nx} = \phi(z_i^{'} \partial_i) \left(\beta_i + \frac{2\lambda_i}{b(p)} \left\{1n \frac{x}{a(p)}\right\}\right) \quad (13)$$
$$\Psi_i = \frac{\partial w_i^*}{\partial 1np_j} = \phi(z_i^{'} \partial_i) \left(\gamma_{ij} - \Psi_i\left(\alpha_j + \sum_{k=1}^{n} \gamma_{jk} 1np_k\right) - \frac{2\lambda_i \beta_j}{b(p)} \left\{1n\left[\frac{x}{a(p)}\right]\right\}^2\right) \quad (14)$$

Where p is a price index calculated as the arithmetic mean of prices for all k animal food groups in the system. The conditional expenditure elasticities are then obtained by $e_i = (\Psi_i/w_i^*) + 1$.

Marshallian (uncompensated) price elasticities are derived as $e_{ij}^u = (\Psi_i/w_i^*) - \partial_{ij}$, where ∂_{ij} is the Kronecker delta equating one when i=j, and zero otherwise. Using the Slutsky equation, the conditional, Hicksian (compensated) price elasticities are given by $e_{ij}^u = (\Psi_i/w_i^*) + e_i w_j$. Estimating system using Brain P Poi 2008 "demand-system estimation: update, Iterated Non-linear Seemingly Unrelated Regression (Itnsur) model" (Poi, 2012), written in STATA 14. We based on Poi's Itnsur and developed a program that has taken into account the two-stage probit model for zero comsumption expenditure and household demographic.

The data used in this research is secondary data in the form of Central Bureau of Statistics of the Republic of Indonesia, March 2016. The data analyzed include socio-demographic data, household residence status, number of household member, household income, household consumption, price and total expenditure. The animal foods in this study include eggs (chicken eggs, local chicken eggs, and duck eggs), chicken (local chicken meat and chicken meat), beef, fish (fresh fish and shrimp including fish, shrimp, squid, and shellfish) as well as milk (milk powder and infant milk). The sample size is 4,298 households. Data processing proved challenging because many households do not consume animal foods, so many zero observations.

RESULTS AND DISCUSSION

Parameter estimates. Almost all parameters in the animal food demand system in Jakarta are significant at alpha 1 to 5%. The parameters of income and square of income are very significant, as well as the parameters of the number of household members are also very significant. This parameter will be used to calculate the income elasticity, its own-price elasticity, and the Marshallian and Hicksian cross price prices. Table 1 shows the parameter estimates of factors affecting animal food demand in Jakarta.

Table 1 – Parameter estimates animal food demand in Jakarta, 2016

Parameter (Coefficient and SEM)	Eggs (1)	Chicken (2)	Beef (3)	Fish (4)	Milk (5)
Constant					
α	1,611414 (0,080396)	-2,640143 (0,110112)	1,453717 (0,096427)	0,027303 (0,080502)	0,547709 (0,093668)
Expenditure					
β	0,192306 (0,012357)	-0,543867 (0,017106)	0,260958 (0,016601)	-0,006042 (0,014685)	0,096646 (0,017742)
Price					
γ_1	0,496095 (0,016039)	-0,500526 (0,031534)	0,135477 (0,020627)	-0,043424 (0,014526)	-0,087622 (0,017905)
γ_2	-0,500526 (0,031534)	1,131309 (0,088904)	-0,536707 (0,056729)	0,114023 (0,036292)	-0,208099 (0,046279)
γ_3	0,135477 (0,020627)	-0,536707 (0,056729)	0,233135 (0,045186)	-0,009269 (0,018845)	0,177364 (0,020366)
γ _4	-0,043424 (0,014526)	0,114023 (0,036292)	-0,009269 (0,018845)	0,016307 (0,009273)	0,102051 (0,021122)
γ_5	-0,087622 (0,017905)	-0,208099 (0,046279)	0,177364 (0,020366)	0,102051 (0,021122)	0,102051 (0,021122)
Square expenditure					
λ	0,021583 (0,000422)	-0,027715 (0,000949)	0,009273 (0,000838)	-0,001496 (0,000678)	-0,001645 (0,000817)
Demography					
η_hhm_tot	0,001392 (0,000910)	-0,002057 (0,000906)	0,000654 (0,000270)	-0,000118 (0,000168)	0,000130 (0,000319)
Demography					
ρ_hhm_tot	0,161776 (0,026703)	0,161776 (0,026703)	0,161776 (0,026703)	0,161776 (0,026703)	0,161776 (0,026703)

Source: Authors' computation from Susenas, 2016.

Income and own-price elasticity. Table 2 present the income elasticities, uncompensated own-price elasticities, and compensated own-price elasticities. All animal foods have positive income elasticity. It is consistent with the economic theory that when income increases, households will increase consumption of animal food as a source of protein (Akaichi & Revoredo-Giha, 2014). A 1% increase in household income will increase the demand for eggs, chicken, beef, fish and milk by 0.38, 1.07, 2.19, 1.44 and 1.84% respectively. Eggs are normal items. It is indicated by the value of income elasticity of less than 1. Beef and milk are luxury items. It is indicated by the value of the elasticity of income of more than 1. Chicken meat and fish are luxury items but tend to be normal items. It is indicated by the value of income elasticity closed to 1 (Cupák, Pokrivčák, & Rizov, 2015, Bilgic & Yen, 2013).

Table 2 – Income elasticity, Marshallian and Hicksian Own-price elasticity

Animal food groups	Income elasticity	Price elasticities		Number of household member
		Marshallian	Hicksian	
Eggs	0,38180 (0,00812)	-0,63816 (0,03787)	-0,48355 (-0,03719)	0,001392 (0,000910)
Chicken	1,07257 (0,01282)	-1,64344 (0,05539)	-1,29633 (-0,05521)	-0,002057 (0,000906)
Beef	2,19585 (0,04045)	-2,60731 (0,24623)	-2,47695 (-0,24644)	0,000654 (0,000270)
Fish	1,44415 (0,03900)	-2,48026 (0,15617)	-2,40039 (-0,15624)	-0,000118 (0,000168)
Milk	1,83761 (0,02409)	-1,22798 (0,06618)	-0,93993 (-0,06641)	0,000130 0,000319)

Source: Authors' computation from Susenas, 2016.

All animal foods have negative price elasticity both Marshallian and Hicksian. It is also in accordance with the economic theory that when there is an increase in prices, households will reduce consumption of a bundle of commodities (Matsuda, 2006). Beef is most sensitive to prices, followed by fish, chicken, fish, and milk (Table 2). Marshallian price elasticity has a greater value (in absolute terms) compared to Hicksian elasticity. It is because the Marshallian price elasticity contains the effect of changes in prices and income, while the elasticity of Hicksian prices only contains the effect of price changes (Demeke & Rashid, 2012, (Weber, 2015).

Demographic effects. The household member includes each of the persons who form household regardless of whether he or she is present or temporarily absent at the date of enumeration. However, a household member who on a journey for six months or longer, or less than six months but intended to move away, is not regarded as a household member (Bellemare, Barrett, & Just, 2013). The number of household members (HH size) influences the demand for household animal food in Jakarta statistically high significance at the 1% level. HH size has a positive relationship with the animal food demand for eggs, beef, and milk, but a negative relationship with chicken and fish. The increase in the number of household members one person will reduce the consumption of chicken and milk meat by 0.09% and 0.017% (Table 2).

Cross-price elasticity. Table 3 shows cross-price elasticity between household animal foods in Jakarta. If the relationship between animal food is positive means, there is a substitution relationship, and if it is negative, then there is a complementary relationship (Matsuda, 2006)(Mittal, 2010), Korir, Rizov, & Ruto, 2018). Marshallian cross-price elasticity for egg groups is negative with all animal food, chicken, beef, fish and milk. It means that among all animal foods complement each other. In other words, households in Jakarta consume animal food simultaneously. If there is an increase in animal food prices, households in Jakarta will reduce consumption of eggs, chicken meat, and milk. Conversely, if there is a decline in animal food prices, households in Jakarta will increase consumption of eggs, chicken, and milk together. The increase in income followed by the decline in milk prices will increase the demand for eggs, chicken and beef by 5.98%, 16.91%, and 0.49% respectively.

Table 3 – Cross-price elasticity of animal food demand

Cross-price elasticity of Marshallian (Uncompensated Elasticity)					
Animal food groups	Eggs	Chicken	Beef	Fish	Milk
Eggs	-0,63816 (0,03787)	0,22027 (0,03276)	-0,00373 (0,02416)	0,00830 (0,01968)	0,03152 (0,02054)
Chicken	-0,02341 (0,04191)	-1,64344 (0,05539)	0,27591 (0,03132)	0,29199 (0,02569)	0,02639 (0,03093)
Beef	-0,69261 (0,16866)	1,10445 (0,17106)	-2,60731 (0,24623)	-0,22684 (0,14089)	0,22647 (0,11884)
Fish	-0,36622 (0,14728)	1,57711 (0,15083)	-0,19269 (0,15121)	-2,48026 (0,15617)	0,01790 (0,10333)
Milk	-0,49490 (0,05496)	-0,21526 (0,06459)	0,11668 (0,04550)	-0,01615 (0,03666)	-1,22798 (0,06618)
Cross-price elasticity of Hicksian (Compensated Elasticity)					
Animal food groups	Eggs	Chicken	Beef	Fish	Milk
Eggs	-0,48355 (0,03719)	0,34383 (0,03271)	0,01894 (0,02420)	0,02941 (0,01969)	0,09137 (0,02064)
Chicken	0,41092 (0,04124)	-1,29633 (0,05521)	0,33958 (0,03132)	0,35131 (0,02569)	0,19452 (0,03102)
Beef	0,19659 (0,16451)	1,81509 (0,17077)	-2,47695 (0,24644)	-0,10541 (0,14085)	0,57068 (0,11921)
Fish	0,21859 (0,14395)	2,04448 (0,15033)	-0,10696 (0,15130)	-2,40039 (0,15624)	0,24428 (0,10369)
Milk	0,24923 (0,05326)	0,37945 (0,06413)	0,22577 (0,04543)	0,08548 (0,03664)	-0,93993 (0,06641)

Source: Authors' computation from Susenas, 2016.

CONCLUSION

This study uses the QUAIDS model approach to see the impact of price changes on animal food demand in urban Jakarta. The number of samples is 4,298 households. The results of the study show that all animal food income elasticity in Jakarta is positive. All price elasticities are either Marshallian or Hicksian were negative. Eggs are normal goods, while chicken, beef, fish, and milk are luxury items. Eggs are substitute with chicken, beef and milk. Households in Jakarta consume animal food simultaneously because it is seen from the cross elasticity of prices that are mostly negative. If there is an increase in animal food prices, households in Jakarta will reduce consumption of eggs, chicken meat, and milk. Conversely, if there is a decline in animal food prices, households in Jakarta will increase consumption of eggs, chicken, and milk together. The increase in income followed by a decrease in milk prices will increase the demand for eggs, chicken, and beef.

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