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Projection of Livestock Products Consumption in Indonesia

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インドネシアでは国の経済成長と世帯の平均収入の増加に伴い動物性タンパク源である畜産物—肉，卵，乳製品の消費量は著しく増加した．このことを念頭に本稿では食品消費の動向を需要モデル（LA/AIDS）を利用し，ジャワ島内の都市部および農村部の家計レベルと地域レベルにおける畜産物消費の分析を行った．その際，インドネシア家計調査による2005年の畜産物消費のデータを用いた．その結果，畜産物は価格弾力的であることが示され，各食品の支出弾力性より，肉および乳は贅沢材，卵は正常材であることが判明した．また，予測モデルを用いて同島の世帯・地域における今後の各畜産物に対する家計支出割合より各食品支出額および消費量を推定した結果，対象年より15年間における畜産物消費量の年間成長率は4–5%と高くなることが分かった．したがって同食品の安定的供給のため国内供給率の上昇が求められ，このことは今後のインドネシア畜産業の発展にも影響を及ぼすと言える．

1. Introduction

Food consumption patterns in Indonesia are changing. People are consuming more livestock products including beef and dairy products than cereals [18]. The proportion of household expenditure on food fell with most of the decline in consumption of cereal and tuberous food group [12]. The share of expenditure on cereal group (rice) as staple food decreased by about 9% during 1990–2002 and its share in income in 2005 became 16%,while expenditure share on livestock products such as meat, egg and milk increased by 2.01% [4]. As income increase, the variety of food consumed also increases.

Continuing prospect of the increasing per capita livestock products consumption has been a major concern for both policy makers and producers. Therefore, food consumption prediction model is needed to provide information for decision makers to evaluate the effects of changes in production due to various production programs and economic conditions including prices.

The aims of this study are to present estimation result from livestock products demand model and to measure livestock products consumption using projected model level considering their budget shares of livestock products in total food expenditure and growth rate in total consumption of livestock products. The following section discusses trend in livestock products consumption over 15 years. The model and data used are then discussed in section 3 and 4, followed by empirical results and conclusion in section 5 and 6, respectively.

2. Livestock Products Consumption in Indonesia

Livestock products are important source of animal protein in Indonesia. Consumption of animal protein from livestock products increased about 12% during 1999–2004.

The consumption of livestock products increased about 37% from 1990 to 2005. The consumption of meat, egg, and milk has increased significantly as the economy grew and per capita income rose. For instance, per capita consumption of livestock products grew slowly after economic shock in 1998. Per capita consumption of meat has increased from 4.45 kg in 1999 to 5.57 kg in 2002. Egg consumption per person doubled, rising from 2.23 kg to 4.4 kg. This trend is followed by milk consumption from 5.23 kg to 7.05 kg per person in the same period [8].

During the economic crisis in 1998, the consumption of

meat, egg, and milk decreased, and the impact of the crisis on the consumption change of livestock commodities was the highest for meat, followed by egg and milk. The consumption of animal protein decreased substantially in 1998 and 1999 by 28.3% and 21.1%, respectively. Subsequently, the contribution of meat in the protein consumption decreased 25.9% in 1998 and 22.2% in 1999. Even as a common commodity, protein consumption from egg decreased by 34.2% in 1998 and 33.3% in 1999 [9]. In 1999, the amount of consumption of meat (cattle and poultry meat), egg, and milk was 1.7, 0.6, and 1.1 million tons, respectively. These amounts were equivalent to 4.1 kg of meat per capita per year, 2.7 kg of egg per capita per year, and 5.09 kg equivalent of milk per capita per year, respectively. In 2003, these figures increased to 6.1 kg, 4.5 kg, and 7.3 kg, respectively.

During 2004–2006, chicken meat and egg had the highest share in consumption (meat about 80% of the total fresh meat and egg about 90% of total egg). This indicates that chicken and egg are the main source of animal protein which people keep consuming due to their relatively cheap price [9].

3. Model Specification

(1) Demand Model

Analysis of livestock products consumption can be estimated by demand model analysis. In this study, household expenditure data is used. The proper model in this study is Almost Ideal Demand System (AIDS) model [2] derived from expenditure function ([16]).

The Linear Approximation AIDS (LA/AIDS) demand function can be written as

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{x}{P^*}\right) + e_i \qquad (1)$$

where, w_i is the budget share of the i^{th} livestock products, which are i=1 for meat, i=2 for egg, and i=3 for milk, p_j is the price of the j^{th} livestock products, x is the total expenditure on food, α_i is the intercept and represents the budget share when all logarithmic prices and real expenditure equal zero. The γ_{ij} is equivalent to the change in the i^{th} budget share with respect to a percentage change in the j^{th} prices with real expenditure held constant. The β_i represent the change in the i^{th} budget share with respect to a percentage change in real expenditure with prices held constant, e_i is error term and P is Stone's price index [20] defined as

$$\ln P^* = \sum_{i=1}^{n} w_i \ln p_i \qquad (2)$$

Parameter estimates of the LA/AIDS are used to calculate the price and expenditure elasticity. Price elasticity is calculated in two ways; uncompensated and compensated elasticity. Uncompensated price elasticity contains both income and price effect whereas compensated elasticity includes only price effects. Following [1] and [19], taking the derivative of equation (1) with respect to $ln\ (p_j)$, uncompensated own ($j=i$) and cross ($j\neq i$) price elasticities of the LA/AIDS are calculated with the following equation:

$$\varepsilon_{ij} = -\lambda_{ij} + \left(\frac{1}{w_i}\right)\left(\frac{\partial w_i}{\partial \ln(p_j)}\right) = -\lambda_{ij} + \left(\frac{\hat{\gamma}_{ij}}{\bar{w}_i}\right) - \hat{\beta}_i\left(\frac{\bar{w}_j}{\bar{w}_i}\right) \qquad (3)$$

The compensated price elasticities become as follow:

$$\varepsilon_{ij}{}^* = \varepsilon_{ij} + \bar{w}_j + \hat{\beta}_i\left(\frac{\bar{w}_j}{\bar{w}_i}\right) = -\lambda_{ij} + \frac{\hat{\gamma}_{ij}}{\bar{w}_i} + \bar{w}_j \qquad (4)$$

where λ_{ij} is Kroneker's delta: $\lambda_{ij}=1$ for $i=j$ and 0 otherwise. Taking the derivative of equation (1) with respect to $ln\ (x)$, the expenditure elasticity can be obtained as follows:

$$\eta_i = 1 + \left(\frac{1}{w_i}\right)\left(\frac{\partial w_i}{\partial \ln(x)}\right) = 1 + \beta_i \Big/ \bar{w}_i \qquad (5)$$

where $\bar{w}_i$ is the average expenditure share, $\hat{\beta}_i$ and $\hat{\gamma}_{ij}$ are parameter estimates.

(2) Projection Model

In many recent studies, demand model projections are based on AIDS demand model (see [10], [17], and [15]. In this study, the livestock products projected consumption model is based on change in budget share of each livestock products between a base year and some future years [3]. When budget share in the base year is

$$w_i^0 = \alpha_{i0} + \sum_{j=1}^{n} \gamma_{ij} \ln p_j^0 + \beta_i\left[\ln x^0 - \ln P^0\right] \qquad (6)$$

and for some future year as

$$w_i^* = \alpha_{i0} + \sum_{j=1}^{n} \gamma_{ij} \ln p_j^* + \beta_i\left[\ln x^* - \ln P^*\right] \qquad (7)$$

the projected change in the budget share is

$$\left(w_i^* - w_i^0\right) = \sum_{j=1}^{n} \gamma_{ij}\left[\ln\left(p_j^* / p_j^0\right)\right] + \beta\left\{\left[\ln\left(x^* / x^0\right)\right] - \left[\ln\left(P^*\right) - \ln\left(P^0\right)\right]\right\} \qquad (8)$$

The future year values of prices and total food expenditure used in (8) can be expressed as follows:

$$p_j^* = (1+\delta_j)p_j^0 = \delta_j^* p_j^0 \tag{9}$$

$$x^* = (1+\sigma)x^0 = \sigma^* x^0 \tag{10}$$

where σ is the growth rate of total food expenditure on food which is calculated by dividing total food expenditure by the food price index and δ_j is inflation rate of food products[1].

Using Stone's price index with the base year budget shares yields

$$\ln(P^0) = \sum_j w_j^0 \ln(p_j^0) \tag{11}$$

and

$$\ln(P^*) = \sum_j w_j^* \ln(p_j^*) = \sum w_j^0 \ln\left[(1+\delta_j)p_j^0\right] \tag{12}$$

from which we obtain

$$\left[\ln(P^*) - \ln(P^0)\right] = \sum_j w_j^0 \ln(1+\delta_j) \tag{13}$$

then substituting (9), (10) and (13) into (8), projected budget share for the representative household in the future period is

$$w_i^* = w_i^0 + \sum_j \gamma_{ij} \ln(1+\delta_j) + \beta\left\{\left[\ln(1+\sigma)\right] - \left[\sum_j w_j^0 \ln(1+\delta_j)\right]\right\} \tag{14}$$

For i^{th} livestock products, expenditure (x_i) are obtained as the product of the budget share and total food expenditure, and quantity consumed (q_i) is obtained by dividing expenditure by the price. The growth rate of household expenditure (r^x) and consumption (r^q) is given by

$$r_i^x = (x_i^*/x_i^0) - 1 \tag{15}$$

$$r_i^q = (q_i^*/q_i^0) - 1 = \left[(x_i^*/p_i^*)/(x_i^0/p_i^0)\right] - 1 = \left[x_i^*/x_i^0(1+\delta_i)\right] - 1 \tag{16}$$

Like ([10], [3]), in this study we use constant-real-price assumption $((p_i^*/p^*)=(p_i^0/p^0))$ i.e. $\delta_1=\delta_2=\ldots=\delta_n=\delta$ for all i. Following the restriction of demand system, budget share is add-up to 1, so

$$\sum_j w_j^0 \ln(1+\delta_j) = \ln(1+\delta)\left(\sum_j w_j^0\right) = \ln(1+\delta) \tag{17}$$

and the homogeneity restriction[2]

$$\sum_j \gamma_{ij} \ln(1+\delta_j) = \left[\ln(1+\delta)\right]\left[\sum_j \gamma_{ij}\right] = 0 \tag{18}$$

Therefore, equation (14) is reduced to

$$w_i^* = w_i^0 + \beta\left\{\left[\ln(1+\sigma)\right] - \ln(1+\delta)\right\} = w_i^0 + \beta\ln\left[(1+\sigma)/(1+\delta)\right] \tag{19}$$

Equation (19) clarifies that the projected budget share depends on growth rate of total food expenditure (σ) and inflation rate of food product (δ).

4. Data

The available raw data from the 2005 national household expenditure survey (SUSENAS-*Survei Sosial Ekonomi Nasional*) were used to estimate the parameters of the structural model. SUSENAS is nationally representative household survey that is conducted by Central Bureau of Statistics (CBS), The Government of Indonesia. This database consist both quantities and expenditures on livestock products consumption for each sample household.

5. Results and discussion

(1) Estimation of parameters

LA/AIDS model was used to calculate the elasticities and coefficients of the livestock products consumption. Table 1 shows the estimated coefficients obtained from the model. It is obvious that although the R^2 values of the equations of each product seem low, in the studies where cross-sectional data is used, these values seem reasonable in system equations ([14], [13]).

To determine the sensitivity of the households towards income and prices, demand elasticities were taken into consideration. Table 2 shows the calculated uncompensated and compensated price elasticities, and expenditure elasticites from the estimation of LA/AIDS model. The uncompensated own price elasticities of household livestock products in the urban and rural areas show a negative sign and follow the theory of demand.

Own-price elasticities of all livestock products are significant at the 1% level. The uncompensated own-price elasticities of livestock products consumption in urban and rural areas show that meat, egg and milk products consumption is sensitive to the change of prices. From the cross-price elasticities analysis, change in the meat price was statistically significant to the change of egg and milk

Table 1. Estimation from LA/AIDS model

Parameters	Meat	Rural Egg	Milk	Meat	Urban Egg	Milk
β	0.0116***	−0.0162***	0.0046***	0.0273***	−0.0077***	−0.0196***
γ_{i1}	0.0640***	−0.0402***	−0.0237***	0.1090***	−0.0441***	−0.0650***
γ_{i2}	0.0014	0.0017	−0.0030	−0.0003	−0.0038***	0.0042*
γ_{i3}	−0.0232***	−0.0133***	0.0366***	−0.0315***	−0.0198***	0.0513***
R^2	0.1370	0.1610	0.2110	0.2760	0.2070	0.3560

Note: ***, ** significant at 1 % and 5 %, likelihood ratio test=−2 ln L(β)=9.019.

Table 2. Uncompensated Elasticity, Compensated Elasticity and Expenditure Elasticity

		Uncompensated Elasticity			Compensated Elasticity			Expenditure elasticity
		Meat	Egg	Milk	Meat	Egg	Milk	
Urban	Meat	−0.742	−0.036	−0.098	−0.333	−0.399	0.136	1.028
	Egg	−0.103	−1.017	−0.046	0.272	−0.61	0.169	−0.959
	Milk	−0.255	0.055	−0.746	0.085	0.418	−0.546	1.021
Rural	Meat	−0.815	−0.013	−0.077	−0.478	0.505	0.245	1.084
	Egg	−0.0724	−0.98	−0.025	−0.405	−0.496	−0.2	−0.984
	Milk	−0.145	−0.03	−0.794	−0.461	−0.518	−0.616	−0.887

Source: Authors calculation from SUSENAS 2005.

consumption with negative sign. Increasing price of meat caused decreasing consumption in egg and milk product. Meat becomes important food for household especially in the urban areas.

The compensated price elasticities are very similar to the uncompensated elasticities in terms of sign and statistical significance. Own-price elasticities of household livestock products carry a negative sign and this show that households are very sensitive to the change of price. Cross-price elasticities show competitive or complementary relations among products. All positive cross-price elasticity indicate that there is substitute response, while negative cross-price elasticity means that products are complements.

There are seven substitution relationships calculated using the compensated demand compared to only one by using the uncompensated demand. The positive statistically significant cross-price elasticities derived from the uncompensated demand of egg price elasticity are inelastic and have small impacts on changes in demand for milk products. Another difference in the compensated and uncompensated demands is the number of complementary relationships. For the uncompensated demand, there are eleven negative cross-price elasticities compared to five complementary relationships for compensated demand.

Expenditure elasticity is measuring the responsiveness of demand to changes in expenditure of the foods. The higher the expenditure elasticity, the more sensitive the household consumption in these foods. From the analysis, expenditure elasticity for meat and milk products is positive, greater than one and statistically significant at the 1% significance level, implying that they are luxury food. Negative sign in the expenditure elasticity show that egg is classified as necessity food. Households are more sensitive in the consumption of meat and milk than that of egg.

(2) Projection of Livestock Products Consumption

In this section, we made projections of Javanese's livestock products consumption to the year 2020. In this analysis, we use expenditure data survey in Java. It is important here to note that Java has contributed about 53% of livestock products consumption in Indonesia [9].

Since the total consumption in any year is equal to the product of consumption per capita and total population, projections must be made of both these elements. For per capita consumption, the relationships between per capita consumption and expenditure, as estimated above, are used. This in turn requires that projections of per capita expenditure are available. Finally, the projected level of consumption per capita is multiplied by the projected

population size.

The result shows that for most livestock products, the household-level growth rates for livestock products consumption were projected to year 2020 (Fig. 1). According to these projections, total livestock products consumption will grow at annual rate of 4.3–5.0% during the projection period. The average growth rates are achieved 4.14%, 4.43% and 2.21% for meat, egg, and milk, respectively.

In the household level, the prediction of budget share of the livestock products to the total food expenditure gave significant increase. During the projected period, budget share of meat will increase by 6.6% and 3.5% for egg, and milk will grow by 7.7% (Fig. 1).

Regional projections consumption are projections of livestock products consumption for urban and rural Java by using average population shares of urban and rural Java in the total population of Java. For each of the two regions, livestock products consumption projections are generated for three livestock products by combining the estimated demand response parameters from the structural model with population projections and assumptions about the future livestock products prices and real total food expenditure.

The annual growth rates of livestock products consumption and projection of food expenditure for urban and rural areas are shown in Fig. 2. Food expenditure is projected to increase from Rp. 130,000.00 in the base year to more than Rp. 250,000.00 in 2020. The annual growth rates in the consumption of livestock products in urban area are around 2.3%, 2.5% and 1.2% for meat, egg and milk, respectively, while only 0.5%–2% in rural area during the entire projection period.

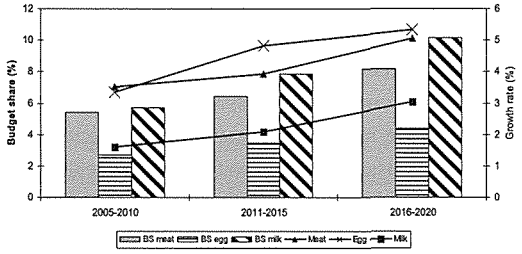

Fig. 1. Growth rate of consumption of livestock products and projected budget share

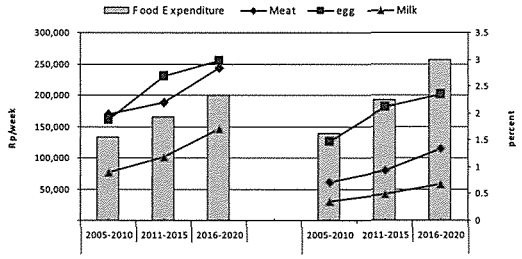

Fig. 2. Growth rate of livestock products consumption and projection of food expenditure in urban and rural area.

The results presented here show substantial growth in the consumption for meat (including poultry meat), egg and milk throughout the projection period. Therefore the domestic demand for livestock products could become important source of rapid growth for the livestock industry in Indonesia.

6. Conclusion

The analysis of livestock products demand model enables to study the importance of own- and cross-price effect on livestock products consumption. The higher the expenditure elasticity for meat and milk, the more sensitive household consumption in these foods is to expenditure changes. The model was used to project meat, egg, and milk consumption in Indonesia, particularly in urban and rural Java to the year 2020 using a constant-real-prices assumption.

Livestock products demand projections model are made from the changes in the budget share of each livestock products items from the base year. The model produces projections for each of livestock products in household and regional levels. Projected budget share for household in the future period is possible to estimate future expenditure and quantity consumed.

Projection of livestock products analysis implies that the demand for most livestock products in Java will continue growing during the next 15 years. Consequently, self-sufficiency in meat, egg and milk product would require the substantial increases in the production of livestock products in the future. Domestic demand for meat, egg and milk products could become an important source for the growing of livestock industry in Indonesia. This sector should respond to these phenomena by enhancing the production of meat, egg and milk products, focusing in the poultry industry, dairy product processing and the feedlot beef cattle fattening.

Note

1) CBS make forecast of inflation rate of food product for the following year of the best year.

2) The analysis of budget share model in this study was using assumption: (1)'Other food' (besides livestock products foods) prices do not have a large impact on the quantity demanded (see [5] and [11]), and (2) All household were assumed to face identical 'other food' prices, so the effect of 'other food' prices are absorbed in the intercept. The estimation of 'other food' can be implicitly assumed that its demand is separable from the demand of livestock products ([6]). Suggestion from [10], [6], and [7], share of 'other food' can be independently estimated. For this reason the equation for other food group is omitted in the estimation. Testing the homogeneity of the model was done using the following way:

$$w_i = \alpha_i + \sum_{j=1}^{n-1} \gamma_{ij} \ln p_{j4t} + \mu_i p_{4t} + \beta_i \ln\left(\frac{x}{P^*}\right) + e_i \quad i = 1,\ldots,n-1,$$

where $p_{j4t} = p_{jt} - p_{4t}$ (j=1,2,3) and $\mu_i = \sum_{j=1}^{n} \gamma_{ij}$.

So testing for homogeneity $\mu_i = 0$ (i=1, ..., n−1) using t-statistics ($p < 0.01$).

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