Journal of Indonesian Economy and Business
Volume 26, Number 2, 2011, 176 – 186

LIVESTOCK PRODUCTS DEMAND IN INDONESIA: CHOOSING BETWEEN AIDS AND ROTTERDAM DEMAND MODELS

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ABSTRACT

This paper examines the livestock products demand in Indonesia. This objective is accomplished by estimating a food demand model using Almost Ideal Demand System (AIDS) and Rotterdam model, and choose an appropriate demand model which best fits the data. A test to choose among the alternative joint model specifications is provided and the methodology is applied to data on demand for livestock products i.e. meat, egg, and milk. . To make consistency with Rotterdam form, first difference LA/AIDS is applied in this study. The estimated parameters find the reasonable sign and significant for the most part of the coefficient. Own price elasticity shown negative sign, indicating that meat, egg and milk are sensitive to prices except for egg in the first differences LA/AIDS model. Real expenditure has significantly effect to the consumption of livestock products. The joint model approach was used to select the appropriate model in this study results that the first difference LA/AIDS or the Rotterdam models are both appropriate to represent Indonesian livestock products demand. For the discrimination of the models, the goodness-of-fit (adjusted R^2), forecasting accuracy (RMSE) and the elasticity of the demand models are also considered to measure the best model. The first difference LA/AIDS model fits well as reflected by its higher adjusted R^2 and the lower RMSE relative to the Rotterdam model. The LA/AIDS model accommodates the high elasticities better than the Rotterdam, since AIDS performed well.

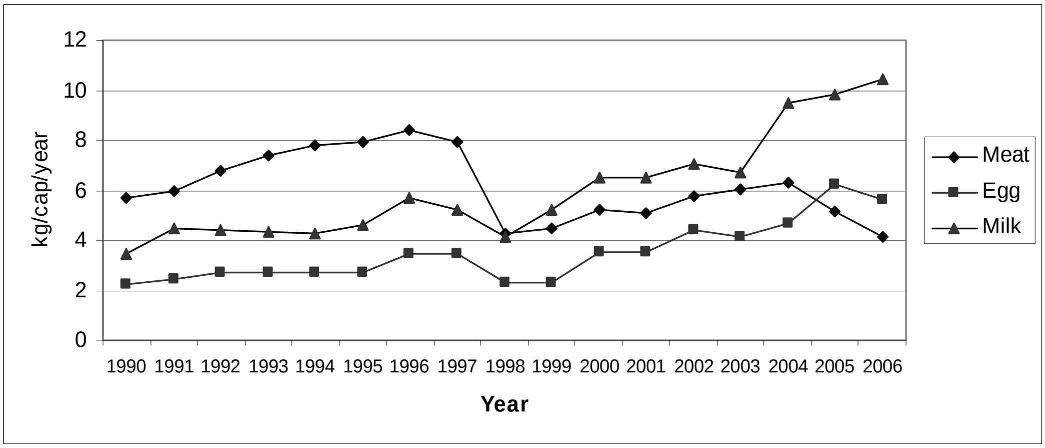
Keywords: *livestock products demand, Rotterdam model, Almost Ideal Demand System (AIDS) model, joint model*

INTRODUCTION

Indonesian food consumption has increased with the increasing value of per capita income. In response to income growth, Indonesians' diets have been changing to eating more high-value food such as livestock products that including beef, poultry meat, egg and dairy products from cereal. The proportion of household expenditure on food fell with most of the decline in consumption of cereal and tuberous food group. The share of expenditure on cereal group (rice) as staple food decreased by about nine percent during 1990-2002 and its share in income in 2005 became 16 percent, while expenditure share on livestock products such as meat, egg and milk

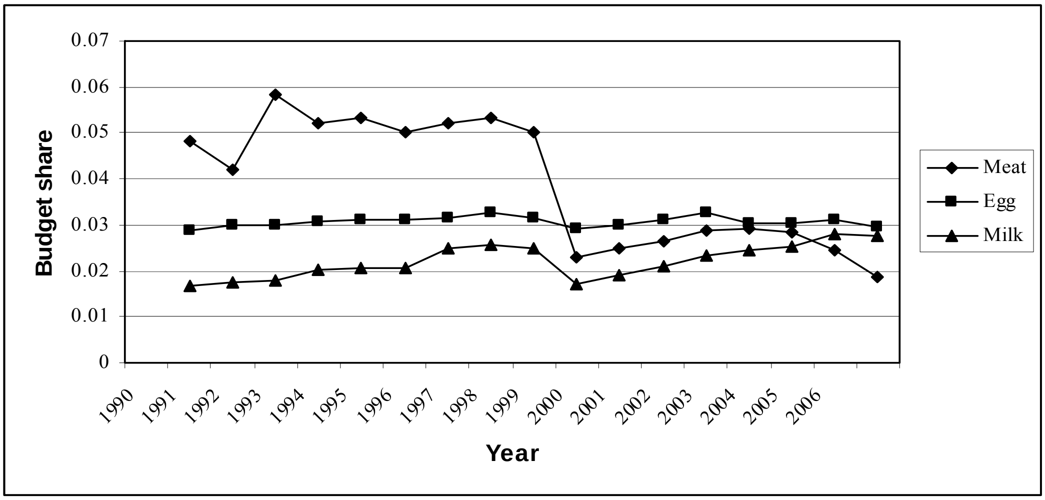
(Figure 2) increased by 2.01 percent (CBS, 2006).

Livestock products are important sources of animal protein in Indonesia. Consumption of animal protein from livestock products increased by 11.84 percent and by only 4.77 percent from fish respectively during 1999-2004. Consumption of livestock products increased an average of 37.36 percent from 1990 to 2005. As shown in Figure 1, per capita consumption of livestock products in Indonesia grew slowly after economic shock in 1998. Per capita consumption of meat, egg and milk in Indonesia has increased from 4.45 kilograms to 5.57 kilograms, 2.23 kilograms to 4.4 kilograms, and 5.23 kilograms to 7.05 kilograms respectively during 1999 to 2002 (DGLS, 2006).



Source: DGLS, various years

Figure 1. Consumption of Livestock Products (kg/cap/year)



Source: CBS, various years

Figure 2. Budget Share of Meat, Egg and Milk

The important considerations should be noted from these figures that they provide little information about the price and income elasticities of each commodity. The elasticity in the consumption figure explains behavioural consumption. In the empirical study of consumption, functional form is the important thing to use for analysing the demand. Demand model plays an important role in the analysis of demand. Demand analysis result elasticity estimation explains change in the demand by change in the independent variables. Different functional forms often result in very different elasticity estimates (Dameus et al, 2002). It is important to make a right choice of model in the demand analysis. Choice a functional form may influence demand parameter estimation. Understanding 'best' livestock products demand model is important in order to give a more accurate evaluation of the consumers' behavior for these products.

Various types of techniques have been used for food demand analysis. In this study, the Almost Ideal Demand system (AIDS) and Rotterdam model are used since each can be estimated in linear form. This paper analyzes empirically the responsiveness of Indonesian households to food price and total expenditure, proxy of income, changes in the consumption of livestock products. This objective is accomplished by estimating a food demand model using appropriate demand model and choose a model which best fits with a given data.

This paper is arranged as follows: the overview of food demand studies are presented in the next section. Section 3 describes the two demand models. The explanation of the data used in this study is done in section 4. Empirical results and the conclusion are in section 5 and 6 respectively.

OVERVIEW OF FOOD DEMAND STUDIES IN INDONESIA

Food demand analyses have been vastly conducted both theoretically and empirically. However, no studies have analyzed the issue of demand model choices econometrically, particularly in the case of specific food such as livestock products in Indonesia. Several studies have provided methods for analysing food consumption behaviour with one model analysing. Alderman and Timmer (1980) utilised double log quadratic model of food quantity consumed.

Chernichovsky and Meesok (1984) derived price and income elasticity of food demand in Indonesia. With double logarithmic function, they estimated household quantity of food with double logarithmic function. They found the effect of income and prices on food consumption pattern. For instance, income and price elasticities of meat were 1.68 and -1.86 respectively. This value was highest among 12 other food groups in Java compared to outer Java.

Whereas Daud (1986) in Widjajanti and Li (1996) analysed urban and rural food consumption pattern with AIDS model, Teklu and Johnson (1987) compared AIDS model and Multinomial Linear Logit (MLL) model for estimating food demand in Indonesia. The resulting estimated elasticities vary significantly across economic levels.

Tabor, Altemeir, and Adinugroho (1989) used Full Information Maximum Likelihood (FIML) technique with time series data of prices, expenditure, and consumption availability. They concluded that Indonesian food staples are normal goods and expenditure elasticities are higher for the higher value foodstuffs than for the lower value starchy staples.

Following previous studies, Rachmad and Erwidodo (1993) analysed urban and rural staple food consumption with AIDS model. Using different commodities Rachmad and Erwidodo (1993), and Jensen and Manrique (1998) also applied linear form of AIDS model for estimating animal food consumption. The demand parameters were estimated for each income group. The demand of high income households was responsive to prices, income and demographic variables, whereas middle to low income household demand was responsive mainly to prices and income. The own price elasticity became more elastic from high to lowest income group. Cross price became greater for low income group.

In their study, Hutasuhut et al (2002) adopted AIDS model in the analysis of beef demand in Indonesia. They found own price of meat in group I (beef-buffalo meat-trimming) inelastic, whereas the second group (chicken, goat meat and innards products) has elastic own price elasticity. Cross price elasticity result in the second group was substitute for first group and the expenditure elasticity fallen overtime.

Most other scholars analysed food consumption using household expenditure survey data focusing on the change of economic condition i.e. price. For instance, Sudaryanto et al (2002) found that the impact of the crisis on livestock products consumption is differed between urban and rural area. The most affected are consumption on chicken meat, beef, eggs, and milk for both region but only consumption on beef was relatively constant in rural area. For the people who still consumed livestock commodities, the rate of their consumption reduces substantially. For the instance in rural areas, chicken meat consumption decreased by 54.9 percent, eggs 33.6 percent and milk 23.6 percent. In urban areas, the negative change in their consumption is 51.6 percent, 32.9 percent and 23.4 percent respectively (Ariani, 2004)

DEMAND MODEL

1. Rotterdam Model

Barten (1964) and Theil (1965) took the Rotterdam form (in natural logarithm) as follow:

$$w_i d\ln q_i = \beta_t d\ln Q + \sum_i \gamma_{ij} d\ln p_i \qquad (1)$$

where w_i represent the average budget share of commodity i; p_i and q_i are the price and quantity of good i, respectively.; *d ln p* and *d ln q* represent dp_i/p_i and dq_i/q_i, respectively: and *d ln Q* is an index number for the change in real income

$$d\ln Q = \sum_i w_i d\ln q_i \qquad (2)$$

for $w_i = p_i q_i / x$ and $x = \sum_i p_i q_i$.

Demand parameters β_i and γ_{ij} are given by

$$\begin{aligned} \beta_i &= p_i(\partial q_i/\partial X) \\ \gamma_{ij} &= (p_i p_j / X) s_{ij} \\ s_{ij} &= \partial q_i/\partial p_i + q_i \partial q/\partial X \end{aligned} \qquad (3)$$

where X is total expenditure and s_{ij} is the *(i,j)*th element of the Slutsky substitution matrix, parameter β is the marginal budget share of commodity i, and γ is a compensated price effect. Taking the logarithmic differential of the budget equation gives:

$$d\ln x = \sum_j w_j d\ln p_j + \sum_j w_j d\ln q_j \qquad (4)$$

This is rewritten as:

$$\sum_j w_j d\ln q_j = d\ln x - \sum_j w_j d\ln p_j \qquad (5)$$

and substitute into (1), giving the following Rotterdam model:

$$w_i d\ln q_i = \sum_j \gamma_{ij} d\ln p_j + \beta_i \left(d\ln x - \sum_j w_j d\ln p_j \right) \qquad (6)$$

The constraint of demand theory can be directly applied to the Rotterdam parameters. In particulars, we have

Adding-up $\sum_i \beta_i = 1$, $\sum_i \gamma_{ij} = 0$ (7)

Homogeneity $\sum_i \gamma_{ij} = 0$, and (8)

Symmetry $\gamma_i = \gamma_j$ (9)

The following elasticities were calculated using these formulas (Barten, 1993):

Expenditure elasticity:

$$\eta_i = \beta_i / \overline{w}_t \quad (10)$$

Compensated elasticity:

$$\varepsilon_{ij} = \gamma_{ij} / \overline{w}_t \quad (11)$$

Uncompensated Elasticity:

$$\varepsilon_{ij} = \left(\gamma_{ij} - \beta_i \overline{w}_j\right) / \overline{w}_i \quad (12)$$

This expression indicates that a good with positive (negative) β_i is a luxury (necessity). Since the budget share of a luxury increases with income (prices remaining constant), the increasing income causes the η_i for such a good to fall toward one and as the consumer becomes more affluent, luxury goods becomes less luxuries. The income elasticity of a necessity also declines with increasing income and, if $\beta_i = 0$, the good is unitary elastic and the budget share will not change in response to income change (again, price held constant).

2. Almost Ideal Demand System (AIDS) Model

AIDS demand model was developed by Deaton and Meullbauer (1980). The AIDS is specified as

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{x}{P}\right) + e_i \quad (12)$$

where, w_i is the budget share of the i^{th} live-stock products, p_j is the price of the j^{th} food that are livestock products such as meat, egg and milk, x is the total expenditure on food, α , β, and γ are the parameters of the variables, e_i is error terms and P is the price index defined by.

$$\ln P = \alpha_0 + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i \quad \ldots(13)$$

This price index causes the system to be non linear. To make the model linear in parameters, Deaton and Muellbauer (1980) suggested using Stone (1954) price index defined as

$$\ln P^* = \sum_{i=1}^{n} w_i \ln p_i \quad (14)$$

The model which uses Stone's price index is called the Linear Approximate AIDS (LA/AIDS) and is defined as follows

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{x}{P^*}\right) \quad (15)$$

The AIDS model, on the other hand, derives demand function for each consumption item in budget share form. However, in the time series context, the LA/AIDS model is often estimated in the first difference form. To make it consistent with Rotterdam form, first difference LA/AIDS is specified as:

$$\begin{aligned} dw_i &= \sum_{j=1} \gamma_{ij} d\ln p_j + \beta d\ln \frac{x}{P^*} \\ &= \sum_{j=1} \gamma_{ij} d\ln p_j + \beta\left(d\ln x - d\ln P\right) \\ &= \sum_{j=1} \gamma_{ij} d\ln p_j + \beta\left[d\ln x - \left(\sum_{i=1} w_i d\ln p_i \right.\right. \\ &\quad \left.\left. + \sum_{i=1} dw_i . \ln p_i + \sum_{i=1} dw_i . d\ln p_i \right)\right] \\ &= \sum_{j=1} \gamma_{ij} d\ln p_j \\ &\quad + \rho_i \left(d\ln x - \sum_{j} w_j d\ln p_j \right) \quad (16) \end{aligned}$$

The following restrictions are imposed on the parameters in the LA/AIDS model:

Adding-up: $\sum_{i=1}^{n}\gamma_{ij}=0$, $\sum_{i=1}^{n}\beta_i=0$, $\sum_{i=1}^{n}\alpha_i=1$, allowing the budget share to sum to unity,

Homogeneity: $\sum_{j=1}^{n}\gamma_{ij}=0$, is based on the assumption that a proportional change in all prices and expenditure do not affect the quantities purchased.

Symmetry: $\gamma_{ij}=\gamma_{ji}$, represents consistency of consumer choice

The elasticity for LA/AIDS model was calculated using these formulas (Barten, 1993):

Expenditure elasticity:

$$\eta_i = 1 + \beta_i / \overline{w}_t$$

Compensated elasticity:

$$\varepsilon_{ij} = -\delta + \left(\gamma_{ij} / \overline{w}_t \right) + \overline{w}_j$$

Un-compensated elasticity:

$$\varepsilon_{ij} = \left(\gamma_{ij} - \beta_i \overline{w}_j\right) / \overline{w}_i$$

Where $\delta = 1$ for i = j and $\delta = 0$ otherwise. $\overline{w}$ is the average budget share in each livestock products equation, β_i and γ_{ij} are estimated parameters.

3. Joint-Model Approach

The Rotterdam and LA/AIDS models are not nested each other (Barten, 1993) have the same right-hand side, but a different left-hand side. Non-nested models are used to explain the same phenomenon. One model as non-nested model is usually not a special case of another model (Doran, 1993). When the demand models are not nested, one needs an alternativetetsing procedure for competing alternatives (Lee *et al.*, 1994). In this study, the authors briefly discuss the problem of model selection and the differences and similarities between the two approaches.

When comparing the performance of alternative model, we adapt the joint model of Barten (1993), Xu and Veeman (1996), and Alston and Chalfant (2001) for test, and jointly both functional and structural specification using the linear

Model 1: y = f(x)

Model 2: z = f (x)

To test each model, the joint model is estimated as

$$\lambda y + (1-\lambda) z = f(x) \tag{17}$$

with λ = 0 representing model 2 and λ = 1 representing model 1. Thus, following Alston and Chalfant (2001), for testing Rotterdam model, the two alternative models can be combined as:

$$(1-\lambda_1)\, dw_i \ln q_i + \lambda_1 w_i = \sum \gamma_j d\ln p_j + \beta\left[d\ln x - \sum w_j d\ln p\right] \tag{18}$$

Equation (18) is a combination model of first different LA/AIDS and Rotterdam model. If $\lambda_1 = 0$, equation (18) can be interpreted that Rotterdam is correct model.

Analogue, LA/AIDS model can be tested in the alternative joint model as follow:

$$\left(1-\lambda_2\right) dw_i + \lambda_2\, dw_i \ln q_i = \sum_{j=1}^{n} \gamma_{ij} d\ln p_j + \beta\left[d\ln x - \sum_{j=1}^{n} w_j\, d\ln p_j\right] \tag{19}$$

If $\lambda_2 = 0$, equation (19) implies that LA/AIDS is correct model. When both models are correct, the test of model performance, forecasting accuracy and elasticity could be used to choose the best model.

DATA

Annual data covering 1990-2005 are used in the estimation of the two demand models.

Quantities of meat, egg and milk consumed are needed in this analysis. Per capita meat, egg and milk consumption data are obtained from various year of *Livestock Statistical Book* published by Directorate General Livestock Services (DGLS) of Indonesia. Prices of livestock products in this analysis are using retail price. The yearly retailed price data are reported by DGLS. Since 2002 Livestock Statistical Book did not published this data. Therefore, additional yearly retailed price data which are not published in the DGLS report are found from other publications like Setiawan (2006).

The expenditure and the budget share of meat, egg and milk consumption data for these periods were assembled from *Per capita Expenditure by Commodity Group* reports published by Central Bureau of Statistics (CBS).

EMPIRICAL RESULTS

1. Estimation of the Two Models

Estimation of parameters in first different LA/AIDS and Rotterdam model are reported in Table 1. The linear expenditure term is statistically significant in most of the expenditure share equations. It is in the expenditure share equations for meat, egg and milk that the null hypothesis of expenditure linearity is not rejected.

A similar conclusion can be reach by comparing the estimated coefficient and the statistical significance of the two models. In the model analysis, the coefficients are reasonable in sign and significant for the most part. Own price elasticity shown negative sign, indicating that meat, egg and milk are sensitive to prices except for egg in the first differences LA/AIDS model. The significant complementary and or substitution relation among food product are shown in the cross-price elasticity with five percent of significance level.

In the case of the real expenditure variable, it is significant at 10 percent level for Rotterdam model for meat expenditure share equation and significant at five percent for the egg and milk expenditure share equations. It is also shown that among the significant parameters are significant at the one percent level, which is very good considering that annual time series data were used.

First difference LA/AIDS model analysis shows that the real expenditure variable is significant at one percent for the meat share equation and significant at five percent for the milk share equation, but insignificant for the egg share equation. It is further also shows that all are significant at the one percent level. The model with R^2, indicates that the inde-

Table 1. Estimates of Parameters from Two Models.

	Rotterdam Model			First Differences LA/AIDS		
	Meat	Egg	Milk	Meat	Egg	Milk
Constant	0.075	0.095	-0.613	0.317	0.659	-0.497
Price of meat	-0.934**	-0.385	-0.617	-1.77**	-0.368**	0.404
Price of egg	-6.157*	-1.27**	0.351	0.85*	0.551*	-0.373
Price of milk	0.784*	-1.273	0.553*	1.35*	-0.338	0.154**
Real expenditure	0.795*	-0.098**	-0.076**	1.73***	0.17	0.501**
R^2	0.703	0.855	0.692	0.61	0.45	0.641
Adj R^2	0.633	0.057	0.08	0.22	-0.055	0.266
RMSE	0.738	0.05	0.29	0.75	0.018	0.062
λ	0.46	0.7	0.49	0.51	0.2	0.34

Note: ***,**, and * denote 1, 5, and 10 percent significant level, respectively.

pendent variables in the LA/AIDS model, explain 74.6 percent of the variation in the data, which is significantly higher than the Rotterdam model.

2. Test for Joint Model

The first joint model contains Rotterdam model, that is, when λ_1, is restricted to zero. Parameter estimates and their standard errors are shown in table 1. The λ_1, test does not reject the Rotterdam model. In other words imposing the Rotterdam model as a restriction on the compound model is supported by these data. The estimated value of λ_1, is 0.69, so we cannot reject the null hypothesis that λ_1, is zero and the Rotterdam model is correct. Even if it were statistically significant, λ_1= 0.06 would seem close to the Rotterdam case.

To test the validity of the LA/AIDS model, equation is estimated. Since the alternative model now is not exactly of the Rotterdam form-just as earlier the alternative was not exactly the LA/AIDS there seems to be no reason to expect $\lambda_2 = 1-\lambda_1$,. Now, a test of the null hypothesis that $\lambda_2 = 0$ is a test that the LA/AIDS model is correct; finding evidence that λ_2, is not zero is evidence against the null hypothesis. A rejection in the direction of $\lambda_2 = 1$ can be interpreted as evidence that the Rotterdam model may be the more appropriate hypothesis.

Along with the estimates obtained earlier for $\lambda_2 = 0$. The λ_2, test rejects the LA/AIDS model. In other words, imposing the LA/AIDS model as a restriction on the compound model is not supported by these data. The estimated value of λ_2 is 0.95 with a much smaller standard error (0. l0), so we can reject the null hypothesis that λ_2, is zero and that the LA/AIDS model is correct.

For the sake of discrimination between the two models, we examined other performance like goodness-of-fit, forecasting accuracy, and the elasticity of the demand models. Each livestock products equation result that adjusted R^2 in the LA/AIDS model is higher than that of Rotterdam model. Based on the predictive accuracy of the model, the Root Mean Square Error (RMSE)s is the lowest form of the first difference LA/AIDS model, suggesting a better fit than the Rotterdam model.

3. Differences in Estimated Elasticities

The results of the joint model tests suggest that the AIDS demand model is appropriate for analysis of Indonesian livestock products consumption data. Statistical testing provides one criterion for model selection. The influence of model choice on elasticity estimates is also of interest. Choosing the models is also influenced by elasticity estimation. Parameter estimates of the LA/AIDS are used to calculate the price and expenditure elasticity.

Price elasticity is calculated in two ways. The first is uncompensated elasticity that contains both price and income effect. The second is compensated elasticity which only includes price effects**.** Table 2 summarises the uncompensated and compensated price elasticities estimates of both models. There is no difference between two models in mean elasticities. The own-price elaticities of the first difference LA/AIDS model have all the correct negative sign, while the Rotterdam model compensated own-price elasticity for egg (0.02) and milk (0.01) are positive, which is unexpected. All the own price elaticities are less than one implying that livestock products are price inelastic. In all cases, the absolute value of own-price elasticities is greater in LA/AIDS model than in Rotterdam model.

Cross-price elasticity shows competitive or complementary relation among food products. Positive cross-price elasticity indicates substitute products, while negative cross-price elasticity means that products are complements. Egg has competitive relationship with meat product. There is substitute relationship between egg and meat and is statistically significant, indicating that the consumption of egg is influenced by prices of meat product.

Table 2. Estimated Elasticities: Rotterdam and First Differences LA/AIDS model.

		Uncompensated		Compensated		Expenditure Elasticity	
		Rotterdam	LA/AIDS	Rotterdam	LA/AIDS	Rotterdam	LA/AIDS
Meat	Meat	-0.38	-0.46	-0.28	-0.31	0.61	1.2
	Egg	0.22	0.19	0.03	0.05		
	Milk	-0.66	-0.05	0.03	0.04		
Egg	Meat	0.18	0.24	0.08	0.13	0.21	0.44
	Egg	-0.62	-0.63	0.02	-0.03		
	Milk	-0.26	-0.22	-0.02	0.005		
Milk	Meat	-0.16	-0.26	0.08	0.08	0.34	1.28
	Egg	-0.61	-0.55	-0.02	0.004		
	Milk	-0.21	-0.23	0.01	-0.02		

Expenditure elasticites for all livestock products carry the expected positive sign and all are statistically significant at the one percent level. Corresponding to these expenditure elasticities, meat and milk are classified as luxury products, whereas egg was found to be necessity for Indonesian diets.

CONCLUSIONS

The functional forms in this study are Rotterdam and AIDS demand model. Comparison of the two models required the use of a non-nested test. Moreover, economic criteria and the elasticity estimates were used to evaluate the demand model.

The joint model approach was used to select the appropriate model in this study. The results from the joint model parameters suggest that the first difference LA/AIDS (represent the AIDS model) or the Rotterdam models are both appropriate to represent Indonesian livestock products demand. However, for the discrimination of the models, the other performances like goodness-of-fit (adjusted R^2), forecasting accuracy (RMSE) and the elasticity of the demand models are also considered to measure the best model. The first difference LA/AIDS model more appropriate than Rotterdam model based on its goodness of fit estimation. The first difference LA/AIDS model fits well as reflected by its higher adjusted R^2 and the lower RMSE relative to the Rotterdam model.

The AIDS model accommodates the high elasticities better than the Rotterdam, since AIDS performed well. Compensated own-price elasticity estimates of egg and milk from the Rotterdam model do not carry the expected sign. Cross-price elasticity shows that the elasticities of substitution among goods are high, so LA/AIDS model performs better than Rotterdam.

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