Nutrient elasticities in meat demand: a case in Malaysia

Tey, (John) Yeong-Sheng and Shamsudin, Mad Nasir and Mohamed, Zainalabidin and Abdullah, Amin Mahir and Radam, Alias

Institute of Agricultural and Food Policy Studies, Universiti Putra Malaysia, Malaysia., Faculty of Environmental Studies, Universiti Putra Malaysia, Malaysia., Department of Agribusiness and Information System, Faculty of Agruculture, Universiti Putra Malaysia, Malaysia., Institute of Agricultural and Food Policy Studies, Universiti Putra Malaysia, Malaysia., Institute of Agricultural and Food Policy Studies, Universiti Putra Malaysia, Malaysia.

NUTRIENT ELASTICITIES IN MEAT DEMAND: A CASE IN MALAYSIA

by

Tey (John) Yeong-Sheng[1], Mad Nasir Shamsudin[2], Zainalabidin Mohamed[3], Amin Mahir Abdullah[1], and Alias Radam[1]*

ABSTRACT

One distinct change in Malaysian food consumption behavior is the preference for meat products over staple and grain foods intact with income growth. Having mentioned the changes in food consumption behaviors, indeed, there are changes in nutrient availability and intake as well. This study aims to provide a better understanding of meat consumption behaviors in terms of income, price, and nutrient elasticities by analyzing the Household Expenditure Survey 2004/05 data. In the first stage, expenditure and own-price elasticities are estimated via the LA/AIDS model. This is followed by an estimation of Engel function in the second stage to obtain the estimates of income elasticities for the meat products. This study shows that the major meat products (beef, pork, mutton, and poultry) are normal goods and own-price elastic. There are mixed messages obtained from the estimated nutrient elasticities.

Keywords: *Meat, price elasticity, income elasticity, nutrient elasticity*

JEL code: Q11, I12

1.0 INTRODUCTION

One distinct change in Malaysian food consumption behavior is the preference for meat products over staple and grain foods intact with income growth. Since there is a limit on total calorie intake, Chern *et al.* (2003) suggested that the ratio of the meat products in food basket becomes larger in comparison to other grain commodities. Hence, meat consumption is increasingly important in Malaysian diet. This is mainly attributed to the affordability and homogeneity of poultry to all ethnics in Malaysia. Generally, poultry sector is industrialized for mass production in order to cope with the pressure of tight marketing margin that caused by the implementation of ceiling price. The recent prices (both oil and grain) hike has forced the government to remove the ceiling pricing in poultry retail price.

[1] Institute of Agricultural and Food Policy Studies, Universiti Putra Malaysia, Malaysia.
* Corresponding author: tyeong.sheng@gmail.com
[2] Faculty of Environmental Studies, Universiti Putra Malaysia, Malaysia.
[3] Department of Agribusiness and Information System, Faculty of Agruculture, Universiti Putra Malaysia, Malaysia.

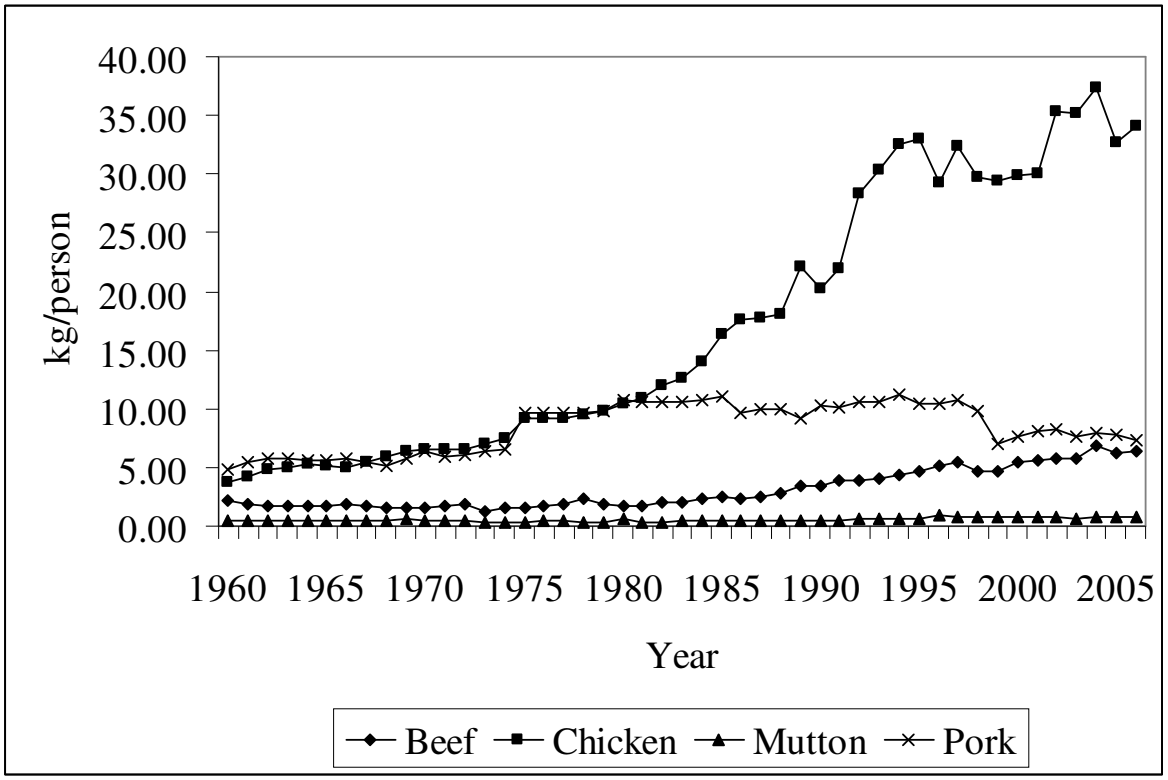
The paragraph above is a brief description to show that the entire agri-food industry is impacted by changes in food consumption behaviors and vice-versa. Having mentioned the changes in food consumption behaviors, indeed, there are changes in nutrient availability and intake as well. By identifying the importance of meat in the diet, it is crucial to relate it to consumption behavior which is the key indicator for demand forecasts, in terms of quantity, price, and nutrient. To be more specific, this study attempts to provide a better understanding of meat consumption behaviors, by estimating income, price, and nutrient elasticities in Malaysia. These meat products comprise of beef, pork, poultry, mutton, and other meats. It is important to take note that fish is not included in this demand analysis. This is because there are many heterogeneous groups in fish.

2.0 MEAT CONSUMPTION AND NUTRIENTS

Figure 1 presents annual per capita meat consumption in Malaysia, 1960-2005. There are two main characteristics of meat consumption in Malaysia over the last four decades. The first characteristic is described by the increasing trend of total meat consumption, which recorded a steady growth from 11.44 kilogram in 1960 to 48.60 kilogram in 2006. A break down sees a tremendous growth in poultry consumption at an average of 5.2 percent annually, recorded from 3.8 kilogram to 34.02 kilogram within the period of 1960-2006.

Second characteristic is the split of white and red meat products in the composition of total meat consumption. Obviously, the total meat consumption is composed mostly by white meat products. Its composition was as much as 75.55 percent in 1960 and hit its peak at 90.64 percent in 1983 before decreased gradually to 85.12 percent in 2006. The decrease in the latter years is attributed to a stylish increase (about 184.76 percent) in beef consumption within the observation period. If the positive trend continues, beef consumption can be expected to overtake pork consumption in future.

FIGURE 1: Annual per capita consumption of meat in Malaysia, 1960-2006

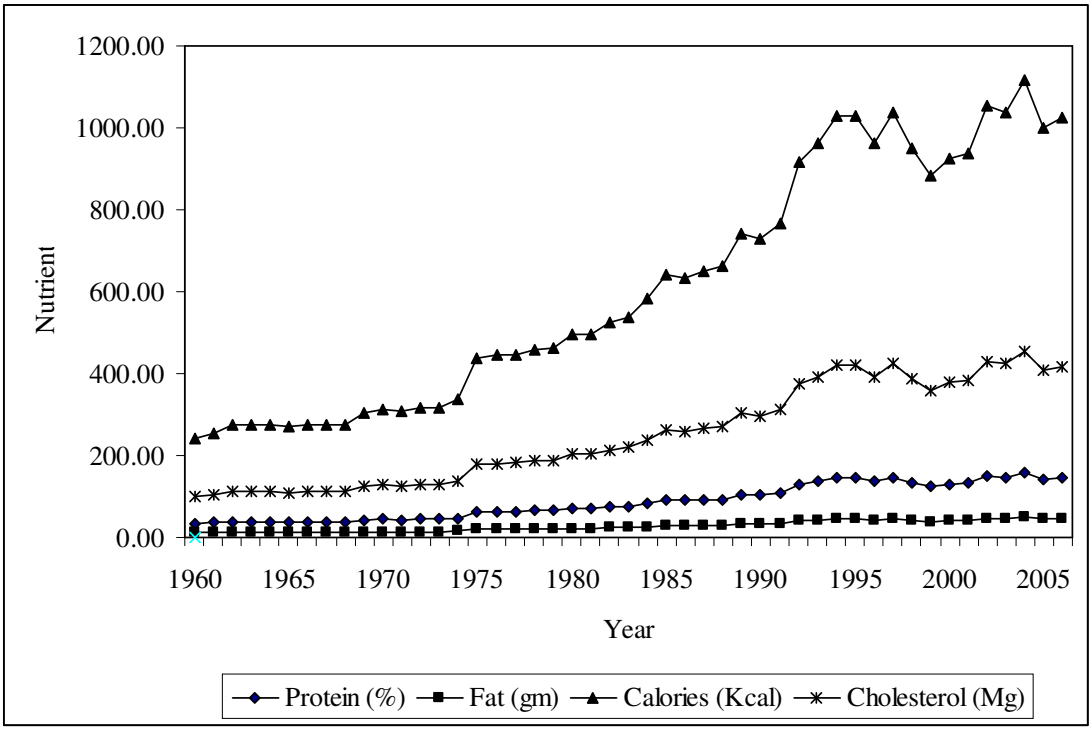


Source: Department of Veterinary Services, 2008.

Figure 2 illustrates annual per capita total nutrient intake from the total meat consumption from 1960 to 2006. Computations of nutritive values are done by multiplying per capita consumption of individual meat with nutritive values in the meat, with assumption that there is no nutritional change in the content of meat products over the years. The nutritive contents include protein (%), fat (gm), calories (kcal), and cholesterol (mg) for beef, pork, mutton, and poultry respectively, as provided by Department of Veterinary Services (2008). Then, the computed nutritive values for beef, pork, mutton, and poultry are aggregated to yield the annual per capita total nutrient intake from the total meat consumption from 1960 to 2006.

The figure illustrates changes in protein (%), fat (gm), calories (kcal), and cholesterol (mg) in total meat consumption clearly. Noor (2002) suggested that the changes are caused by economic growth which is associated with lifestyle change. The sedentary lifestyle is further flooded with rapid growth of meat based fast food industry. That explains none other but the popularity of meat consumption in the country. Hence, the role of rice as main calorie source has diminished while calorie sourced from meat has hiked from 241 kcal in 1960 to 1025 kcal in 2006. Perhaps the main intention of meat consumption is for protein intake, however, the consumption is always coupled with higher cholesterol. All these changes brought about an inevitable prevalence of health diseases in the population.

FIGURE 2: Annual nutrient intake from total meat consumption in Malaysia, 1960-2006



Source: Computed from nutritive values provided by Department of Veterinary Services (2008)

3.0 DATA

This study involves two-stage estimation of demand elasticities. The first stage utilizes cross-sectional data to derive income and price elasticities. This study uses data collected from 14,084 respondents in the Household Expenditure Survey 2004/05. Such large number of respondents provides higher degrees of freedom in econometric estimation than time-series data, as suggested by Chern *et al.* (2003) that the cross-sectional data can produce more plausible and reliable estimates of demand elasticities than time-series data.

In the data, zero consumption happens when households did not purchase any meat product within the survey period. Table 1 presents the percentage of respondents with zero consumption. On average, zero consumption is found to be the highest in other meats (98.55%), which are formed by many exotic meat products (eg: turtle, deer, etc). This is followed by mutton (97.37%), pork (82.19%), beef (63.26%), and poultry (24.23%).

Table 1. Percentage of respondents with zero consumption, 2004/2005

Meat	Percentage (%)
Beef	63.26
Pork	82.19
Mutton	97.37
Poultry	24.23
Other meats	98.55

Source: Household Expenditure Survey 2004/2005, Malaysia

Table 2 presents the nutritive value of meat per kilogram. It is useful in the second stage that incorporates a matrix of the derived demand elasticities with nutritive values in each individual meat product from secondary data that obtained from Department of Veterinary Services (2008) to yield nutrient demand elasticities.

Table 2. Nutritive value of meat per kilogram

	Beef	Pork	Lamb	Chicken	Other meats[4]
Protein (%)	2.99	2.93	2.20	2.89	11.28
Fat (gm)	0.93	0.97	1.30	0.74	7.84
Calories (Kcal)	21.10	21.20	20.50	19.00	170.58
Iron (Mg)	0.30	0.11	0.10	0.12	1.44
Cholesterol (Mg)	8.60	8.60	7.80	8.90	62.75

Source: Department of Veterinary Services (2008)

4.0 MODEL SPECIFICATION

As the zero consumption rates are considerably high in the data, the estimation procedures are deemed necessary to correct the possible bias created by the presence of zero consumption in the meat products. In order to do so, two-step estimator developed by Heien and Wessells (1990) is utilized to obtain the inverse Mills ratios (IMRs) via probit model. The IMRs are then incorporated into Linear Approximate Almost Ideal Demand System (LA/AIDS) model. The LA/AIDS model for the 5 meat products can be expressed as follows:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log(p_j) + \beta_i \log(x / P^L) + \sum_k \gamma_k H_k + \theta_i imr_i + \mu_i \quad (1)$$

where i, j = 1, 2, ……., 5 meat products, w_i is the budget share of the *i*th meat product, p is the price of the *i*th meat product, x is the aggregate total expenditure of meat, H_k includes household size and dummy variable of urban, μ_i's are random disturbances assumed with zero mean and constant variance, and P^L is Laspeyres price index for the aggregate food that can be defined by:

[4] Nutritive values in other meats are averages of nutritive values of ostrich, turkey, quail, deer, venison, grog legs, rabbit, and turtle.

$$\log(P) = \sum_i \overline{w_i} \log(P_i) \tag{2}$$

The adding up, homogeneity and symmetry restrictions are imposed for the LA/AIDS models. The adding-up restriction is satisfied with given $\sum_i w_i = 1$ for all j:

$$\sum_i \alpha_i = 1, \sum_i \gamma_{ij} = 0, \sum_i \beta_i = 0, \sum_i \theta_i = 0 \text{ and } \sum_i \kappa_{ki} = 0 \tag{3}$$

The homogeneity restriction is satisfied for the LA/AIDS model in and only if, for all j:

$$\sum_k \gamma_{jk} = 0 \tag{4}$$

The symmetry is satisfied by:

$$\gamma_{ij} = \gamma_{ji} \tag{5}$$

Derivation of demand elasticities

By using the procedures of Green and Alston (1990), the demand elasticities of the LA/AIDS models can be computed at sample means. The expenditure elasticities can be estimated by:

$$e_i = \frac{\beta_i}{\overline{w_i}} + 1 \tag{6}$$

The Marshallian measures of price elasticities can be computed by:

$$s_{ij} = -\delta_{ij} + \left(\frac{\gamma_{ij}}{\overline{w_i}}\right) - \left(\frac{\beta 1_i}{\overline{w_i}}\right)\overline{w_j} \quad \forall i, j = 1..., n \tag{7}$$

where δ_{ij} is the Kronecker delta that is unity if $i = j$ and zero otherwise.

Since the LA/AIDS model does not provide a direct estimate of income elasticity, Chern *et al.* (2003) and Chern (2000) suggested that an estimation of Engel function is useful to derive income elasticity from expenditure elasticity. The Engel function can be expressed as:

$$\log x = \alpha_0 + \alpha_1 \log X + \beta \log P^L + \sum_k \gamma_k H_k + \varepsilon \tag{8}$$

where x is total expenditures of the meat products, X is total expenditures of food and non-food consumer goods and services, P^L is Laspeyres price index for the aggregate food, and ε is random disturbances assumed with zero mean and constant variance.

The responsiveness of expenditure on food items by income change can be derived by,

$$. e_e = \frac{\partial x}{\partial X}\frac{X}{x} \tag{10}$$

Hence, income elasticity can be estimated as follows:

$$e_y = e_i * e_e \tag{11}$$

Measuring nutrient elasticities

The second stage is to yield nutrient elasticities by applying the technique used by Akinleye and Rahji (2007), Huang and Lin (2000), and Huang (1996). In simple term, nutrient elasticity matrix, say N, for the case of ℓ nutrients and *n* foods can be obtained as a product of multiplying matrix S by matrix D as follows:

$$N = S^* D \tag{12}$$

where N is the ℓ x (*n*+1) matrix of nutrient elasticities in response to changes of food prices and income, S is the ℓ x *n* matrix with entries of each row indicating a food's share of a particular nutrient, and D is the *n* x (*n* + 1) matrix of demand elasticities.

5.0 RESULTS

Demand elasticities, namely own-price and expenditure elasticities that derived from the Malaysian meat demand system using the LA/AIDS are presented in Table 3. All the negative sign of own-price elasticities conform to the law of demand arising from microeconomic theory. It is obvious that the own-price elasticities are elastic, ranging from -1.2743 to -10.4535. For instance, 10 percent increase in the price of poultry will result in 12.743 percent decrease in demand for poultry, having other things remained constant. The impact of its price change on demand is not as much as beef (-2.3840), mutton (-2.7838), pork (-5.6610), and other meats (-10.4535). In other words, this estimate suggests the indispensible preference of poultry compared to other meat products, given that it is the only most affordable and consumable meat product by all ethnics in Malaysia.

On another hand, the derivation obtained more than unity expenditure elasticities for various meat products (except beef). As income increases, Malaysian consumers are likely to increase their expenditure on these foods faster that the income growth. If income increases 10 percent, Malaysian consumers are likely to increase their expenditure on mutton by 11.168 percent. However, the expenditure does not provide information on quantity intake, which relates to nutrition intake in another perspective. Hence it is needed to obtain the estimates of income elasticity in this study.

Table 3. Estimated demand elasticities of meat, Malaysia, 2004/2005

	Price elasticity					Expenditure elasticity
	Beef	Pork	Mutton	Poultry	Other meats	
Beef	*-2.3839*	-0.8185	-0.8197	-0.1942	1.2297	0.7136
Pork	-2.3153	*-5.6610*	1.0172	-1.1951	4.4442	1.456
Mutton	-1.8450	-0.2150	*-2.7838*	-1.1473	3.0469	1.1168
Poultry	-1.6666	0.9734	-18.8504	*-1.2743*	1.8298	1.0866
Other meats	7.3603	4.4023	20.3369	2.8385	*-10.4535*	-11.324

Note: Highlighted values are own-price elasticities.

By working on extra Engel function, income elasticities that yielded from the previous expenditure elasticities are presented in Table 4. It is obvious that the value of elasticities has decreased to less than unity (except other meats). The less than unity income elasticities imply that beef, pork, mutton, and poultry are normal goods to Malaysian consumers. It means that when income increases, demand for quantity of each individual meat products increases as well when other things remain constant. It is led by pork (0.6487) and followed by mutton (0.4975), poultry (0.4841), and beef (0.3179). In contrast, the negative sign of other meats indicate that these exotic meats are inferior goods, which will result against the direction of normal goods in view of income growth.

Table 4. Estimated income elasticities of meat, Malaysia, 2004/2005

Meat	**Income elasticity**
Beef	0.3179
Pork	0.6487
Mutton	0.4975
Poultry	0.4841
Other meats	-5.0449

The income elasticities mentioned above that signifies how change in income will affect demand for meat quantity are indicators of likelihood. An alignment in the format of indication by using matrix technique between income and price elasticities and nutritive values of the meat products yielded nutrient elasticities from meat demand. The yielded nutrient elasticities are presented in Table 5. The second column shows the negative relationship between income and aggregated nutrient intake in meat demand. For example, 10 percent income growth will have aggregated fat intake decreased by 31.958 percent. As meat products are highly related to over-consumption of fat, saturated fat, cholesterol rather than under-consumption of other nutrients, such estimates suggest that Malaysian consumers are increasingly concerned of the nutritional contents in their meat intake, by holding other things constant. Perhaps that explains why there is demand for trimmed/lean meat.

The other columns in the table show the effects on the nutrients in response to changes in meat prices. It is very clear that there is positive price impact on all the meat products (except other meats). A 10 percent increase in the price of beef will increase

protein (%) intake by 27.021 percent when other things remain unchanged. However, the unwanted nutrients also come in a package with meat intake. A further look sees that 10 percent increase in the price of beef will have fat (gm), calories (kcal), and cholesterol (mg) increased more significantly than protein (%) intake. This is applied to pork, mutton, and poultry as well. A deeper thought can relate these indicators (elasticities) to actual market scenario. One, the fallacy of meat prices which do not imply the actual nutrient contents. Two, unlawfulness of meat producers who do not provide consumers with actual nutrient contents. By putting both concerns together, it signals a need for policy makers to seek possible imposition of labeling and traceability on meat products.

Table 5. Estimated nutrient elasticities of meat, Malaysia, 2004/2005

Nutrients	Income	Price				
		Beef	Pork	Mutton	Poultry	Other meats
Protein (%)	-2.3130	2.7021	1.4787	7.5956	0.9747	-4.0025
Fat (gm)	-3.1958	4.2151	2.4403	12.0682	1.5701	-6.0484
Calories (Kcal)	-3.2519	4.3056	2.4873	12.1172	1.6127	-6.2041
Iron (Mg)	-3.3782	4.4683	2.6904	12.8614	1.7545	-6.6075
Cholesterol (Mg)	-3.1047	4.0582	2.3539	11.2608	1.5093	-5.8677

6.0 CONCLUSIONS

This study aims to provide a better understanding of meat consumption behaviors in terms of income, price, and nutrient elasticities by analyzing the Household Expenditure Survey 2004/05 data. In the first stage, expenditure and own-price elasticities are estimated via the LA/AIDS model. This is followed by an estimation of Engel function in the second stage to obtain the estimates of income elasticities for the meat products. This study shows that the major meat products (beef, pork, mutton, and poultry) are normal goods and own-price elastic.

There are mixed messages obtained from the estimated nutrient elasticities. As per capita income increases, Malaysian consumers are increasingly health conscious of their meat intake. However, they could be misled by the common price-quality fallacy which is attributed to the lack of nutrient information made available to them. Authorities are needed to step in to reinforce the needy. Else, an open market to invite internationally recognized meat producers who meets the international requirements (eg: as defined by United States Department of Agriculture) can lead to a market force that pushes current market to be safety- and quality-oriented.

REFERENCES

Akinleye SO and Rahji M (2007). Nutrient Elasticities among Nigerian Households Differentiated by Income, *Agekon*, 46(2): 274-288.

Chern WS (2000). Assessment of Demand-Side Factors Affecting Global Food Security. Chapter 6, in Chern WS, Carter CA and Shei SY, eds. *Food Security in Asia: Economics and Policies*. Cheltenham, UK: Edward Elgar Publishing Limited.

Chern WS, Ishibashi K, Taniguchi K and Yokoyama Y (2003). Analysis of Food Consumption Behavior by Japanese Households. Food and Agricultural Organization; Economic and Social Development, Paper 152.

Deaton A and Muellbauer J (1980). An Almost Ideal Demand System, *American Economics Review*, 70: 312-326.

Department of Veterinary Services. (2008). Livestock Statistics. Malaysia.

Green R and Alston JM (1990). Elasticities in AIDS Models, *American Journal of Agricultural Economics*, 72: 442-45.

Heien D and Wessells CR (1990). Demand System Estimation with Microdata: A Censored Regression Approach, *Journal of Business & Economic Statistics*, 8(1): 365–371.

Huang KS (1996). Nutrient Demand Elasticities in A Complete Food Demand System, *American Journal of Agricultural Economics*, 78: 21-29.

Huang KS and Lin BH (2000). Estimation of Food Demand and Nutrient Elasticities from Household Survey Data. Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Technical Bulletin No. 1887.

Noor MI (2002). The Nutrition and Health Transition in Malaysia, *Public Health Nutrition* 5(1A): 191-195.

Appendix 1. Maximum likelihood estimates of the LA/AIDS model

	Beef	**Pork**	**Mutton**	**Poultry**	**Other meats**
	Coefficient (Std. Error)	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**	**Coefficient (Std. Error)**
Intercept	0.1072	0.2211	-0.1217	-0.0219	0.8154
	(0.0203)***	(0.0136)***	(0.0085)***	(0.0181)	-
Log (price of beef)	-0.2355	-0.0649	-0.0083	-0.1068	0.4154
	(0.0040)***	(0.0028)***	(0.0017)***	(0.0054)***	-
Log (price of pork)	-0.4133	-0.4133	0.0106	-0.7086	1.5246
	(0.0086)***	-	(0.0064)*	(0.0201)***	-
Log (price of mutton)	-0.3263	-0.0185	-0.0185	-0.6841	1.0474
	(0.0925)***	(0.0359)	-	(0.1257)***	-
Log (price of poultry)	-0.3245	0.1095	-0.1945	-0.1945	0.6040
	(0.0258)***	(0.0187)***	(0.0106)***	-	
Log (price of other meats)	1.2996	0.3872	0.2106	1.6940	-3.5914
	-	-	-	-	
Log (*x*/Laspeyres price index)	-0.0506	0.0401	0.0012	0.0517	-0.0424
	(0.0030)***	(0.0021)***	(0.0013)***	(0.0037)***	-
Log (household size)	0.0096	0.0006	0.0005	0.0315	-0.0422
	(0.0006)***	(0.0005)	(0.0003)*	(0.0009)***	-
Urban dummy	-0.0468	0.0417	0.0052	-0.0038	0.0037
	(0.0031)***	(0.0022)***	(0.0013)***	(0.0042)	-
IMR	0.3661	0.6241	0.5314	-0.0219	0.8154
	(0.0033)***	(0.0053)***	(0.0040)***	(0.0181)	-

Note: Significance levels are denoted by *** for 1%, ** for 5%, and * for 10%.

Appendix 2. Regression results for Engel curve analyses

	Coefficient	**(Std. Error)**
Intercept	0.3984	(0.1120)***
Log (total expenditure)	0.4455	(0.0077)***
Laspeyres price index	0.6629	(0.0486)***
Log (household size)	0.0291	(0.0088)***
Urban	-0.1240	(0.0103)***

Note: Significance levels are denoted by *** for 1%, ** for 5%, and * for 10%.