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Assessing the Demand for a Healthy Diet in Sri Lanka: The Almost Ideal Demand System with Infrequency of Purchase

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ABSTRACT

Due to the high prevalence of diet related diseases and malnutrition, assessing dietary choices in terms of a healthy diet is essential in the Sri Lankan context. This paper employed the Linear Approximation of the Almost Ideal Demand System (LA/AIDS) to estimate price and expenditure elasticities for fourteen food groups, by utilizing the Household Income and Expenditure Survey, 2006/07. Demographic and socio-economic characteristics were also considered in the estimation, and particular concern was given to the infrequency of purchase. The results revealed that own and relative prices, real expenditure, demographic and socio-economic characteristics will immensely affect the dietary choices and income related policies will have a more impact on promoting food consumption. Hence, the government should pay more attention to these aspects when establishing policies.

KEYWORDS: AIDS model, Censoring, Demand, Elasticity, Healthy diet

INTRODUCTION

Food demand patterns of a particular country play a vital role in developing policies. They assist to improve the nutritional status of individuals and households through identifying the most appropriate policy interventions. They help the government in which food subsidy strategies should be implemented. Moreover, the knowledge of the food consumption behaviour is essential for sectoral and macroeconomic policy analysis (Weliwita *et al.*, 2003).

The estimation of price and income elasticities of food is the key to the analysis of food demand behaviour. According to the literature, primary attention has been paid in the past to the estimation of food demand elasticities in developed countries (Weliwita *et al.*, 2003). Although a number of studies have been published on the subject in developing countries, there is a paucity of studies on food demand behaviour of Sri Lankans in the published literature.

Conversely, consumption of plenty of foods may not provide all the essential nutrients that the body needs to be healthy and function efficiently whereas, a healthy diet does. According to the food based dietary guidelines for Sri Lankans, a healthy diet comprises of six food groups: grains and tubers, fruits, vegetables, fish, pulses, meat and eggs, milk and/or milk products and nuts and oil seeds (Ministry of Health, 2011), which provide carbohydrates, proteins, fats, vitamins and minerals.

However, due to urbanization, economic growth and changes in lifestyle patterns, Sri Lanka is experiencing a nutritional transition, which leads to under-nutrition, overweight and obesity. A quarter of adults in Sri Lanka are suffering from metabolic syndrome, while one in every five adults is diagnosed with either diabetes or pre-diabetes. Recent studies signify that the prevalence of hypertension, obesity, dyslipidaemia in urban areas are reaching epidemic proportions. Further, 18.3% of total mortality and 16.7% of hospital expenditure in Sri Lanka account for diet-related chronic diseases (Jayawardena *et al.*, 2012).

Despite all the evidences of diet related non-communicable diseases, studies on the subject of dietary choices are rather scarce in the Sri Lankan context (Jayawardena *et al.*, 2012). Therefore, this study aims to determine the factors and what impacts do they have on consuming a healthy diet, by incorporating an economic framework to the households in Sri Lanka. Moreover, this intends to present price and expenditure elasticities of demand for different food groups which should be included in a Sri Lankan's healthy diet, in order to discover the most suitable policy interventions for the country.

METHODOLOGY

Model Specification

Among the models which have been proposed to analyze consumption patterns, the Rotterdam model and the Translog model have been frequently used in past (Feng and Chern, 2000). Nevertheless, the Almost Ideal Demand System (AIDS) proposed by Deaton and Muellbauer, (1980) is widely used in recent years and has considerable advantages over both the Rotterdam and Translog models. It "gives an arbitrary first-order approximation to any demand system; satisfies the axioms of choice exactly; aggregates perfectly over

consumers without invoking parallel linear Engel curves; has a functional form which is consistent with known household-budget data; simple to estimate, largely avoiding the need for non-linear estimation; and can be used to test the restrictions of homogeneity and symmetry through linear restrictions on fixed parameters" (Deaton and Muellbauer, 1980).

The AIDS was developed through the minimum cost or expenditure function, which is required to achieve a specific utility level at given prices. Here, the budget shares of various commodities are linearly related to logarithms of real expenditure and relative prices (Deaton and Muellbauer, 1980). Although the true AIDS model possesses many desirable properties, its nonlinearity makes it difficult to estimate (Feng and Chern, 2000). Therefore, the Linear Approximation of the AIDS (LA/AIDS) was used in this study. The LA/AIDS can be defined as;

$$W_i = \alpha_i + \beta_i \ln\left(\frac{X}{P^*}\right) + \sum_j \gamma_{ij} \ln(P_j) \quad \textbf{(1)}$$

Where, W_i = budget share of i^{th} food group; X = the total expenditure on all foods per household; P^* = price index; P_j = prices of the j^{th} food items.

To avoid nonlinearity, P^* in the equation (1) was estimated as the Stone price index:

$$\ln(P^*) = \sum_i \overline{W_i} \ln(P_i) \quad \textbf{(2)}$$

Where, $\overline{w_i}$ denotes the mean budget share of i^{th} food item (Bett *et al.*, 2012).

The α_i parameter is the average budget share when all prices and real expenditure are equal to one. The β_i and γ_{ij} parameters measure the change in the i^{th} budget share for a unit change in the real income and P_j respectively, ceteris paribus (Weliwita *et al.*, 2003).

Data and Estimation Procedure

Data for the analysis were taken from the Household Income and Expenditure Survey (HIES) 2006/07, conducted by the Department of Census and Statistics, Sri Lanka. It has been conducted over a period of 12 monthly rounds. HIES provided information on demographic and socio-economic characteristics, income and expenditure of households in Sri Lanka, excluding the Northern province and Trincomalee district in the Eastern province. The completed sample size was 18,544 households.

The weekly consumption of 148 food items was selected according to the six food groups which have been recommended by the Ministry of Health, (2011). Since, consumption has been measured by different units, food items were aggregated into n (n=15) groups: grains, prepared foods, tubers, fruits, fruit vegetables, leafy vegetables, pulses, meat, fish, eggs, milk, milk products, nuts, dried fruits and fats and oils, with respect to the units of measurements.

Sector as urban (urban=1, otherwise=0) and estate (estate=1, otherwise=0), household size, gender of the household head (male=1, female=0), education level of the head and spouse, employment status of the head and spouse (employed=1, unemployed=0), presence of children up to three years of age (yes=1, no=0), presence of heart diseases, blood pressure and diabetes (yes=1, no=0) and owned land extent were incorporated into the equation (1), as demographic and socio-economic characteristics.

Because, the actual market prices of commodities have not been collected in the survey, the unit values (expenditure/quantity) were used as proxies for prices as it is the common practice in literature (Weliwita *et al.*, 2003). For the households which had zero expenditure, the unit values were replaced by the average values of the nonzero unit values within the most ideal cluster.

Due to the infrequent consumption, budget shares of all food groups were censored using the two-stage decision process. In the first stage, the decision to buy or not to buy was expressed as a dummy variable (1 if a household buys and 0 otherwise). Then, a probit regression was carried out for (n-1) food groups and the Inverse Mills Ratios (IMRs) for each household for each food group were computed using θ (standard normal density) and Θ (cumulative probability function), where IMR $(\Phi_i) = \theta/\Theta$. Secondly, estimated IMRs were used in the AIDS as an instrumental variable (Weliwita *et al.*, 2003). Hence, the estimating model is:

$$W_i = \alpha_i + \beta_i \ln\left(\frac{X}{P^*}\right) + \sum_j \gamma_{ij} \ln(P_j) + \sum_k \zeta_{ik} Z_k + \omega_i \Phi_i + \varepsilon_i \quad \textbf{(3)}$$

Where, Z_k is the matrix of demographic or socio-economic variables and ζ_{ik} is the relevant vector of parameters; ω_i = coefficient of i^{th} IMR; ε_i = error term of i^{th} food equation (Bett *et al.*, 2012).

To conform to the demand theory, adding up (4), homogeneity (5) and symmetry (6) restrictions were imposed on the equation (3):

$$\sum_i \alpha_i = 1,\ \sum_i \beta_i = 0,\ \sum_i \gamma_{ij} = 0,\quad j = 1,\ldots,n. \quad \textbf{(4)}$$

$$\sum_j \gamma_{ij} = 0, \qquad i = 1,\ldots, n. \quad (5)$$

$$\gamma_{ij} = \gamma_{ji}, \qquad i, j = 1,\ldots, n. \quad (6)$$

Elasticities

Marshallian price elasticities [equation (7)] and expenditure elasticity [equation (8)] of i^{th} food group were calculated as;

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\{\gamma_{ij} - \beta_i \overline{W_j}\}}{\overline{W_i}} \quad (7)$$

Where, δ_{ij} = Kronecker delta, which is equal to one for $i = j$ and zero for $i \neq j$ (Bett *et al.*, 2012).

$$\eta_i = 1 + \frac{\beta_i}{\overline{W_i}} \quad (8)$$

Since, adding up restrictions ensure $\sum W_i = 1$, one equation (dried fruits) was dropped from the system. A Seemingly Unrelated Regression (SUR) technique was employed to avoid possible correlation of errors of each equation. The estimation was carried out by the use of Stata 11.2, under the constrained Iterated SUR (ITSUR) procedure.

RESULTS AND DISCUSSION

Usually, model significance in SUR models is checked through Chi-square tests. In the present model, Chi-squares for all equations were significant at 1% level. Table 1 reported that most of the IMR coefficients were significant at 5% level, implying ignorance of zero budget shares when estimating the system, would generate biased and inconsistent parameter estimates.

Besides, majority of the price coefficients were significant at 5% level, while parameters of real expenditure were significant for all food groups except milk. The negative coefficients for the budget shares of grains, prepared foods, leafy vegetables, pulses, nuts and fats and oils inferred that their consumption would increase less proportionately as income rises. Moreover, positive coefficients denoted that consumers would spend more on fruits, meat, fish and milk products with an income increase.

In addition, results indicated that prepared foods have the highest demand while having the lowest demand for grains in the urban sector, with compared to the rural sector. This may be due to the fact that most of the people in urban areas are engaged with tight daily routines and thus, they will tend more to consume prepared foods. Not surprisingly, it showed that estate community prefers more grains than the rural community, as cereals are well-liked components in their diets. Further, higher prices of fish in estate regions due to shortages and higher transportation costs may be the cause for the low consumption of fish.

Convincing rice is the staple food in Sri Lanka, increase in the household size led to an increased demand for grains. Apparently, gender, education level and employment status of the household head did not significantly contribute for many food budget shares. Nevertheless, results revealed that households where the spouse is employed go for more grains and lesser prepared foods and fish. Parameter estimates implied that presence of children in a household would increase the demand for milk products and fruits while lowering the demand for grains and prepared foods. It may be because; parents give the first priority for their children's diet.

When diseases are considered, presence of heart diseases and blood pressure were not critical while presence of diabetes was significant for the budget shares of some foods. However, with several unusual results, it indicated that the people consume foods regardless of their diseases.

Since, Sri Lanka has an agriculture based economy, certainly, the demand for grains increases with more owned lands, while lowering the demand for prepared foods.

Elasticities

Table 2 showed that own price elasticities of all food groups carry a negative sign as expected. The values denoted that prepared foods, yams, fruits, meat, milk and milk products are more responsive to their own price changes, while all others are less responsive. Not surprisingly, grains, fruit and leafy vegetables and pulses showed inelasticities with price changes. It may be because; rice is the staple food in Sri Lanka and meals consisting of several vegetables and pulses together with rice. Since coconuts were taken into the nuts group, its elasticity value also can be accepted as; most of the curries are prepared using coconut milk.

Cross price elasticities highlighted that people may substitute grains with prepared foods according to the price changes, in order to get carbohydrates. Moreover, it implied that yams and grains are complements. Fruit and leafy vegetables behaved as complements with fruits. Conversely, it signified that people may consume either leafy vegetables or fruits in order to obtain vitamins and minerals. The negative relationship between fruit vegetables and leafy vegetables proved the usual dietary pattern of Sri Lankans i.e.; fruit vegetables and leafy vegetables together with rice.

Table 1. Outcome of the AIDS model

Variables	Coefficients of i^{th} budget shares													
	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
Constant	0.61*	0.59*	0.00	(0.07)*	0.08*	0.02*	0.14*	(0.27)*	(0.42)*	(0.01)	(0.03)*	0.07*	0.32*	0.08*
IMR	(0.03)*	0.00	0.01*	0.00*	0.00*	(0.01)*	0.00	0.00*	0.02*	0.00	0.00	0.00	(0.11)*	0.01*
lnp_i														
lnp1	0.04*	0.02*	0.00*	0.00	(0.04)*	0.00*	(0.01)*	0.02*	(0.03)*	0.00*	0.00*	0.01*	(0.01)*	(0.01)*
lnp2	0.02*	(0.03)*	0.00*	0.00*	0.01*	0.00	0.00*	0.00*	0.00*	0.00	0.00	0.00*	0.00*	0.00*
lnp3	0.00*	0.00*	0.00*	0.00	0.00*	0.00	0.00*	0.00	0.00	0.00	0.00*	0.00*	0.00*	0.00
lnp4	0.00	0.00*	0.00	0.00*	0.00	0.00	0.00*	0.00	0.00*	0.00	0.00	0.00	0.00*	0.00
lnp5	(0.04)*	0.01*	0.00*	0.00	0.02*	0.00*	0.00*	0.02*	0.00	0.00	0.00*	0.01*	(0.01)*	0.00*
lnp6	0.00*	0.00	0.00	0.00	0.00*	0.01*	0.00*	0.00	0.00	0.00*	0.00*	0.00	0.00*	0.00
lnp7	(0.01)*	0.00*	0.00*	0.00*	0.00*	0.00*	0.03*	(0.01)*	0.00	0.00*	0.00	0.00*	0.00*	0.00
lnp8	0.02*	0.00*	0.00	0.00	0.02*	0.00	(0.01)*	(0.01)*	0.01*	0.00*	0.00	(0.01)*	0.00*	(0.01)*
lnp9	(0.03)*	0.00*	0.00	0.00*	0.00	0.00	0.00	0.01*	0.02*	0.00*	0.00*	0.01*	(0.01)*	0.00
lnp10	0.00*	0.00	0.00	0.00	0.00	0.00*	0.00*	0.00*	0.00*	0.01*	0.00	0.00*	0.00*	0.00*
lnp11	0.00*	0.00	0.00*	0.00	0.00*	0.00*	0.00	0.00	0.00*	0.00	0.00*	0.00*	0.00*	0.00*
lnp12	0.01*	0.00*	0.00*	0.00	0.01*	0.00	0.00*	(0.01)*	0.01*	0.00*	0.00*	(0.01)*	0.00*	0.00*
lnp13	(0.01)*	0.00*	0.00*	0.00*	(0.01)*	0.00*	0.00*	0.00*	(0.01)*	0.00*	0.00*	0.00*	0.04	0.00*
lnp14	(0.01)*	0.00*	0.00	0.00	0.00*	0.00	0.00	(0.01)*	0.00	0.00*	0.00*	0.00*	0.00*	0.02*
lnp15	0.00	0.00*	0.00	0.00*	0.00	0.00*	0.00*	0.00*	0.00	0.00	0.00*	0.00*	0.00	0.00*
ln XP	(0.06)*	(0.04)*	0.00*	0.02*	0.00*	(0.01)*	(0.01)*	0.05*	0.08*	0.00*	0.00	0.01*	(0.05)*	(0.01)*
D1	(0.05)*	0.04*	(0.01)*	0.00*	(0.02)*	0.00*	(0.01)*	0.02*	0.02*	0.00*	0.00	0.01*	(0.01)*	0.00*
D2	0.09*	(0.02)*	0.00*	(0.02)*	0.00	0.00*	0.01*	0.00	(0.06)*	0.00	0.00	0.00	(0.01)*	0.01*
D3	0.02*	0.01*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	(0.01)*	0.00*	0.00	0.00*	0.00*	0.00
D4	0.00	0.00	0.00	0.01*	0.01*	0.00	0.00*	(0.01)*	0.00	0.00	0.00	0.00	0.00	0.00
D5	0.00*	0.00	0.00	0.00*	0.00	0.00*	0.00	0.00	0.00*	0.00*	0.00	0.00*	0.00	0.00
D6	0.00*	0.00*	0.00	0.00*	0.00	0.00*	0.00	0.00*	0.00	0.00*	0.00	(0.01)*	0.00	0.00*
D7	0.00*	0.00*	0.00	0.00*	0.00	0.00*	0.00*	0.00*	0.00	0.00*	0.00	0.00*	0.00	0.00
D8	0.01*	(0.01)*	0.00	0.00*	0.00*	0.00	0.00*	0.00*	(0.01)*	0.00	0.00*	0.00*	0.00*	0.00*
D9	(0.03)*	(0.01)*	0.00*	0.01*	0.00*	0.00*	0.00*	0.00	0.00	0.00	0.00	0.05*	0.00*	0.00
D10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00*	0.00	0.00	0.00	0.00
D11	(0.01)*	0.00	0.00	0.00	0.00	0.00*	0.00	0.00*	0.00	0.00	0.00	0.00	0.00	0.00
D12	(0.01)*	0.01*	0.00*	0.01*	0.00	0.00*	0.00	0.00*	0.00	0.00*	0.00	0.00	0.00	0.00
D13	0.01*	(0.01)*	0.00*	0.00*	0.00*	0.00	0.00	0.00	0.00*	0.00	0.00*	0.00*	0.00*	0.00*

**significant at 5% level.*

Note: W_i = i^{th} budget share; i = 1,...,14, lnp_i = natural logarithm of i^{th} food price; i = 1,...,15: 1 = grains, 2 = prepared foods, 3 = yams, 4 = fruits, 5 = fruit vegetables, 6 = leafy vegetables, 7 = pulses, 8 = meat, 9 = fish, 10 = eggs, 11 = milk, 12 = milk products, 13 = nuts, 14 = fats and oils, 15 = dried fruits, ln XP = natural logarithm of real expenditure, D1 = urban sector, D2 = estate sector, D3 = household size, D4 = gender of the head, D5 = education level of the head, D6 = employment status of the head, D7 = education level of the spouse, D8 = employment status of the spouse, D9 = presence of children, D10 = presence of heart diseases, D11 = presence of blood pressure, D12 = presence of diabetes, D13 = owned land extent

Surprisingly, results revealed that meat cannot be substituted either with pulses, fish or eggs as protein sources. On the other hand, elasticities reported that fish can be substituted with meat. As a wholesome food which gives several nutrients, milk and milk products are substitutable with each other. In addition, it can be said that fats are consumed as either nuts or fats and oils.

The positive values of expenditure elasticities of all food groups highlighted that all of them are normal and thus, increase in income would lead to higher consumption. The estimates for yams, fruits, eggs, milk and milk products were almost equal to one. However, meat and fish estimates emphasized that they can be considered as luxuries. It inferred that higher income households spend proportionately more on meat and fish. Implying grains, prepared foods, fruit and leafy vegetables, pulses, nuts and fats and oils play an important role in household diets, the estimates showed that they are necessities.

Table 2. Price and expenditure elasticities

ϵ_{ij}	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**-0.77**	0.32	-0.18	-0.07	-0.43	-0.18	-0.19	0.27	-0.27	0.27	-1.07	0.11	0.06	-0.15
2	0.12	**-1.32**	0.09	-0.06	0.10	0.02	0.08	-0.07	-0.06	0.01	-0.10	-0.03	0.03	0.06
3	-0.01	0.04	**-1.13**	0.00	0.02	-0.01	0.03	0.00	-0.01	0.03	-0.40	0.02	-0.02	0.01
4	0.01	0.01	0.00	**-1.12**	0.00	0.01	0.03	-0.04	0.01	-0.04	-0.04	0.01	-0.01	0.00
5	-0.15	0.12	0.07	-0.05	**-0.73**	-0.06	-0.06	0.24	-0.03	0.06	-0.90	0.06	-0.04	-0.12
6	-0.01	0.00	-0.01	-0.01	-0.02	**-0.23**	-0.02	-0.04	-0.01	-0.14	1.00	-0.01	-0.01	-0.01
7	-0.04	0.05	0.05	0.01	-0.04	-0.06	**-0.34**	-0.34	-0.02	-0.12	0.44	-0.05	-0.02	-0.02
8	0.12	0.04	0.05	-0.01	0.18	-0.05	-0.26	**-1.25**	0.01	-0.17	0.39	-0.09	-0.03	-0.18
9	-0.08	0.05	0.00	0.05	0.02	0.02	0.06	-0.07	**-0.95**	-0.12	0.51	0.06	-0.05	0.00
10	0.02	0.01	0.02	-0.01	0.01	-0.10	-0.03	-0.06	-0.01	**-0.43**	-0.24	-0.03	-0.01	-0.05
11	-0.01	0.00	-0.02	0.00	-0.01	0.09	0.01	0.01	0.00	-0.03	**-2.65**	0.02	0.03	-0.06
12	0.08	0.02	0.09	-0.02	0.08	-0.01	-0.07	-0.31	0.00	-0.26	1.05	**-1.13**	0.09	-0.03
13	-0.01	0.01	-0.11	-0.10	-0.08	-0.05	-0.06	-0.19	-0.11	-0.15	1.50	0.02	**-0.46**	0.07
14	-0.02	0.03	0.01	-0.02	-0.05	-0.01	-0.02	-0.18	-0.02	-0.14	-1.31	-0.02	0.04	**-0.35**
η_i	0.74	0.62	1.10	1.38	0.96	0.69	0.78	2.13	1.46	1.18	1.35	1.08	0.39	0.77

Note: 1 = grains, 2 = prepared foods, 3 = yams, 4 = fruits, 5 = fruit vegetables, 6 = leafy vegetables, 7 = pulses, 8 = meat, 9 = fish, 10 = eggs, 11 = milk, 12 = milk products, 13 = nuts, 14 = fats and oils, ε_{ij} : diagonal values = own price elasticities, off diagonal values = cross price elasticities, η_i = expenditure elasticities

CONCLUSIONS AND RECOMMENDATIONS

This study examined the demand for a healthy diet in Sri Lanka, employing the LA/AIDS model. The results revealed that the sector, household size, employment status of the spouse, presence of children and owned land extent will have a significant impact on dietary choices. The importance of adapting proper dietary practices should be highlighted through mass media and various health care programmes, because; consumers do not have much knowledge and are less conscious about diet related diseases.

Since, most of the food groups were more responsive to income than to prices, income related policies will have a more impact on promoting food consumption.

Consequently, any food policy should pay attention to the above circumstances, in order to prevent malnutrition and food insecurity.

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