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Econometric analysis of the demand for pulses in Sri Lanka: an almost ideal estimation with a censored regression

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Abstract: Due to high prevalence of dietary diseases and malnutrition in Sri Lanka, it is essential to assess food consumption patterns. Because pulses are a major source of nutrients, this paper employed the Linear Approximation of the Almost Ideal Demand System (LA/AIDS) to estimate price and expenditure elasticities for six types of pulses, by utilizing the Household Income and Expenditure Survey, 2006/07. The infrequency of purchases, a typical problem encountered in LA/AIDS estimation is circumvented by using a probit regression in the first stage, to capture the effect of demographic factors, in consumption choice. Results reveal that the buying decision of pulses is influenced by the sector (rural, urban and estate), household size, education level, presence of children, prevalence of blood pressure and diabetes. All pulses types except dhal are highly responsive to their own prices. Dhal is identified as the most prominent choice among all other alternatives and hence, it is distinguished as a necessity whereas, the rest show luxurious behavior, with the income. Because dhal is an import product, consumption choices of dhal may be severely affected by any action which exporting countries introduce, while rest of the pulses will be affected by both price and income oriented policies.

Keywords: AIDS model, censoring, demand, elasticity, probit, pulses.

Introduction

Even though there are plenty of eloquent speeches on 'Nutritional Transition', globalization and rapid economic growth propel the world to concentrate more on material development. It causes a gradual shift in food culture, dietary consumption patterns, and nutritional status through altering the availability of and access to food (Hawkes, 2009; Kennedy *et al.,* 2004). These circumstances will drive the world to suffer from several diet-related chronic diseases, where the developing nations would be mostly affected (Hawkes, 2009; Popkin, 2006; Popkin and Gordon-Larsen, 2004).

Sri Lanka, a developing country which has a lower-middle-income economy is now experiencing a nutritional transition along with under-nutrition, overweight and obesity. Recent studies proclaim that the prevalence of hypertension, obesity and dyslipidaemia has been becoming epidemic in urban areas (Jayawardena *et al.,* 2012). Along with extremely vulnerable first two years of life (World Bank, 2007), prevalence of stunting, wasting and underweight among children from 6 - 59 months of age corroborates the child malnutrition in Sri Lanka with proportions of 13.1, 19.6 and 23.5 percent respectively (Jayatissa *et al.,* 2012). Further, one-fourth of Sri Lankan adults are suffering from metabolic syndrome, while one in every five adults is undergoing either diabetes or pre-diabetes. Additionally, past studies reported that diet-related chronic diseases are liable for 18.3% of total mortality and 16.7% of hospital expenditure in Sri Lanka (Jayawardena *et al.,* 2012).

Pulses as a wholesome food, which consists of wide range of nutrients, including carbohydrate, protein, dietary fibre, unsaturated fat, vitamins and minerals, as well as non-nutrients, such as antioxidants and phytoestrogens (Pulse Australia n.d.), plays a significant role in Sri Lankans' food basket. Due to its nutritional composition, it is evident that heart health and diabetes management can be encouraged through the consumption of pulses (Canglobal Management Inc., 2001). However, to the best of our knowledge, there are no published studies on the consumption patterns of pulses in the Sri Lankan context.

Conversely, it is essential to understand food consumption patterns in order to foresee how policy changes will affect the country (Sahn, 1988). They support policy planners to identify the most appropriate policy interventions which improve the nutritional status of individuals and households, to design various food subsidy strategies which the government should pursue and to conduct sectoral and macroeconomic policy analyses (Weliwita *et al.,* 2003). In this background, this study aims to investigate price and expenditure elasticities, in order to discover the consumption behaviour of several types of pulses, by households in Sri Lanka. Moreover, this intends to determine the impact of demographic factors which influence the dietary choices of these pulses.

Methodology

Model Specification

The Almost Ideal Demand System (AIDS) proposed by Deaton & Muellbauer (1980) was employed in our study, since it has considerable advantages over both the Rotterdam and Translog models which have been frequently used in the past to analyze consumption patterns because 'The AIDS, gives an arbitrary first-order approximation to any demand system; it satisfies the axioms of choice exactly; it

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

The development of AIDS was done through the minimum cost or expenditure function, which is required to achieve a specific utility level at given prices. The AIDS model in budget share form can be expressed as:

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

Where, W_i = budget share of i^{th} pulses group; X = the total expenditure on all types of pulses per household; P_j = prices of the j^{th} pulses group; P = price index defined as;

$$ln\,P = \alpha_0 + \sum_k \alpha_k \, ln\,P_k + \frac{1}{2}\sum_j \sum_k \gamma_{kj} \, ln\,P_k \, ln\,P_j \qquad (2)$$ (Deaton and Muellbauer, 1980)

The α_i parameter is the average budget share when all prices and real expenditure are equal to one. Where, 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 (Weliwita *et al.*, 2003).

The nonlinearity of the true AIDS makes it difficult to estimate, even though it possesses many desirable properties (Feng and Chern, 2000). To avoid nonlinearity, P in equation (1) was estimated as the Stone price index:

$$ln(P^*) = \sum_i \overline{W_i} \, ln(P_i) \qquad (3)$$

Where, $\overline{W_i}$ stands for the mean budget share of i^{th} pulses group (Bett *et al.*, 2012).

Therefore, the Linear Approximation of the AIDS (LA/AIDS) was used in this study, where the budget shares of various commodities are linearly related to logarithms of real expenditure and relative prices (Deaton and Muellbauer, 1980). Hence, the LA/AIDS can be defined as;

$$W_i = \alpha_i + \beta_i \, ln\left(\frac{X}{P^*}\right) + \sum_j \gamma_{ij} \, ln(P_j) \qquad (4)$$

Data and Estimation Procedure

Data for the analysis were taken from the Household Income and Expenditure Survey (HIES) 2006/07, conducted over a period of 12 monthly rounds, by the Department of Census and Statistics, Sri Lanka. HIES provided information on demographic and socio-economic characteristics, income and expenditure of 18,544 households in Sri Lanka, excluding the Northern province and Trincomalee district in the Eastern province. For our study, weekly consumption of six types of pulses (dhal, green gram, cowpea, soybean, soya meat, and gram) was selected.

HIES doesn't provide the actual market prices of commodities. Hence, a proxy of unit values (expenditure/quantity) was used as prices since it is the common practice literature (Park *et al.*, 1996; Weliwita *et al.*, 2003) has followed. However, some

households might hold zero expenditure due to non-preference, sufficient household inventory, or responses to market prices. The unit values of those households were replaced by the average values of the nonzero unit values within the most ideal cluster (Weliwita *et al.,* 2003).

A probit regression was carried out for all six types of pulses, to model the dichotomous behaviour of the consumption decision to buy or not to buy. Following extant literature on demand (Bett *et al.,* 2012; Heien & Wessells, 1990; Park *et al.,* 1996; Tiffin and Arnoult, 2010), demographic characteristics (Table 1) were considered in the probit regression, with the intention of capturing taste and preferences among various households.

Further, to circumvent the infrequent consumption observed in most households, Inverse Mills Ratios (IMRs) for each household for each pulses group were computed using probit parameters, where IMR (Φ_i)=θ(standard normal density)/ Θ(cumulative probability function) and then, they were used in the AIDS as an instrumental variable (Weliwita *et al.,* 2003).

Hence, the estimating model is:

$$W_i = \alpha_i + \beta_i \ln\left(\frac{X}{P^*}\right) + \sum_j \gamma_{ij} \ln(P_j) + \omega_i \Phi_i + \varepsilon_i \qquad (5)$$

Where, ω_i = coefficient of i^{th} IMR; ε_i= error term of i^{th} pulse equation (Bett *et al.,* 2012).

To conform to the demand theory, adding up (6), homogeneity (7) and symmetry (8) restrictions were imposed on the equation (5)

$$\sum_i \alpha_i = 1, \sum_i \beta_i = 0, \sum_i \gamma_{ij} = 0, \sum_i \omega_i = 0, \qquad j = 1,\ldots,n. \qquad (6)$$

$$\sum_j \gamma_{ij} = 0, i = 1,\ldots,n. \qquad (7)$$

$$\gamma_{ij} = \gamma_{ji}, i, j = 1,\ldots, n. \qquad (8)$$

Elasticities

The expenditure elasticity of pulse type was estimated as;

$$\eta_i = 1 + \frac{\beta_i}{W_i} \qquad (9)$$

Table 1 - Demographic variables.

VARIABLE	DESCRIPTION
Sector	Two dummy variables; urban=1, otherwise=0 estate=1, otherwise=0
Household size	
Gender of the household head	One dummy variable male=1, female=0
Education level of the head	
Education level of the spouse	
Presence of children up to three years of age	One dummy variable if present=1, otherwise=0
Presence of heart diseases	One dummy variable if present=1, otherwise=0
Presence of blood pressure	One dummy variable if present=1, otherwise=0
Presence of diabetes	One dummy variable if present=1, otherwise=0

Both Marshallian (uncompensated) and Hicksian (compensated) price elasticities were calculated as equations 10 and 11, respectively.

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\{\gamma_{ij} - \beta_i \overline{W_j}\}}{\overline{W_i}} \quad (10)$$

$$\varepsilon_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{\overline{W_i}} + \overline{W_j} \quad (11)$$

Where, δ_{ij} = Kronecker delta, which is equal to one for $i = j$ and zero for $i \neq j$ (Taljaard *et al.,* 2004).

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

Results and discussion

Empirical Results

Description of the Sample

Descriptive statistics show that more than half of the sample consists of rural sector, while estate sector is contributing for the least proportion. In Sri Lanka, father is the person who is in charge of almost all household activities. Therefore, very often he becomes the head of the household. Convincing this situation, results state that 76% of the sample is accounted for male-headed households. When presence of children is considered, more is aged above three years. Moreover, with respect to the incidence of heart diseases, blood pressure, and diabetes, only a lesser proportion signifies their presence. In the sample, household size varies within 1 and 18, with an average of 4.3861. Education level has been measured as an array of 0-16, where 0 stands for no schooling or studying in grade 1 and 16 for passed post graduate degree/diploma (Table 3).

Results obtained from the probit model (Table 2) highlights that the model is significant for all types of pulses at 1% level. Further, model significance in SUR models is usually checked through Chi-square tests. Here, Chi-squares for all equations are significant at 1% level (Table 5). Moreover, revealing that ignorance of zero budget shares when estimating the system would generate biased and inconsistent parameter estimates; most of the IMR coefficients are significant at 1% level (Table 6).

Demographic Effects

Out of all demographic factors we selected, the sector and household size have a

Table 2 - Model significance in probit.

VARIABLES	PROB> CHI2
D1 – Dhal	0.0000
D2 – Green gram	0.0000
D3 – Cowpea	0.0000
D4 – Soybean	0.0000
D5 – Soya meat	0.0000
D6 – Gram	0.0000

Table 3 - Descriptive statistics of demographic variables.

DUMMY VARIABLES		PERCENTAGE	
Sector	Urban sector	24.98	
	Estate sector	9.29	
	Rural sector	65.73	
Gender of the head	Male	76.19	
	Female	23.81	
Presence of children	Yes	24.75	
	No	75.25	
Presence of heart diseases	Yes	4.64	
	No	95.36	
Presence of blood pressure	Yes	10.46	
	No	89.54	
Presence of diabetes	Yes	7.76	
	No	92.24	
CATEGORICAL VARIABLES	MEAN	STANDARD DEVIATION	RANGE
Household size	4.3861	1.8034	1-18
Education level of the head	7.5019	3.9174	0-16
Education level of the spouse	8.0465	3.8572	0-16

prominent contribution to the consumption of any type of pulses (Table 4). As household size increases, tendency to consume all pulses except dhal, will become lower suggesting that their demand will be price and/or income oriented. Nevertheless, it also shows that only the estate sector has a significant influence on the dhal consumption, implying that Sri Lankans tend to purchase dhal regardless of any concerns. However, the significant role arises from the estate sector with compared

Table 4 - Parameter estimates of the Probit model.

VARIABLES	DHAL	GREEN GRAM	COWPEA	SOYBEAN	SOYA MEAT	GRAM
Dhal price	-0.4921[a]	0.5290[a]	0.5180[a]	0.2200	0.4068[a]	0.4883[a]
Green gram price	0.0719	-0.7405[a]	0.1170	-0.1367	0.7497[a]	0.4032[a]
Gram price	0.1942	0.3225[a]	0.2818[c]	0.9214[a]	0.4119[a]	-0.4591[a]
Cowpea price	-0.7772[a]	0.6828[a]	-1.2134[a]	0.4060[b]	0.0193	0.9357[a]
Soybean price	0.5607[a]	0.4862[a]	0.4939[a]	-0.7533[a]	0.6636[a]	0.4647[a]
Soya meat price	0.4249[a]	0.3531[a]	0.2321[a]	0.4221[a]	-0.4296[a]	0.4266[a]
Real income	0.2516[a]	0.9180[a]	0.7397[a]	0.4013[a]	0.7816[a]	1.0062[a]
Constant	-1.3270[c]	-7.3124[a]	-9.0424[a]	-3.2164[a]	-4.4818[a]	-7.1753[a]
Urban sector	-0.1064	0.1505[a]	-0.1051[b]	-0.1177[b]	-0.0871[a]	0.1402[a]
Estate sector	0.2885[b]	-0.1500[a]	-0.3867[a]	-0.2321[a]	0.0448	0.0617
Household size	0.0103	-0.0970[a]	-0.0888[a]	-0.0382[a]	-0.0752[a]	-0.1038[a]
Gender of the head	-0.0946	0.0199	0.1903	-0.0414	0.0900	-0.0815
Education level of the head	0.0004	0.0065	-0.0082	-0.0226[a]	-0.0092[c]	0.0150[b]
Education level of the spouse	-0.0161	-0.0010	0.0236[a]	0.0034	-0.0133[a]	0.0277[a]
Presence of children	-0.0006	0.1220[a]	0.0568	0.0053	0.0973[a]	0.1982[a]
Presence of heart diseases	-0.0011	0.0815	0.0507	-0.0547	-0.0619	0.0358
Presence of blood pressure	0.0598	0.0589	0.1428[b]	-0.1502[c]	-0.0843[c]	0.0351
Presence of diabetes	-0.1130	0.2514[a]	0.0987	-0.0689	-0.2877[a]	0.1120[b]

Note: Superscripts a, b, and c denote statistical significance at 1, 5, and 10 percent level, respectively

Table 5 - Model significance in SUR.

EQUATION	CHI-SQUARE VALUE	P VALUE
W1 –Dhal	2611.20	0.0000
W2 –Green gram	537.98	0.0000
W3 –Cowpea	332.81	0.0000
W4 –Soybean	151.47	0.0000
W5 –Soya meat	573.62	0.0000

to the rural sector can be due to the ethnic distribution, in which majority of estate community has been built up with Tamils and dhal is a well-liked component in their diets.

The level of education is related to the ability to process more complex information and make decisions (Negassa, 2009). In this study, education level is found as a significant factor, which influences the consumption choice of pulses except for dhal and green gram. Nonetheless, results denote that buying decision of many types of pulses will be more affected by the education level of the spouse than the household head's. This may be as expected as most household heads in the sample are males and spouse is the female. In Sri Lanka in most households, buying decisions of food items lie in the hands of the female of the house.

Convincing that healthy feeding habits during the childhood ensure optimum growth and development, estimates highlight those households where children are present consume more gram, green gram and soya meat. When health issues are considered, only the blood pressure and diabetic patients seems to be conscious on adding pulses to their diets while households with heart patients show no significant impact, with compared to non-patients. The parameter estimates signify that blood pressure patients will more likely to choose cowpea, while gram and green gram are more favoured by diabetic patients.

Price Effects and Price Elasticities

Of the outcome which was obtained from the probit model (Table 4), own-price coefficients are negative for all kinds of pulses, as expected. However, in contrast to what is expected, SUR estimates gave a significant positive sign for the consumption of dhal (Table 6).

Marshallian or uncompensated price elasticity contains both the income effect and substitution effect while Hicksian or compensated price elasticity reflects only the substitution effect. The Marshallian own price elasticities of all pulses types are negative and consequently, consistent with the utility theory (Table 7). The values denoted that only dhal is less responsive to its own price changes, while all others are more responsive. It infers that, in case of a general price increase, consumption of all

Table 6 - Parameter estimates of the AIDS.

VARIABLES	DHAL	GREEN GRAM	COWPEA	SOYBEAN	SOYA MEAT	GRAM
Dhal price	0.0454[a]	0.0055	0.0207[a]	-0.0120[a]	-0.0405[a]	-0.0191
Green gram	0.0055	-0.0373[a]	0.0182[a]	0.0019	0.0174[a]	-0.0057
Cowpea price	0.0207[a]	0.0182[a]	-0.0667[a]	0.0119[a]	0.0026	0.0133
Soybean price	-0.0120[a]	0.0019	0.0119[a]	-0.0219[a]	0.0042	0.0159
Soya meat price	-0.0405[a]	0.0174[a]	0.0026	0.0042	-0.0247[a]	0.0409
Gram price	-0.0191[b]	-0.0057	0.0133[b]	0.0159[a]	0.0409[a]	-0.0454
Real income	-0.1696[a]	0.0297[a]	0.0146[a]	0.0001	0.0199[a]	0.1053
IMR	-0.5422[a]	-0.0111[b]	-0.0025	-0.0150[a]	-0.0410[a]	0.6119
Constant	2.5994[a]	-0.2441[a]	-0.1410[a]	0.0516[c]	-0.0519	-1.2140

Note: Superscripts a, b, and c denote statistical significance at 1, 5, and 10 percent level, respectively

Table 7 - Marshallian/uncompensated elasticities.

ε_{ij}	DHAL	GREEN GRAM	COWPEA	SOYBEAN	SOYAMEAT	GRAM
Dhal	-0.7713	-0.0467	0.0254	-0.0326	-0.1409	-0.2316
Green gram	0.0892	-1.1300	0.0341	0.0051	0.0253	-0.1039
Cowpea	0.1096	0.0190	-1.1927	0.0319	-0.0123	-0.0604
Soybean	0.0663	-0.0245	0.0172	-1.0591	-0.0080	-0.0536
Soya meat	0.0347	0.0152	-0.0085	0.0114	-1.0823	-0.0019
Gram	0.0704	-0.0498	0.0188	0.0429	0.0815	-1.2104
η_i	0.7793	1.0799	1.0389	1.0002	1.0504	1.2439

Note: ε_{ij} : diagonal values = own price elasticities, off diagonal values = cross price elasticities, η_i = expenditure elasticities

pulses except dhal would drop by a larger proportion. In addition, rice is the staple food in Sri Lanka and usually, meals consisting of several vegetables and dhal together with rice. Therefore, price inelasticity of dhal is not surprising since dhal is a very popular component in almost all Sri Lankan diets and hence, people generally used to purchase dhal despite its price.

When Marshallian cross price elasticity is considered, they suggest that pulses can be more of substitutes than they are complements. However, Hicksian price elasticity is a better measure of substitutability between two goods, since it measures only the substitution effect leaving the income effect out (Weliwita *et al.,* 2003). Hicksian cross-price elasticities indicate that all types of pulses are having substitutable relationships with each other (Table 8). Amid all the estimates, the substitutable relationship which

Table 8 - Hicksian/compensated elasticities.

ε_{ij}	DHAL	GREEN GRAM	COWPEA	SOYBEAN	SOYAMEAT	GRAM
Dhal	-0.1726	0.7831	0.8237	0.7359	0.6662	0.7241
Green gram	0.3790	-0.7284	0.4204	0.3771	0.4159	0.3587
Cowpea	0.4014	0.4233	-0.8038	0.4064	0.3810	0.4053
Soybean	0.3557	0.3765	0.4030	-0.6877	0.3821	0.4083
Soyameat	0.3433	0.4428	0.4029	0.4074	-0.6664	0.4906
Gram	0.4068	0.4164	0.4673	0.4746	0.5349	-0.6734

Note: ε_{ij} : diagonal values = own price elasticities, off diagonal values = cross price elasticities

green gram, gram, cowpea, soybean and soya meat show with dhal (0.7831, 0.7241, 0.8237, 0.7359, and 0.6662 respectively) is relatively stronger than others. It renders that Sri Lankans are quite likely to consume dhal and thus, it holds the most prominent choice among all other alternatives. Moreover, conveying that income effect outweighs the substitution effect, some of the cross price elasticities are negative for the Marshallian demand, while being positive for the Hicksian demand.

Expenditure Effects and Elasticities

Probit estimates for the real expenditure are significant at 1% level and positive for all types of pulses, and it suggests that consumption choice of pulses will be encouraged by an increase of real income (Table 4). SUR estimates of real expenditure also comply with probit estimates except dhal (Table 6). The positive coefficients of green gram, gram, cowpea, soybean, and soya meat denote that, when income rises consumers would spend more on those pulses. Negative coefficient of the dhal budget share infers that its consumption would increase less proportionately as income increases. It is again due to the habitual preference for dhal in most meals and hence, the trend of consumers to purchase dhal occurs so common, regardless of their status of income.

The expenditure elasticities are positive for all pulses and imply that all of them are normal and therefore, increase in income would lead to higher consumption (Table 7). Conveying that dhal plays a crucial role while becoming essential component in household diets, the elasticity estimates reveal it as a necessity. On the other hand, green gram, gram, cowpea, soybean and soya meat are identified as luxuries, which people devote an increasingly larger share of income as they receive more. Amongst all luxury pulses, gram holds the highest expenditure elasticity (1.2439), which highlights the expensive prices of gram with compared to others and consequently, consumers would not purchase gram very often.

Conclusions and recommendations

By employing the LA/AIDS, this study examined the demand for pulses which are more often consumed by Sri Lankans, while paying particular attention to the problem of zero expenditure. The demographic factors which influence the buying decision of these various kinds of pulses were captured through a Probit regression. Expenditure equations were corrected for possible zero expenditures by calculating inverse mills ratios from the probit regressions and including it in the LA/AIDS estimation.

Among the demographic factors we considered, sector (urban, estate, and rural) and the household size show a strong impact on the consumption choice of all pulses types. However, we failed to find any significant contribution from the gender of the household head. Nevertheless, purchasing decision is affected by the education level of the head and spouse of the household, presence of children, existence of blood pressure and diabetes as well.

All types of pulses which are more preferred by households where children, blood pressure and diabetic patients are present; are both price and expenditure elastic. Hence, when establishing policies, the government should be more careful in order to ensure adequate nutrition status for an active and healthy life at all times for all people.

Nevertheless, all pulses except dhal are quite responsive to both income and their own prices. As all of them are rich in plenty of nutrients, policies should be focused on encouraging the local production and also, not to impose tariff for pulses which are imported. Being a necessity and a price inelastic food commodity, dhal plays a significant role in Sri Lankans' meals. It suggests that consumption of dhal will not be diminished even during economic shocks such as falling income in a recession or increases in food prices. Accordingly, the country's dietary choices will be hugely affected by the restrictions or any other action which exporting countries introduce to strengthen their trade activities, because dhal is a purely an imported product.

Consequently, the government should be more attentive on above circumstances, in order to prevent malnutrition and food insecurity in Sri Lanka.

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