Effects of Household Composition on Consumers Budget for Food Items

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Abstract

Consumer demand behavior involves the purchasing and other consumption related activities of people and its study is concerned with the examination of everyday life. In the present study, we use the different forms of Engel models in order to study the consumer demand behavior for different food and non-food items in Bangladesh by using the full set of micro-level cross sectional Household Income and Expenditure Survey (HIES) data of Bangladesh. Engel curves are used to classify goods into luxuries, necessities, and inferior items and this can be viewed as an important application of these curves. By using this model the researcher found that for food items a positive significant effect of income for age group greater than 18 years for both male and female. Finally Engel curves have been shown in graphically linear and semi-logarithmic form with respect to family with children and without children.

Keywords: Engel curve, heteroscedasticity, household composition, non-food item

Introduction

One of the most consistent patterns of consumer demand found in economics is the Engel's Law, which suggested that as income rises, the share of budget spent on food (and, by extension, non-food) tends to decline. Engel curves can be used to classify goods into luxurious, necessities, and inferior items and this can be viewed as an important application of these curves (Allen and Bowley, 1935).

In the estimation of demand functions it is possible to distinguish between two diverse approaches. The first approach involves the estimation of a single demand equation. Hence, the focus is placed on a particular commodity, or commodity group, and the demand characteristics of a single market are established (Parks, october, 1969). This was the initial methodology employed in applied demand analysis. The second demand function estimation approach is the estimation of a complete system of demand equations. The need for such a system approach arose out of various theoretical, as well as practical considerations (Thomas, 1987).

Estimation of complete demand system within a framework consistent with classical demand theory was originated with (Raunikar and Huang, 1987) pioneering contribution and now constitute a large body of theoretical and applied literature. Many models have been proposed so far, but perhaps the most important in current uses, apart from the original Linear Expenditure System (LES), Rotterdam model (Barten, 1968) and the trans-log model is the Almost Ideal Demand System (AIDS) (Khanam and Ferdous, June 2000). Since the Engel function is the basis of the most of the improved demand systems, the present study considers different forms of Engel models (and hence curves) for analyzing consumer demand behavior (Banks et al., 1997).

In the present study, we use the different forms of Engel models in order to study the consumer demand behaviour for different food and non-food items in Bangladesh by using the full set of Household Income and Expenditure Survey (HIES) data of Bangladesh for year 2010.

The study further considers the estimation and comparison of the different forms of Engel models for different household composition with respect to age and sex. Then extensive study of the effect of children in relationship between budget share and income has been conducted through the estimation and graphical presentation of the Engel curves for the two groups, i.e., households with children and households without children.

Literature Review

In 1963, C. E. V. Leser shows the measurement of the demand for various commodities and commodity groups and of their price elasticity's is an econometric problem which has received the attention of economists and statisticians since the beginning of that century (Leser, 1963) . "Additive Utility Functions and Linear Engel Curves " investigate the class of additive utility functions yielding demand functions which are locally linear in income, or, equivalently, yielding income-consumption curves which are linear in some region of the commodity space (Pollack, 1971). S.J. Paris discuss the form of the relationship between a consumer's income and his expenditure on the range of commodities available in the market (Paris and Houthakker, 1955). The paper is based on a comparative study of the use of alternative algebraic forms in the analysis of data from the Dutch budget collection and from the two British pre-war enquiries at present under analysis in Cambridge. In 1960, F.G.Forsyth describes the results of the ministry of labour's 1953-54 household expenditure enquiries are used to test whether the expenditure differences between different sizes of family can be explained by the equivalent scale hypothesis (Forsyth, 1960).

Baten and Ferdous (1998) made an attempt to compute all direct and cross demand elasticity for 17 food items or item groups for Bangladesh with respect to price by making certain want independence assumptions from the knowledge of budget shares and income elasticity (Baten and Ferdous, 1998). Khanam and Ferdous analysed the nutritional behavior of the people of Bangladesh in terms of nutrient demand elasticity of 16 selected food items calculated by Frisch's (1959) method (Khanam and Ferdous, June 2000 , Khanam, December 2007). The concept of 'money flexibility' was also considered for defining demand elasticity in terms of Engel elasticity and budget shares . The study used the micro level Household Expenditure Survey data (HES:1991/92) published by Bangladesh Bureau of Statistics (BBS) and found that budget share was highly responsive to the expenditure and size variables but not to the age and sex of the household head (Khanam and Ferdous, July 2000, Hazra A. and Datta P, 2007). Mullah and Rezina Ferdous attempted to analyze the consumer demand behaviour by applying three different forms of Engel models in slightly modified versions (Mulla and Ferdous, 2005).

Objectives of the present study

The main objectives of the study includes

(1) Estimation of the different forms of Engel models to analyze the consumer demand behaviour for food items.
(2) Ordinary Least Squares (OLS) parameter estimates of Engel model of different household composition with respective to age and sex compositions.
(3) Estimate the effect of budget share in case of families with children and without children by linear and semi-logarithmic Engel model.

Methodology

The present study is based on the full set of micro-level cross sectional Household Income and expenditure Survey (HIES) – 2010 data of 12240 households obtained from Bangladesh bureau of statistics (BBS). The HIES-2010 data is a cross sectional data as variables are collected at the same point in time for each household (BBS, 2010). Moreover, the HIES data considered in the present study are micro-level data as the information is collected at disaggregated level for each household and the data is in row form (i.e., without any aggregation or any type of data sorting).

Empirical Specification of the Engel curves: We have the following forms of Engel models

Double-logarithmic model: $\log q_i = \alpha_i + \beta_j \log y + \varepsilon_i$ ………………………………. (1)

Linear model : $q_i = \alpha_i + \beta_j y + \varepsilon_i$ ……………………..………………(2)

Semi-logarithmic model : $q_i = \alpha_i + \beta_j \log y + \varepsilon_i$ …………………….……………. (3)

Log-reciprocal model : $\log q_i = \alpha_i - \beta_i y^{-1} + \varepsilon_i$ ……………………………..... (4)

Where, q_i is the quantity demanded for commodity i,

y is per capita total income,

ε_i is the stochastic vector,

α_i and β_i are the parameters to be estimated.

Budget share (Wi) instead of quantity demanded for a commodity (q_i) has been used as dependent variable for the Engel models in the present study.

The budget share Wi , for commodity i , is defined by-

$$W_i = \frac{\frac{p_i q_i}{z}}{\frac{X}{z}} = \frac{p_i q_i}{X}$$

And it is the fraction of total expenditure going to each good.

Where, p_i =unit price of the ith commodity,

q_i =Quantity of commodity i which is consumed,

X =Total expenditure of household and

z = The household size.

And the per capita total income is defined as $y = \frac{Y}{z}$

Where, Y=total income of the household and

z = the household size.

So substituting W_i for q_i in equations (1), (2), (3) and (4) we respectively get the following models

Double-logarithmic model: $\log W_i = \alpha_i + \beta_j \log y + \varepsilon_i$ ………………..……… (5)

Linear model : $W_i = \alpha_i + \beta_j y + \varepsilon_i$ ………………..…………… (6)

Semi-logarithmic model : $W_i = \alpha_i + \beta_j \log y + \varepsilon_i$ …………….……….…… (7)

Log-reciprocal model : $\log W_i = \alpha_i - \beta_i y^{-1} + \varepsilon_i$ ………………………….. (8)

A major problem in our data is that, no record is provided on expenditure or consumption of some goods during the survey period for many households. Since there are so many zero consumptions in our data for some goods, we can not use logWi in the above forms (equations (5) and (8) because on the left hand side of these equations log of zero is meaningless. So double logarithmic and log reciprocal forms of Engel models can not be used in the present study.

However in equation (8) we have used Wi instead of logWi and then log-reciprocal model transformed to only reciprocal model. So finally we have the following models:

Linear model : $W_i = \alpha_i + \beta_j y + \varepsilon_i$

Semi-logarithmic model : $W_i = \alpha_i + \beta_j \log y + \varepsilon_i$

Reciprocal model : $W_i = \alpha_i - \beta_i y^{-1} + \varepsilon_i$

Where α_i and β_i are the parameters to be estimated and the stochastic vector ε_i is assumed to have the usual properties of zero expectation, constant variance and zero correlation with x. Adding up restriction requires that $\sum W_i$ =1, which is satisfied provided $\sum \alpha_i = 1$, $\sum \beta_i = 0$. Above equation are our final specified forms of Engel models.

Econometric Validation

Heteroscedasticity: An important assumption of the classical linear regression model is that the disturbances term ε_t has a constant variance, i.e. $\text{var}(\varepsilon_t) = \sigma^2$, a constant. If this assumption is violated the disturbance is said to be heteroscedastic.

Detection of heteroscedasticity : To detect the heteroscedasticity the Breusch-Pagan-Godfrey (BPG) test is a more general and simple test. It covers a wide range of heteroscedastic situations and uses the OLS residuals. To illustrate this test, let us consider the K- variable linear regression model as follows:

$$y_t = \beta_1 + \beta_2 X_{2t} + \beta_3 X_{3t} + \ldots\ldots + \beta_k X_k + \varepsilon_t,\ t = 1,2,3,\ldots\ldots\ldots n \quad \ldots\ldots..(9)$$

Let us assume that the error variance $\sigma^2{}_t$ is described as follows

$$\sigma^2{}_t = f(\alpha_1 + \alpha_2 z_{2t} + \alpha_3 z_{3t} + \ldots\ldots\ldots + \alpha_m z_{mt}) \quad \ldots\ldots\ldots(10)$$

that is $\sigma^2{}_t$ is some function of the non-stochastic variables Z's, some or all of the X's can serve as Z's. Specifically, let us assume that,

$$\sigma^2{}_t = \alpha_1 + \alpha_2 z_{2t} + \alpha_3 z_{3t} + \ldots\ldots\ldots + \alpha_m z_{mt} \quad \ldots\ldots\ldots(11)$$

that is $\sigma^2{}_t$ is a linear function of the Z's. If $\alpha_1 = \alpha_2 = \alpha_3 = \ldots\ldots\ldots = \alpha_m = 0, \sigma_t{}^2 = \alpha_1$ which is a constant. Therefore, to test whether $\sigma^2{}_t$ is homoscedastic. So we may test the hypothesis that $\alpha_1 = \alpha_2 = \alpha_3 = \ldots\ldots\ldots = \alpha_m = 0$. This is the basic idea behind the Breusch-Pagan-Godfrey (BPG) test.

Table 1: Results for BPG tests of heteroscedasticity.

Item	Models from Engel curves		
	χ^2 values for Linear model with 1 df	χ^2 values for Semi-logarithmic model with 1 df	χ^2 values for Reciprocal model with 1 df
Rice	79546.23	417.73	2466.25
Pulse	3.96	472.23	369.26
Fish	28.39	51.24	18.62
Potato	1785.75	1274.65	1438.42
Vegetable	5584.52	563.33	675.95
Oil and fat	1145.45	208.35	208.64
Salt	12563.95	701.26	785.36
Chili	4185.79	468.83	654.29
Onion	1145.89	317.94	311.24
Other spices	14.90	84.65	23.46

For the Engel models (linear, semi-logarithmic and reciprocal model) the BPG test statistics follows the chi-square distribution with 1 df and from the chi-square table we find that for 1 df at 5% level of significant the critical chi-square value is 3.84. Since all the observed chi-square values (as given in the above table) for all the food items for linear, semi-logarithmic and reciprocal model are greater than 3.84, we may conclude that there are heteroscedasticity in the error variances of three models

Remedial measure for the study: In our study, since error variance σ_i^2 is not directly known, to remove the heteroscedasticity problem we need to make plausible assumption about the heteroscedasticity problem. Prais and Houthakker (1955) found in their analysis of family budgets that the residuals from the regression have variance increasing with household income (Paris and Houthakker, 1955). As we have used the per capita total expenditure instead of income variable, following the Prais and Houthakker finding we assume that per capita total income (y) is responsible for heteroscedasticity problem for the three different models from Engel function so that the error variance of the model is proportional to the per capita total expenditure i.e., $E(\varepsilon_i^{\,2}) = \sigma^2 y$. To get rid of the heteroscedasticity problem, we divide all models throughout by the square root of the per capita total expenditure ($\sqrt{y}$).

Thus our finally specified Engel's models become

Linear model : $\frac{W_i}{\sqrt{y}} = \frac{\alpha_i}{\sqrt{y}} + \frac{\beta_i y}{\sqrt{y}} + \frac{\varepsilon_i}{\sqrt{y}}$ …………….. ……..(12)

Semi-logarithmic model: $\frac{W_i}{\sqrt{y}} = \frac{\alpha_i}{\sqrt{y}} + \frac{\beta_i \log y}{\sqrt{y}} + \frac{\varepsilon_i}{\sqrt{y}}$ ………….. ….(13)

Reciprocal model : $\frac{W_i}{\sqrt{y}} = \frac{\alpha_i}{\sqrt{y}} - \frac{\beta_i y^{-1}}{\sqrt{y}} + \frac{\varepsilon_i}{\sqrt{y}}$ ……………… (14)

Result and Discussion

In present study, three different forms of Engel models each containing one explanatory variable have been estimated for 10 foods items. The results have been discussed elaborately from different aspects. To discuss consumer demand behavior regarding the different food items, first the authors study the parameter estimates of the linear, semi-logarithmic and reciprocal forms of the Engel models considered in the present study.

The "heteroscedasticity corrected" Ordinary least squares (OLS) parameter estimates of three Engel models as represented by equation (12), (13) and (14) for different food and non-food items. It is evident from figure 1 that for necessary and luxuries items the linear and semi-logarithmic Engel curves are downward and upward slopping respectively; whereas the reciprocal Engel curves slopes in opposite directions, i.e., upwards for necessary and downwards for luxurious items. Again these Engel curves are quite different from the curves given in the previous section obtained by Brown and Deaton where the quantity demanded rather than budget shares were considered in the Y axis and income rather than per capita total income were considered in the X axis (Brown and Deaton, 1972). It should be mentioned here that for the other food (considered in the present study), the shapes of different forms of Engel curves are the same as those shown in figures 1. For convenience only, the curves for important items (two foods vegetables and other spices) have been shown.

Table1 2: Ordinary least squares (OLS) parameter estimates of Engel models for 10 different foods and 2 different non-food items. (p-values are in the parentheses, Household size = 12240).

Items	Models from Engel curves		
	Linear model	**Semi-logarithmic model**	**Reciprocal model**
Rice	β = -0.0709 (0.003) $R^2 = 0.880$	β = -0.414 (0.004) $R^2 = 0.862$	β = 3.33 (0.001) $R^2 = 0.858$
Pulse	β = -0.16(0.049) $R^2 = 0.628$	β = 1.65 (0.0054) $R^2 = 0.630$	β = 16.67 (0.0021) $R^2 = 0.629$
Fish	β = 0.0719(0.001) $R^2 = 0.748$	β = 1.542 11(0.0033) $R^2 = 0.756$	β = 17.0 12(0.0035) $R^2 = 0.750$
Potato	β = -0.029 (0.002) $R^2 = 0.676$	β = -1.24 (0.0022) $R^2 = 0.671$	β = 4.66(0.31) $R^2 = 0.670$
Vegetables	β = -0.057 (0.004) $R^2 = 0.798$	β = -0.36 (0.0005) $R^2 = 0.793$	β = -3.09 (0.001) $R^2 = 0.792$
Oil and Fats	β = -0.01 (0.002) $R^2 = 0.837$	β = 0.33 (0.004) $R^2 = 0.837$	β = -3.2 (0.34) $R^2 = 0.837$
Salts	β = -0.013 (0.005) $R^2 = 0.769$	β = -0.0464 (0.001) $R^2 = 0.758$	β = 1.415 (0.001) $R^2 = 0.716$
Chili	β = -0.020 (0.0001) $R^2 = 0.763$	β = -0.131 (0.00035) $R^2 = 0.757$	β = 3.55(0.13) $R^2 = 0.755$
Onion	β = -0.0669(0.002) $R^2 = 0.755$	β = 0.337 (0.005) $R^2 = 0.753$	β = 1.728 (0.004) $R^2 = 0.757$
Other Spices	β = 0.03387(0.002) $R^2 = 0.740$	β = 0.1361 (0.0021) $R^2 = 0.742$	β = 3.117 (0.0044) $R^2 = 0.743$

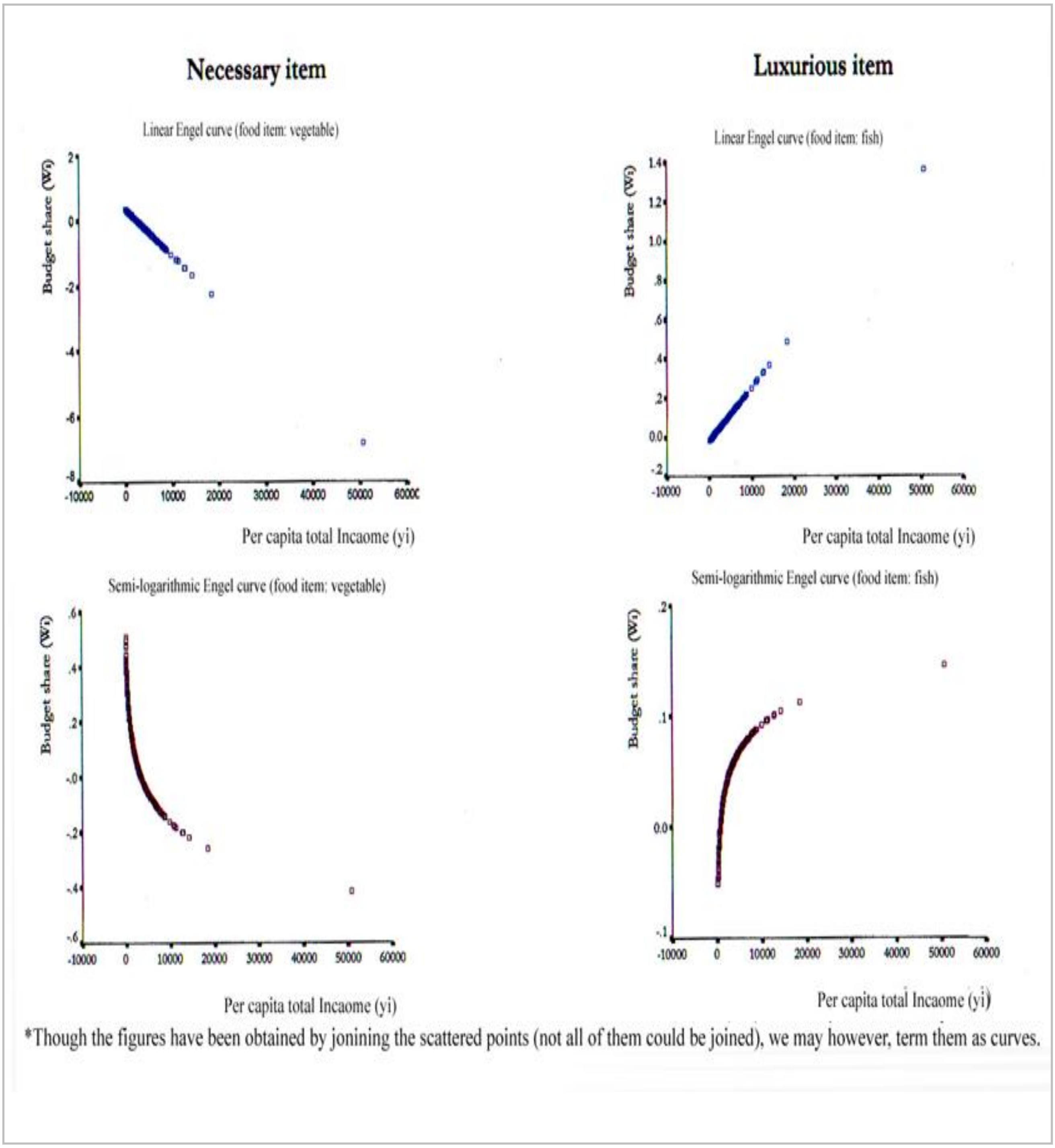

Figure1: Curves showing different forms of Engel functions for necessary and luxurious food items.

Figure: 1 shows the three forms of Engel curves considered in this study for food items and non-food item. These curves explain the types of food items. The Engel curves in the following figures allow luxuries (β_i >0) and necessities (β_i <0).

Table 3: Ordinary Least Squares (OLS) parameter estimates of Engel Models for Rice of household composition. (P-values are in parenthesis, household size =12240)

Item	Group	Linear model	Semi-logarithmic Model	Reciprocal model
Rice	G-1: 0-13 (male)	β=-9.63 (0.01) $R^2 = 0.796$	β=-1.03 (0.002) $R^2 = 0.753$	β=0.357 (0.0033) $R^2 = 0.730$
	G-2: 14-17 (male)	β=-1.07 (0.01) $R^2 = 0.916$	β=-1.28 (0.005) $R^2 = 0.914$	β=-9.45 (0.005) $R^2 = 0.896$
	G-3: ≥18 (male)	β=-4.94 (0.04) $R^2 = 0.866$	β=-1.02 (0.003) $R^2 = 0.864$	β=0.314 (0.0088) $R^2 = 0.847$
	G-4: 0-13 (female)	β=-1.11 (0.01) $R^2 = 0.771$	β=-1.26 (0.002) $R^2 = 0.741$	β=0.565 (0.0012) $R^2 = 0.725$
	G-5: 14-17 (female)	β=-6.55 (0.05) $R^2 = 0.858$	β=-7.86 (0.0044) $R^2 = 0.856$	β=0.976 (0.0044) $R^2 = 0.830$
	G-6: ≥18 (female)	β=-5.60 (0.07) $R^2 = 0.865$	β=-8.57 (0.0088) $R^2 = 0.863$	β=0.324 (0.0078) $R^2 = 0.847$

Responsiveness of budget share of rice to the per capita income in Engel model:

In general all models for most of the household compositions, explain between 80 to 90 percent of the variation except the age group 0-13 for both male and female. In application, no single model is superior to another model for rice over different household composition on the basis of these R^2 values. It is evident from table 3 that the per capita income coefficient (β_i) in each model is statistically significant for rice within each of the household compositions. This implies that budget shares for rice are responsive to the per capita income for every household composition. Except reciprocal model, the coefficient is negative and statistically significant at 1 percent level of significance. This indicates that the income elasticity computed from the estimated linear and semi-logarithmic models are less than 1, which shows that, the commodity "rice" is a necessary for every household composition with respect to age and sex.

Table 4: Ordinary Least Squares (OLS) parameter estimates of Engel models for Pulse. (P-value in parenthesis, household size =12240)

Item	Group	Linear model	Semi-logarithmic model	Reciprocal model
Pulse	G-1: 0-13 (male)	β=-1.35 (0.004) $R^2 = 0.665$	β=-1.85 (0.045) $R^2 = 0.665$	β=-2.14 (0.032) $R^2 = 0.667$
	G-2: 14-17 (male)	β=-2.73 (0.031) $R^2 = 0.557$	β=8.180 (0.038) $R^2 = 0.557$	β=0.750 (0.037) $R^2 = 0.582$
	G-3: ≥18 (male)	β=1.620 (0.009) $R^2 = 0.619$	β=2.064 (0.008) $R^2 = 0.621$	β=3.574 (0.005) $R^2 = 0.623$
	G-4: 0-13 (female)	β=7.646 (0.001) $R^2 = 0.631$	β=9.052E-06 (0.005) $R^2 = 0.631$	β=1.27 (0.008) $R^2 = 0.646$
	G-5: 14-17 (female)	β=-3.02 (0.000) $R^2 = 0.679$	β=-4.50E-05 (0.000) $R^2 = 0.683$	β=-0.498 (0.000) $R^2 = 0.680$
	G-6: ≥18 (female)	β=6.392 (0.852) $R^2 = 0.572$	β=2.786 (0.345) $R^2 = 0.575$	β=3.526 (0.256) $R^2 = 0.574$

Responsiveness of budget share of pulse to the per capita income in Engel model:

In general all models for most of the household compositions, explain between 57 to 69 percent of the variation. It is evident from table 4 that the per capita income coefficient (β_i)

in each model is statistically significant at 1 percent level of significance for pluse within each of the household compositions. This implies that budget shares for pulse are responsive to the per capita income for every household composition. From the table 4 the coefficient is negative and statistically significant at 1 percent level of significance for age group 0-13 for male & age group 14-17 for female. This indicates that the income elasticity for this group computed from the estimated linear, semi-logarithmic & reciprocal model are less than 1 and other groups are greater than 1.

Table 5: Ordinary Least Squares (OLS) parameter estimates of Engel Models for Fish.
(P-value in parenthesis, household size =12240)

Item	Group	Linear model	Semi-logarithmic model	Reciprocal model
Fish	G-1: 0-13 (male)	$\beta = 1.62$ (0.025) $R^2 = 0.745$	$\beta = 1.950$ (0.024) $R^2 = 0.746$	$\beta = 0.155$ (0.038) $R^2 = 0.747$
	G-2: 14-17 (male)	$\beta = -3.11$ (0.075) $R^2 = 0.746$	$\beta = -4.33$ (0.035) $R^2 = 0.746$	$\beta = -2.089$ (0.041) $R^2 = 0.761$
	G-3: ≥18 (male)	$\beta = 4.554$ (0.056) $R^2 = 0.752$	$\beta = 1.731$ (0.085) $R^2 = 0.757$	$\beta = 0.160$ (0.045) $R^2 = 0.756$
	G-4: 0-13 (female)	$\beta = 1.009$ (0.089) $R^2 = 0.770$	$\beta = 1.274$ (0.072) $R^2 = 0.771$	$\beta = 0.245$ (0.002) $R^2 = 0.771$
	G-5: 14-17 (female)	$\beta = 4.593$ (0.065) $R^2 = 0.741$	$\beta = 9.403$ (0.096) $R^2 = 0.745$	$\beta = 1.252$ (0.008) $R^2 = 0.745$
	G-6: ≥18 (female)	$\beta = 9.486$ (0.092) $R^2 = 0.712$	$\beta = 2.219E$ (0.056) $R^2 = 0.722$	$\beta = 0.173$ (0.007) $R^2 = 0.708$

Responsiveness of budget share of fish to the per capita income in Engel model:

In application, no single model is superior to another model for fish over different household composition on the basis of these R^2 values. Here it is mentioned from the table 4 that group-4 that is female of age group 0-14 provides more R^2 value than the other group. It is evident from table 4 that the per capita income coefficient (β_i) in each model is statistically significant for fish within each of the household compositions. This implies that budget shares for fish are responsive to the per capita income for every household composition. Except group-2, the coefficient is positive and statistically significant at 1 percent level of significance. This indicates that the income elasticity computed from the estimated all three models are greater than 1.Which shows that, the commodity "fish" is a luxurious for every household composition with respect to age and sex.

Table 6: Ordinary Least Squares (OLS) parameter estimates of Engel models for Potato. (P-value in parenthesis, household size =12240)

Item	Group	Linear model	Semi-logarithmic Model	Reciprocal model
	G-1: 0-13 (male)	β=-474 (0.005) $R^2=0.704$	β=-5.53 (0.009) $R^2=0.704$	β=-1.32 (0.006) $R^2=0.697$
	G-2: 14-17 (male)	β=-2.78 (0.002) $R^2=0.687$	β=-3.62 (0.002) $R^2=0.688$	β=0.522 (0.009) $R^2=0.694$
	G-3: ≥18 (male)	β=-2.28 (0.005) $R^2=0.667$	β=-4.37 (0.004) $R^2=0.665$	β=2.036 (0.003) $R^2=0.662$
	G-4: 0-13 (female)	β=-3.46 (0.002) $R^2=0.687$	β=-3.90 (0.003) $R^2=0.687$	β=4.198 (0.005) $R^2=0.684$
Potato	G-5: 14-17 (female)	β=-2.46 (0.004) $R^2=0.655$	β=-2.90 (0.002) $R^2=0.654$	β=0.265 (0.007) $R^2=0.652$
	G-6: ≥18 (female)	β=-1.98 (0.003) $R^2=0.630$	β=-4.04 (0.002) $R^2=0.631$	β=3.045 (0.006) $R^2=0.628$

Responsiveness of budget share of potato to the per capita income in Engel model:

In general all models for most of the household compositions, explain between 60 to 70 percent of the variation. It is evident from table 5 that the per capita income coefficient (β_i) in each model is statistically significant at 1 percent level of significance for potato within each of the household compositions. So no model is superior than others. This implies that budget shares for potato is responsive to the per capita income for every household compositions. From the table 5the coefficient is negative and statistically significant at 1 percent level of significance. Which indicates that the income elasticity computed from the estimated linear and semi-logarithmic model are less than 1. This implies that, the commodity "potato" is a necessary for every household composition with respect to age and sex.

Table 7: Ordinary Least Squares (OLS) parameter estimates of Engel models for Vegetable (P-value in parenthesis, household size=12240)

Item	Group	Linear model	Semi-logarithmic model	Reciprocal model
	G-1: 0-13 (male)	$\beta=$-1.18 (0.081) $R^2=0.824$	$\beta=$-1.45 (0.055) $R^2=0.826$	$\beta=$-8.26 (0.025) $R^2=0.819$
	G-2: 14-17 (male)	$\beta=$-7.82 (0.092) $R^2=0.793$	$\beta=$-9.25 (0.045) $R^2=0.792$	$\beta=$0.391 (0.029) $R^2=0.784$
	G-3: ≥18 (male)	$\beta=$-3.79 (0.064) $R^2=0.788$	$\beta=$-7.27 (0.027) $R^2=0.786$	$\beta=$7.528 (0.035) $R^2=0.782$
Vegetable	G-4: 0-13 (female)	$\beta=$-6.51 (0.075) $R^2=0.793$	$\beta=$-7.50 (0.038) $R^2=0.793$	$\beta=$0.104 (0.042) $R^2=0.791$
	G-5: 14-17 (female)	$\beta=$-6.67 (0.083) $R^2=0.819$	$\beta=$-9.64 (0.042) $R^2=0.824$	$\beta=$-6.15 (0.011) $R^2=0.806$
	G-6: ≥18 (female)	$\beta=$-4.66 (0.069) $R^2=0.779$	$\beta=$-1.01 (0.094) $R^2=0.783$	$\beta=$1.330 (0.031) $R^2=0.774$

Responsiveness of budget share of vegetable to the per capita income in Engel model:

In general all models for most of the household compositions, explain between 77 to 83 percent of the variation. It is evident from table 7 that the per capita income coefficient (β_i) in each model is statistically significant at 1 percent level of significance for vegetables within each of the household compositions. This implies that a budget share for vegetables is responsive to the per capita income for every household compositions. From the table 7 the coefficient is negative and statistically significant at 1 percent level of significance. This indicates that the income elasticity computed from the estimated linear and semi-logarithmic model are less than 1. Which implies that, the budget shares with higher per capita income and the commodity "vegetable" is a necessary for every household composition with respect to age and sex.

Engel curve for food and non-food items

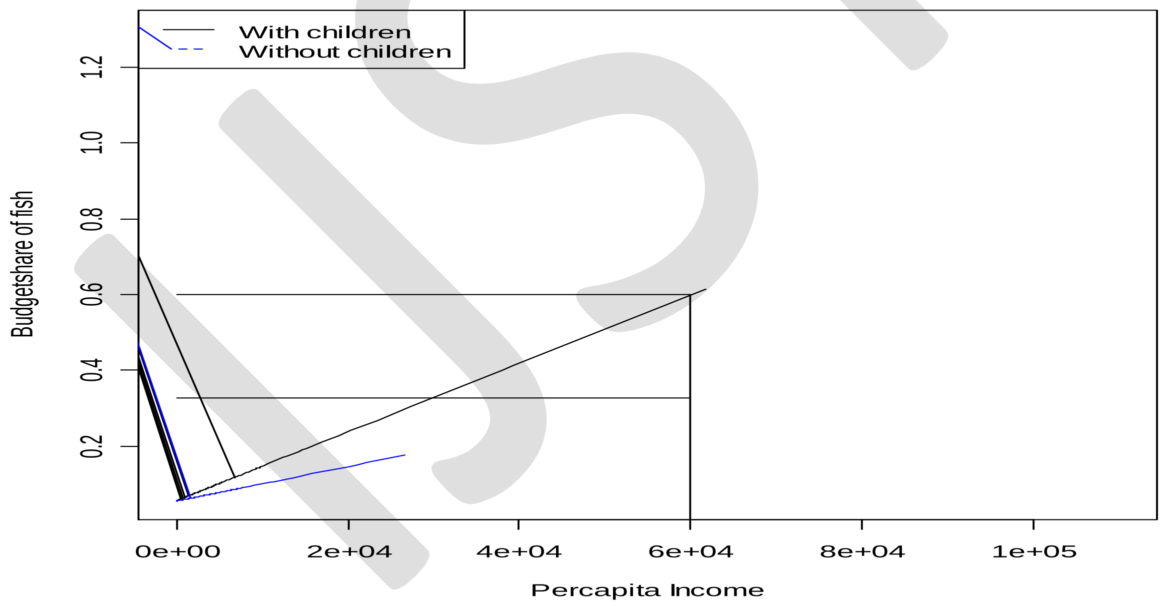

Figure 2: Engel curve for non-food (tobacco) and food (fish) on linear model for families with and without children in the given range of income.

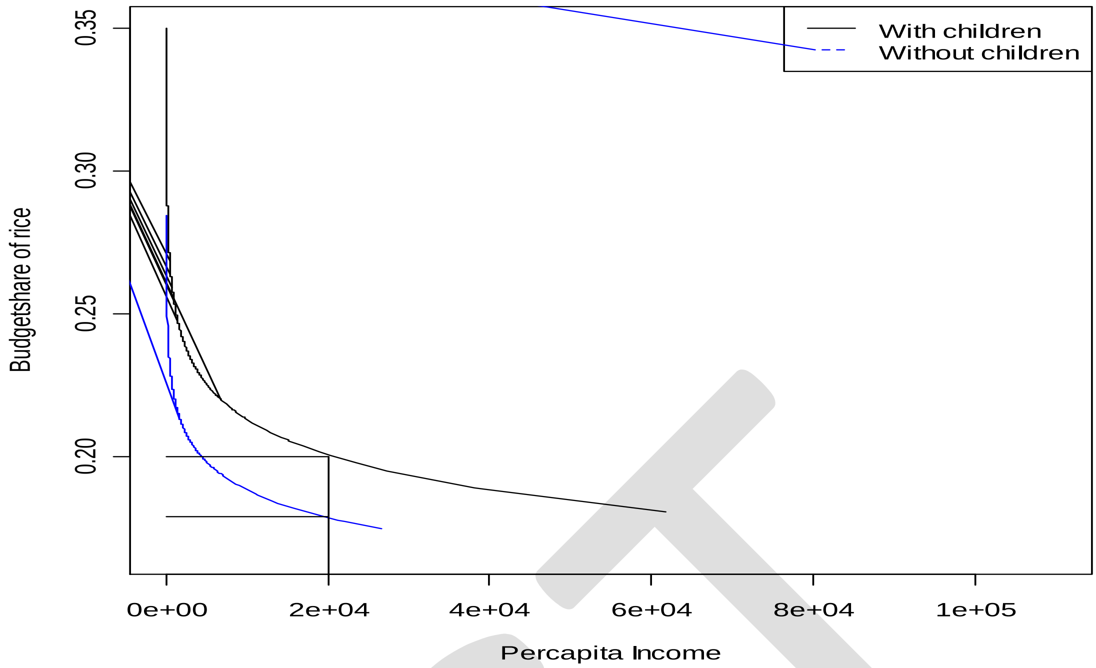

Figure 3: Engel curve for food item (rice) on Semi-logarithmic model for families with and without children in the given range of income.

From the above figure $\Delta y = (57100, 80500)$ we found that the income compensation required at the level of tobacco budget share q_i=0.15, means that for a given budget share, for tobacco and tobacco products, the families with children need to have greater per capita income than that of the families without children. However the budget share for tobacco increases as income increases for both type of families. On the other hand $\Delta w_i = (0.327, 0.60)$; the increase in demand for food attributable to children at a given income means that for a given per capita income of the families with children need to have greater budget share for fish than that of families without children. However the budget share for food and non-food items increases as per capita income increases for both type of families that are directly related as for linear model.

For the figure-3, Semi-logarithmic Engel model, we observed that $\Delta w_i = (0.179, 0.20)$; for a given per capita income, the families with children need to have greater budget for rice than that of families without children. That is for semi-logarithmic Engel model, budget share for rice and per capita income of the families are inversely related.

Conclusion

The commodities rice, potato, vegetables, pulse, oil and fat, salt, chili, onion and betel-nuts are the necessary for every household composition with respect to age and sex for both linear and semi-logarithmic Engel model. On the other hand the commodities fish and tobacco and tobacco-products are the luxurious items for every household composition with respect to age and sex for both linear and semi-logarithmic Engel model.

For a given budget share, for tobacco and tobacco products, the families with children need to have more per capita income than that of the families without children. However the budget share for tobacco increases as income increases for both type of families. For a given per capita income of the families with children need to have more budget share for fish than that of families without children. Thus budget share of food items have significant effect on the families with and without children.

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Appendix

Table 8: Ordinary Least Squares (OLS) parameter estimates of Engel models for Oil. (P-value in parenthesis, household size =12240)

Item	Group	Linear model	Semi-logarithmic model	Reciprocal model
Oil	G-1: 0-13 (male)	β=-1.89 (0.000) $R^2 = 0.857$	β=-2.50 (0.000) $R^2 = 0.858$	β=1.55 (0.000) $R^2 = 0.857$
	G-2: 14-17 (male)	β=-1.76 (0.000) $R^2 = 0.830$	β=-3.09 (0.000) $R^2 = 0.832$	β=0.164 (0.000) $R^2 = 0.829$
	G-3: ≥18 (male)	β=-9.45 (0.000) $R^2 = 0.830$	β=-1.63 (0.000) $R^2 = 0.830$	β=6.497 (0.000) $R^2 = 0.829$
	G-4: 0-13 (female)	β=-8.33 (0.000) $R^2 = 0.847$	β=-8.83 (0.000) $R^2 = 0.847$	β=2.427 (0.000) $R^2 = 0.847$
	G-5: 14-17 (female)	β=-2.05 (0.000) $R^2 = 0.820$	β=-3.23 (0.000) $R^2 = 0.822$	β=5.25 (0.000) $R^2 = 0.816$
	G-6: ≥18 (female)	β=1.788 (0.000) $R^2 = 0.800$	β=1.30 (0.000) $R^2 = 0.800$	β=2.423 (0.000) $R^2 = 0.801$

Table 9: Ordinary Least Squares (OLS) parameter estimates of Engel models for Salt. (P-value in parenthesis, household size =12240)

Item	Group	Linear model	Semi-logarithmic model	Reciprocal model
Salt	G-1: 0-13 (male)	β=-1.44 (0.054) $R^2=0.780$	β=-1.52 (0.067) $R^2=0.779$	β=1.742 (0.073) $R^2=0.788$
	G-2: 14-17 (male)	β=-2.11 (0.087) $R^2=0.800$	β=-2.88 (0.023) $R^2=0.807$	β=-0.205 (0.098) $R^2=0.790$
	G-3: ≥18 (male)	β=-9.08E-07 (0.093) $R^2=0.748$	β=-1.88E-05 (0.051) $R^2=0.747$	β=1.597E-02 (0.063) $R^2=0.744$
	G-4: 0-13 (female)	β=-2.00E-06 (0.029) $R^2=0.791$	β=-2.28E-05 (0.019) $R^2=0.790$	β=4.5936E-03 (0.045) $R^2=0.775$
	G-5: 14-17 (female)	β=-9.99 (0.045) $R^2=0.770$	β=-1.22 (0.023) $R^2=0.769$	β=9.032 (0.095) $R^2=0.761$
	G-6: ≥18 (female)	β=-9.98 (0.037) $R^2=0.755$	β=-2.18 (0.071) $R^2=0.761$	β=1.93 (0.001) $R^2=0.752$

Table 10: Ordinary Least Squares (OLS) parameter estimates of Engel models for Chili. (P-value in parenthesis, household size =12240)

Item	Group	Linear model	Semi-logarithmic model	Reciprocal model
Chili	G-1: 0-13 (male)	β=-2.64 (0.034) $R^2 = 0.797$	β=-3.19 (0.041) $R^2 = 0.798$	β=4.456 (0.087) $R^2 = 0.791$
	G-2: 14-17 (male)	β=-2.89 (0.054) $R^2 = 0.749$	β=-3.74 (0.035) $R^2 = 0.750$	β=-0.114 (0.044) $R^2 = 0.736$
	G-3: ≥18 (male)	β=-1.62 (0.054) $R^2 = 0.754$	β=-3.44 (0.067) $R^2 = 0.754$	β=1.371 (0.085) $R^2 = 0.745$
	G-4: 0-13 (female)	β=-2.30E-06 (0.076) $R^2 = 0.795$	β=-2.52E-05 (0.098) $R^2 = 0.794$	β=1.268 (0.099) $R^2 = 0.789$
	G-5: 14-17 (female)	β=-1.88 (0.045) $R^2 = 0.737$	β=-2.36 (0.089) $R^2 = 0.757$	β=0.183 (0.087) $R^2 = 0.731$
	G-6: ≥18 (female)	β=-1.84 (0.051) $R^2 = 0.710$	β=-4.30E-05 (0.076) $R^2 = 0.717$	β=1.213 (0.096) $R^2 = 0.704$

Table 11: Ordinary Least Squares (OLS) parameter estimates of Engel models for Onion. (P-value in parenthesis, household size =12240)

Item	Group	Linear model	Semi-logarithmic model	Reciprocal model
Onion	G-1: 0-13 (male)	β=-4.19 (0.044) $R^2=0.771$	β=-5.17 (0.057) $R^2=0.771$	β=1.666 (0.071) $R^2=0.778$
	G-2: 14-17 (male)	β=-1.35 (0.085) $R^2=0.774$	β=-1.98 (0.066) $R^2=0.776$	β=-7.44 (0.092) $R^2=0.769$
	G-3: ≥18 (male)	β=-4.77 (0.034) $R^2=0.750$	β=-6.17 (0.011) $R^2=0.749$	β=2.143 (0.037) $R^2=0.755$
	G-4: 0-13 (female)	β=-9.82 (0.013) $R^2=0.777$	β=-1.21 (0.042) $R^2=0.777$	β=1.658 (0.022) $R^2=0.776$
	G-5: 14-17 (female)	β=-4.27 (0.023) $R^2=0.793$	β=-4.40 (0.051) $R^2=0.792$	β=0.137 (0.066) $R^2=0.797$
	G-6: ≥18 (female)	β=-6.20 (0.050) $R^2=0.700$	β=-2.03 (0.073) $R^2=0.705$	β=2.619 (0.000) $R^2=0.703$

Table 12: Ordinary Least Squares (OLS) parameter estimates of Engel Models for Other spices (P-value in parenthesis, household size =12240)

Item	Group	Linear model	Semi-logarithmic model	Reciprocal model
Other Spices	G-1: 0-13 (male)	β=2.607 (0.044) $R^2=0.734$	β=3.389 (0.023) $R^2=0.735$	β=5.152E-02 (0.091) $R^2=0.748$
	G-2: 14-17 (male)	β=-1.32 (0.012) $R^2=0.745$	β=-2.55 (0.041) $R^2=0.747$	β=-0.340 (0.080) $R^2=0.749$
	G-3: ≥18 (male)	β=-3.59 (0.011) $R^2=0.734$	β=7.372 (0.032) $R^2=0.734$	β=2.604 (0.087) $R^2=0.736$
	G-4: 0-13 (female)	β=4.047 (0.015) $R^2=0.753$	β=3.399 (0.017) $R^2=0.753$	β=-3.37 (0.099) $R^2=0.754$
	G-5: 14-17 (female)	β=-1.53 (0.035) $R^2=0.740$	β=-2.45 (0.055) $R^2=0.741$	β=-0.390 (0.089) $R^2=0.744$
	G-6: ≥18 (female)	β=1.248 (0.056) $R^2=0.727$	β=6.109 (0.067) $R^2=0.727$	β=3.354 (0.095) $R^2=0.729$