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CONSUMER DEMAND BEHAVIOR OF RURAL HOUSEHOLDS IN DINAJPUR SADAR UPAZILA: APPLICATIONS OF DIFFERENT TYPES OF ENGEL MODELS

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ABSTRACT

In this paper, an attempt has been made to analyze the consumer demand behavior for different food items in rural households of Dinajpur sadar upzila by applying different forms of Engel models in slightly modified version. This has been done by analyzing the parameter estimates of the Engel models and interpreting the elasticities computed from these estimates. The study used the micro level cross-section data containing 638 households which were collected adopting a two-stage random sampling method. The Engel models were found to provide a very good fit to each of the food items under consideration. Budget shares showed high responsiveness to the expenditure variable in each form of Engel model for different food items considered in the present study.

Key words: *Engel Models, Elasticities, Luxuries, Necessities and Inferior items.*

INTRODUCTION

The study of consumer demand behavior occupies an important place in obtaining a form which would fit the expenditure structure of the consumers. Demand analysts are always in search of specifications and functional forms of demand equations which are fundamentally concerned with finding out how the demand for a commodity will alter as certain specified variables change . One of the most consistent patterns of consumer demand found in economics is the Engel's Law (Engel, 1857) which states that as income rises, the share of budget spent on food tends to decline. The estimation of Engel's models and hence Engel's curves has a long tradition in empirical economic research. Engel's curves can be used to classify goods into luxuries, necessities and inferior items and this can be viewed as an important application of these curves.

The present study has made an attempt to estimate different forms of Engel models in order to study the consumer demand behavior for different food items in rural households of Dinajpur sadar upazila. This has been done by analyzing the parameter estimates of the Engel models and also by considering the expenditure elasticities computed from these estimates. The study thus serves the following two purposes: (a) Estimation of different types of Engel models to analyze the consumer demand behavior for different food items under consideration, (b) Calculation of expenditure elasticities for different food items using the parameter estimates of the different forms of Engel models.

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MATERIALS AND METHODS

(i) The Data

The study used the micro-level cross section data containing 638 households from four villages of Dinajpur sadar upazila. The data were collected in 2005-2006, adopting a two-stage sampling method. The upazila of Dinajpur sadar was selected purposively, then two unions (out of ten), namely Chehelgazi (with 33552 population) and Kamalpur (with 20075 population*) were selected randomly (BBS, 2005). The number of households as recorded in the government mouza lists was used for determining the households. A revenue village with a jurisdiction list number and defined area is called mouza. A mouza may be same as a village or there may be more than one villege in a mouza. After selecting the unions, two villages were chosen randomly from each selected union and all the households of the selected villages are considered for the study. Data were aggregated into the following 7 categories: (a) cereals, (b) roots and pulses, (c) vegetables, (d) fish, (e) meat and egg, (f) milk and sugar, (g) oil and spices. Monthly total expenditure and budget shares of the selected food categories were calculated for the sampled households.

(ii) The Engel Models

According to the static theory of consumer demand, the quantity demanded for the ith commodity (q_i) is specified as:

$$q_i = q_i(y, p) = q_i(y \mid p_1, p_2, ..., p_n) \qquad (1)$$

where, y stands for income and p denotes an n dimensional price vector. However, due to the lack of price information, it is usually assumed that prices are held constant, that is, $p = p^*$ (say). Demand equation (1) then becomes:

$$q_i = q_i(y \mid p_1^*, p_2^*, ..., p_n^*) = q_i(y) \qquad (2)$$

which, in fact, turns out to be a function of income only. Such a relation is generally known as consumer's Engel curve for ith commodity. Now the question of interest is how consumption patterns will change among the households at different levels of income. Interpretation of income elasticity will enable us to explain this.

(iii) Different Forms of Engel Models

The most commonly used forms of Engel models are as follows:

Engel Model	Mathematical Formula	
Linear	$q_i = a_i + b_i y + e_i$	(3)
Double logarithmic	$\log q_i = a_i + b_i \log y + e_i$	(4)
Semi- logarithmic	$q_i = a_i + b_i \log y + e_i$	(5)
Log-reciprocal	$\log q_i = a_i - b_i y^{-1} + e_i$	(6)

Where, a_i and b_i are parameters and e_i is the random error term with zero mean, constant variance and zero correlation with *y*.

(iv) Model Specification

In many developing countries (e.g. Bangladesh, India, Pakistan, etc.), consumers usually have the tendency to provide wrong information regarding their income. This leads to the researcher to consider per capita total monthly expenditure instead of income *(y)* as the explanatory variable and it is defined as $x = \frac{X}{z}$;

Where, *X* denotes total monthly expenditure of households and z, the household size.

However, the literature review of some previous studies with Engel models (Ferdous, 1997 ; Khanam and Ferdous, 2000 ; Mullah and Ferdous, 2006 etc.) has shown that a model in which budget shares are considered related to per capita total expenditure provides an excellent fit to the data. As a consequence, we have used budget share (W_i) as the dependent variable rather than quantity demanded for ith commodity (q_i), where W_i is defined as follows:

$W_i = \frac{p_i q_i / z}{X / z} = \frac{p_i q_i}{X}$, where p_i and q_i are respectively unit price and quantity demanded of the ith commodity.

Since, for many items in the budget, households are observed to consume zero amounts of the various commodities under consideration, we cannot use $\log W_i$ and as such double logarithmic Engel model has to be dropped from the present study. However, using W_i instead of $\log W_i$, log-reciprocal model (6) can be transformed to only reciprocal model. Thus our finally specified Engel models become:

Linear $\quad W_i = \alpha_i + \beta_i x + \varepsilon_i \quad$ (7)

Semi- logarithmic $\quad W_i = \alpha_i + \beta_i \log x + \varepsilon_i \quad$ (8)

Reciprocal $\quad W_i = \alpha_i - \beta_i x^{-1} + \varepsilon_i \quad$ (9)

Where, α_i and β_i are the parameters to be estimated and ε_i is the random error term with zero mean, constant variance and zero correlation with x.

(v) Elasticity Formula

From the Engel models specified in equations (7), (8), and (9), the corresponding expenditure elasticities (*EE*) are derived as follows (Derivation is shown in Appendix):

Linear model: $\quad EE = 1 + \frac{\beta_i x}{W_i} \quad$ (10)

Semi- logarithmic model: $\quad EE = 1 + \frac{\beta_i}{W_i} \quad$ (11)

Reciprocal model: $\quad EE = 1 + \frac{\beta_i}{x W_i} \quad$ (12)

(vi) Estimation

In dealing with household expenditure data, a careful attention is needed in the estimation of a possibly heteroscedastic demand system subject to cross equations or non-liner restrictions. In the present study, the Engel models have been estimated by Ordinary Least Squares (OLS) procedure using ***SPSS*** version 12.0 (SPSS, Inc) in the absence of cross equation or non-liner restrictions. The usual mean-variance assumptions are made regarding the random error term.

However, using ***R*** software version 2.7.1 (R, 2008) the Breusch-Pagan-Godfrey (BPG) test has been performed which confirmed the presence of heteroscedasticity in the data set. In order to solve this problem, it is assumed that the error variance is proportional to the per capita total monthly expenditure (*x*), that is $E(\varepsilon_i^2) = \sigma^2 x$ and our specified Engel models are divided throughout by the square root of the per capita total monthly expenditure ($\sqrt{x}$). The model thus becomes a without intercept model and hence the regression-through-the-origin model has been used for estimation.

RESULTS AND DISCUSSIONS

Responsiveness of Budget Shares to Expenditure in Engel Models
Table 1 presents the "heteroscedasticity corrected" Ordinary Least Squares (OLS) estimates of the parameters of the three Engel models for different food items under consideration. The values in parentheses denote the corresponding p-values.

It can be observed from Table 1 that the explanatory power of the independent variable (i.e., per capita total monthly expenditure) for each of three types of Engel models was quite strong for all the items, except for milk and sugar. The R^2 values indicate that each of these models can explain more than 91 percent of the total variation in the budget shares for cereals and oil and spices. On the other hand, for the items roots and pulses, vegetables, fish and meat and egg, it has exceeded 0.6 suggesting that all the models have fitted better for these items. The reason behind these high R^2 values may be attributed to the fact that we have considered the regression-through-the-origin model as a solution to the problem of heteroscedasticity which usually provides a high R^2 value. As a result, such R^2 values obtained from no intercept models are not comparable to the conventional R^2 values. Nevertheless, from a pure statistical point of view, we may consider making inference based on these R^2 values computed from the no intercept models. However, since the R^2 values obtained from different types of Engel models are almost identical, it won't be possible to claim the superiority or applicability of the models based on these R^2 values.

Table 1: Heteroscedasticity-corrected OLS parameter estimates of three types of Engel models for 7 different food items

Items	**Linear model**	**Semi-logarithmic model**	**Reciprocal model**
Cereals	α = .422** β = -.000111** R^2 = .925	α = 1.633** β = -.447** R^2 = .948	α = .069** β = -202.356** R^2 = .955
Roots and Pulses	α = .062** β = -.000009** R^2 = .847	α = .149** β = -.033** R^2 = .848	α = .035** β = -14.114** R^2 = .848
Vegetables	α = .060** β = -.000012** R^2 = .880	α = .163** β = -.039** R^2 = .878	α = .031** β = -13.802** R^2 = .870
Fish	α = .039** β = -.000005** R^2 = .766	α = .064** β = -.010** R^2 = .762	α = .032** β = -1.730** R^2 = .760
Meat and Egg	α = .042** β = .000004^{NS} R^2 = .652	α = .049** β = .004^{NS} R^2 = .649	α = .041** β = 3.121^{NS} R^2 = .649
Milk and Sugar	α = .014** β = .0000034† R^2 = .402	α = .005† β = .003* R^2 = .403	α = .017** β = 1.949** R^2 = .403
Oil and Spices	α = .065** β = -.000014** R^2 = .922	α = .194** β = -.048** R^2 = .924	α = .028** β = -19.24** R^2 = .919

Significant at **p<0.01, *p<0.05 and †p<0.10 level of probability

It is also evident from Table 1 that the expenditure coefficient (β_i) in each model was statistically significant for all the food items except for meat and egg. Thus the budget shares for most of the items were highly responsive to the expenditure variable. Since the budget share is the dependent variable in the present study, a negative and statistically significant expenditure coefficient means that the budget share decreased with per capita total expenditure suggesting that the expenditure elasticity was less than one implying the commodity as a "necessity". This was the case for the items cereals, roots and pulses, vegetables, fish and oil and spices in all three types of Engel models as shown in Table 1. However, for each of these items, the expenditure elasticities (given in Table 2) were significantly less than one (i.e., inelastic) indicating that with the increase in expenditure, budget shares for these items increased but less proportionately. These results are logical because the rural people of Bangladesh consider all of these items as necessities. However, the findings also support Deaton and Muellbauer's (1980) results for most of these items on British 1974 family Expenditure Survey data.

A positive and statistically significant expenditure coefficient, on the other hand, means that the budget share rose with per capita total expenditure indicating that the expenditure elasticity exceeded one implying the commodity as a "luxury". This was the case for milk and sugar in each of the three types of Engel models considered in the present study. These results are also consistent with the demand behavior of the consumers of Bangladesh and may be due to rising expenditure and less proportionate increase in income.

Table 2: Estimates of Expenditure Elasticities for 7 different food items from different Engel models

Items	**Linear model**	**Semi-logarithmic model**	**Reciprocal model**
Cereals	0.362752	-0.736192	0.468328
Roots and Pulses	0.722147	0.310834	0.800612
Vegetables	0.576347	0.068612	0.777030
Fish	0.766667	0.684323	0.963057
Meat and Egg	1.167082	1.113023	1.059653
Milk and Sugar	1.347666	1.207511	1.091195
Oil and Spices	0.537080	-0.073633	0.708837

Different forms of Engel curves explaining the types of food items

Figure 1 presents the three forms of Engel curves for the food items cereals and milk and sugar. These curves allow luxuries ($\beta_i \rangle 0$) and necessities ($\beta_i \langle 0$). It should be mentioned that for other food items, these curves are the same as those shown in Figure 1.

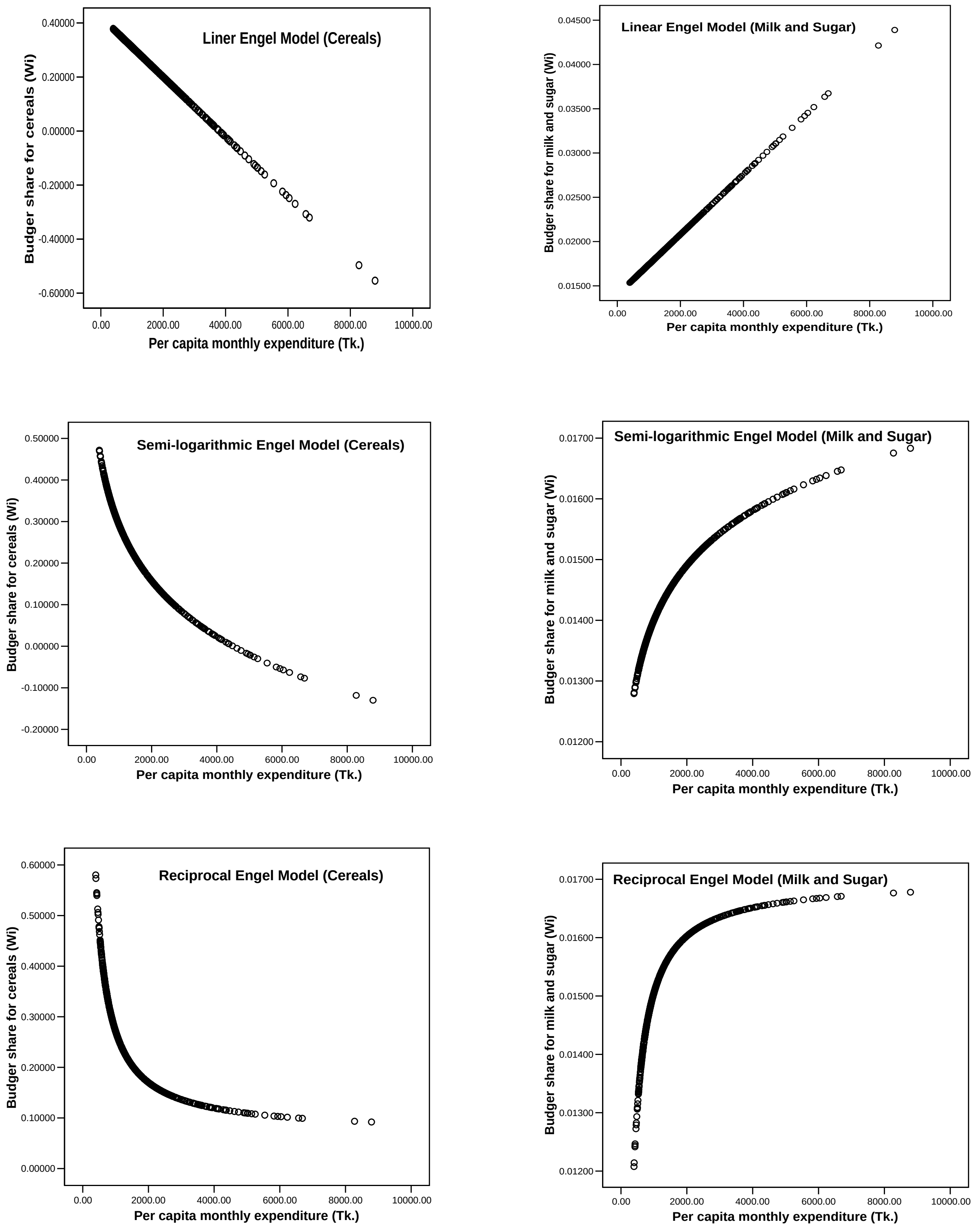

Figure 1: Curves showing different forms of Engel functions for necessary and luxurious food items

It is evident from the curves that for necessary and luxurious items, each of these three forms of Engel curves has shown similar behavior, i.e., for cereals (necessary item), they were downward sloping and for milk and sugar (luxurious item), they sloped upwards. These results are quite different from those obtained by Mullah and Ferdous (2006). In their study, for necessary and luxurious items, the linear and semi-logarithmic Engel curves were downward and upward sloping respectively, whereas the reciprocal Engel curve sloped in the opposite directions.

CONCLUSION

In the present study, it is intended to analyze the consumer demand behavior in rural households of Dinajpur sadar upazila by applying three different forms of Engel models. In doing so, the study considered linear, semi-logarithmic and reciprocal forms of Engel models in which budget share and per capita total monthly expenditure were considered as the dependent and independent variables, respectively. Each of these applied models provided a very good fit to the all the food items considered in the current study. The budget shares for most of the items were highly responsive to the expenditure variable in each form the Engel models. The items cereals, roots and pulses, vegetables, fish and oil and spices were considered as necessities by the consumers of concerned upazila of Dinajpur. Milk and sugar, on the other hand, was viewed as significant luxury product. The expenditure coefficient (β_i) was found to be insignificant for the item meat and egg, which was showed as luxury product. This indicates that the purchasing capacity of the rural people of Dinajpur is not too high to have such a rich food item regularly. Hence it is necessary to implement any agricultural price intervention policies for the people of rural Dinajpur in order to maximize their satisfaction with minimum expenditure. The study is thus likely to contribute to public policy formulations in the rural area of Bangladesh.

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APPENDIX

Expenditure Elasticity (EE) of Demand and Derivation of its Elasticity from Engel models: Expenditure elasticity of demand is a technique to measure how responsive or sensitive the consumers are, to a change in total expenditure while the other factors remaining the same. The coefficient (degree) of Expenditure Elasticity of demand (EE) measures the percentage change in the amount of a commodity purchased per unit of time ($\delta q_i/q_i$) resulting from a given percentage change in consumers expenditure ($\delta x/x$). Thus, we have

$$EE = \frac{\delta qi / qi}{\delta x / x} = \frac{\partial q_i}{\partial x} \times \frac{x}{q_i}$$

Where, δq_i = change in quantity demanded for the ith item,
δx = change in the per capita total expenditure,
x = per capita total expenditure,
q_i = quantity demanded for the ith commodity.

If, (i) EE < 0 (i.e., if quantity demanded for the commodity decreases as total expenditure increases), the good is inferior.

(ii) 0 <EE < 1, the good is normal or necessity.

(iii) EE > 1 (i.e., if quantity demanded for the commodity increases as total expenditure increases), the good is luxury.

Expenditure Elasticity (EE) for different Engel models can be derived using the following relation:

$$EE = \frac{\delta qi / qi}{\delta x / x} = \frac{\partial q_i}{\partial x} \times \frac{x}{q_i}$$

Again ,

$$W_i = \frac{p_i q_i}{X} = \frac{p_i q_i}{zx} \quad \text{[since } x = \frac{X}{z} \Rightarrow X = zx \text{]}$$

$$\therefore q_i = \frac{W_i zx}{p_i}$$

Thus, Expenditure Elasticity becomes

$$EE = \frac{\partial}{\partial x}\left(\frac{W_i zx}{p_i}\right) \times \frac{x}{q_i}$$

$$= \left(\frac{W_i z}{p_i} + \frac{zx}{p_i}\frac{\partial W_i}{\partial x}\right) \times \frac{x}{q_i}$$

$$= \frac{W_i zx}{p_i q_i} + \frac{zx^2}{p_i q_i}\frac{\partial W_i}{\partial x}$$

$$= \frac{W_i zx}{W_i zx} + \frac{zx^2}{W_i zx}\frac{\partial W_i}{\partial x} \qquad [\text{since } q_i = \frac{W_i zx}{p_i} \Rightarrow p_i q_i = W_i zx\ ]$$

$$= 1 + \frac{x}{W_i}\frac{\partial W_i}{\partial x} \qquad (**)$$

Differentiating both sides of equations (7), (8), and (9) with respect to x, we obtain

$\frac{\partial W_i}{\partial x} = \beta_i$, $\frac{\partial W_i}{\partial x} = \frac{\beta_i}{x}$ and $\frac{\partial W_i}{\partial x} = \frac{\beta_i}{x^2}$

Now substituting the values of $\frac{\partial W_i}{\partial x}$ in (**), we get the Expenditure Elasticity for following Engel models,

Linear model: $EE = 1 + \frac{\beta_i x}{W_i}$

Semi- logarithmic model: $EE = 1 + \frac{\beta_i}{W_i}$

Reciprocal model: $EE = 1 + \frac{\beta_i}{xW_i}$