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Effects of Changes in Household Size, Consumer Taste & Preferences on Demand Pattern in India

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ABSTRACT

Current research in applied demand analysis has been addressing the twin issues of degree of non-linearity or curvature of the Engel curves and the ability to capture price effects appropriately by the demand system. Further, in addition to income and prices, the role of demographic variables like household size, composition and dynamic aspects like consumer taste & preferences are also emphasized in recent literature. Continuous efforts are being made to modify the existing models and propose new ones to incorporate the above developments. The purpose of this study is to re-examine the usefulness of the popular linear expenditure system vis-à-vis two other flexible models viz. Nasse expenditure system, a generalization of the linear expenditure system itself, and the almost ideal demand system in the above context for India.

We extend the above three models by incorporating dummy variables representing three income groups, rural-urban sectors and their interactions; one demographic variable namely household size and time trend variable representing consumer taste & preferences into the appropriate demand model parameters. National Sample Survey data on consumer expenditure for five quinquennial rounds viz. 27 (1972-73), 32 (1977-78), 38 (1983), 43 (1987-88) and 50 (1993-94) at the all India level; and comparable retail price series from Jain and Minhas (1991) and Tendulkar and Jain (1993) are used for estimating the above models. Seven broad commodity groups viz. (i) cereals & substitutes, (ii) pulses, (iii) milk & products, (iv) edible oil & fats, (v) meat, eggs and fish, (vi) other food and (vii) total nonfood are used in this analysis.

The empirical results show wide variation in marginal budget shares and demand elasticities across income groups, rural-urban sectors and alternative models. The household size and consumer taste & preferences are found to be statistically significant. The results have confirmed the earlier findings that there are significant changes in consumer tastes away from cereals and pulses in favor of other food and nonfood commodities. It is found that the linear expenditure system, despite its limitations of linearity and additivity, could provide a good description of consumption patterns in India, i.e. able to capture curvature in Engel curves, provided adequate care is taken to distinguish a few meaningful income categories and rural-urban sectors. The demand parameters have also exhibited some well-known patterns.

The results show further that flexible models, which are theoretically superior, gave unacceptable positive price responses for some commodities and violated second order conditions of utility maximization. It is found that some ad-hoc separability restrictions are needed, thereby limiting the flexibility of the model, to get negative own-price responses in these models. But, second order conditions are still violated. The tests of nested hypotheses also confirm the need for inclusion of household size, consumer taste, income group and rural-urban dummies along with their interaction variables in the demand system.

1. Introduction

Studies on family budgets have a long history.[1] Ever since the pioneering works of Engel, Pigou and Schultz on the quantification of consumer behavior, there have been a number of attempts to make this area of research a scientific discipline. Valuable contributions also came from Allen and Bowley, Wold and Jureen and Prais and Houthakker to this area. The need for collection of consumer expenditure data and quantification of the implied demand parameters cannot be over emphasized. In both planned and market economies, the estimated demand parameters serve a variety of purposes. These applications include poverty level estimation, optimal commodity tax rates, demand projections, and wide ranging macro economic decisions. For e.g., knowledge about likely future demand for goods and services can help in avoiding unduly large deficit/surplus of commodities thereby leading to an efficient allocation of resources. Income elasticities of demand are the conceptual basis for demand projections. There have been a large number of studies on consumer behavior in India. More recent studies include for e.g. Radhakrishna and Ravi (1992), Meenakshi (1996), Ray (1996), Murty (1997, 1998, 1999), Meenakshi and Ray (1999) and Radhakrishna and Murty (1999). These studies are varied in nature and focus.

Some of the above studies have shown the importance of incorporating consumer taste & preferences in a single equation as well as demand system framework. This could explain the decline in per capita consumption of cereals (both superior and coarse cereals) and pulses, despite positive income response, implying shifts in consumption from cereals and pulses to

[1] See Brown and Deaton (1972) for an excellent survey of studies of household expenditure and Bhattacharya (1975) for Indian studies. Radhakrishna and Murty (1999) have reviewed the works on complete demand systems. Pollak and Wales (1992) and Deaton (1997) are the most comprehensive recent texts on the subject.

other foods and non-food over time. Murty (1997), using a single equation approach has shown that the above conclusion holds for ten semi-arid tropical states in India. The purpose of this study is to carry this analysis a little further by incorporating household size and time trend, the latter as proxy for consumer taste & preferences, into demand parameters of three alternative demand systems, giving due importance to income distribution effects. The present exercise is preliminary in nature and will be extended to state specific data. The chosen models are the popular linear expenditure system (LES), its generalization called Nasse expenditure system (NES) and the almost ideal demand system (AIDS). We hope to re-examine the usefulness of the restrictive LES vis-à-vis the flexible NES and the AIDS models.

2. Methodology

In demand analysis, dynamic effects are usually captured either by introducing lagged consumption or simple time trend as a shifter variable in parameters of a demand function. The inclusion of past consumption has the advantage of nice interpretation as habit formation in the case of non-durable commodities and stock adjustment for durable goods. However, it is well known that a lagged dependent variable may lead to problems of auto-correlation and dynamic instability of the model.

Earlier studies [e.g. Radhakrishna and Ravi (1992)] have represented changes in consumer taste & preferences as parameter/regime shifts using dummy variable. But, this approach has the inherent disadvantage of identifying the exact time point of regime shift before hand. This can be quite tricky and subjective. Meenakshi (1996), however, has used a time trend variable to allow shifts in parameters. In this study, we use time trend to capture changes in consumer taste & preferences in a year-to-year systematic way through shifts in parameters of a demand system. Likewise, effects of changes in household size are modeled through a procedure, now known as, 'demographic translation'. Here again, certain parameters of the demand system are made to depend on demographic variables such as household size [e.g. Meenakshi and Ray (1999)].

In developing countries like India, a major issue relates to capturing income distribution effects on consumption. This is akin to capturing curvature in the underlying Engel curves. Earlier studies have suggested segregation of data into real income (total expenditure) groups and estimate separate model for each real income group [e.g. Radhakrishna and Ravi (1992)]. This requires estimation of income-class specific cost of living indices, which can be tedious and cumber-some. It is decided therefore to distinguish three broad income/population groups viz., lowest 30%, middle 40% and top 30% of the population based on estimated number of persons from NSS family budget survey itself. In view of the grouped nature of the published data, the percentage of population covered by these three income groups can only be made approximately 30%, 40% and 30%.

Based on these considerations, two dummy variables representing three income groups, one dummy variable for rural-urban sectors and their interactions are created. These are in addition to explanatory variables - per capita total expenditure, consumer price indices, household size, and time trend. Interactions of rural-urban dummy with income group dummies enables us to distinguish differences in consumer taste & preferences, and household size effects across the income groups and rural-urban sectors. These dummy variables enter the appropriate demand model parameters as discussed below:

2.1 Linear Expenditure System (LES):

Stone (1954) has proposed a demand system known as linear expenditure system that has found numerous applications in applied demand analysis. Stone has derived the LES from linear demand equations by imposing the general restrictions of consumer theory as well as the particular restriction of additivity. He has considered a main model (LES) and suggested a few other variants. It will be seen that the LES is relatively simple in estimation and its parameters are amenable to easy interpretation.

The LES in its well-known form is written as follows:

$$(2.1) \qquad p_i q_i = p_i c_i + b_i \left(y - \Sigma^{n}_{j=1} p_j c_j\right) \qquad (i = 1,2,\ldots,n)$$

where $(q_1, q_2,\ldots,q_n)$ is the vector of quantities purchased by the consumer at prices $(p_1, p_2,\ldots,p_n)$ with income y

It is interpreted that the consumer first allocates his budget for the minimum necessary purchases of goods in accordance with parameters c at their prices. This amounts to $\Sigma^{n}_{j=1} p_j c_j$. The consumer then allocates the remaining amount, $(y - \Sigma^{n}_{j=1} p_j c_j)$, to all commodities in the proportion of b_i to the ith item. Following this interpretation, the expenditure on any item can be seen as consisting of two components- one, a committed or subsistence expenditure, $p_i c_i$, and second, a portion of uncommitted or supernumerary expenditure, $b_i (y - \Sigma^{n}_{j=1} p_j c_j)$. The c_i parameter is called 'committed quantity' for the ith commodity.[2] Since the partial derivative of $p_i q_i$ w.r.t. y equals b_i, this parameter is called the marginal budget share on ith commodity.

[2] This interpretation for c_i is only suggestive and it is not always possible to do so, particularly when c_i is negative. A negative c_i is, however, not inconsistent with theory.

It can be seen that (2.1) satisfies the homogeneity restriction. The adding-up property requires $\Sigma^n_{i=1} b_i = 1$. The substitution matrix would be negative semi-definite, if

(2.2) $$0 < b_i < 1, \text{ for all } i, \text{ and } y - \Sigma^n_{j=1} p_j c_j > 0.$$

The LES yields linear Engel curves. The model is consistent w.r.t. aggregation over individuals provided we assume identical b vector for all consumers. The c vector, however, can vary across consumers. The consistency w.r.t aggregation over commodities requires the use of item specific c vector as weight for computing group price indices.

Direct and indirect utility and Cost Functions of LES:

The direct utility function underlying the LES known as Stone-Geary utility function is written as

(2.3) $$u(q) = \pi^n_{i=1}(q_i - \gamma_i)^{\beta i}$$

Maximization of (2.3) subject to the budget constraint yields the Marshallian demand functions (2.1). It can be verified that $c_i = \gamma_i$ and $b_i = \beta_i / \Sigma^n_{k=1}\beta_k$. Without loss of generality, assuming $\Sigma^n_{k=1}\beta_k = 1$, the direct utility function can be re-written as

(2.4) $$u(q) = \pi^n_{i=1} (q_i - c_i)^{bi}$$

Re-writing (2.1) as a quantity equation, we can express q_i as a function of prices and income. Substituting this into (2.4) and simplifying, we get the indirect utility function of the LES as

(2.5) $$\psi(y,p) = (y - \Sigma^n_{j=1} p_j c_j) / (b_0 \, \pi^n_{k=1} p_k^{bk})$$

where $b_0 = \pi^n_{k=1} b_k^{-bk}$. The indirect utility function in (2.5), in line with the general indirect utility function, is homogeneous of degree zero in prices and income. Note also that $\psi(y,p)$ is non-additive for $c_j \neq 0$ for any j because there exists no monotonic transformation F( ) such that

$$F(\psi(y,p)) = \psi_1(y, p_1) + \psi_2(y, p_2) + ... + \psi_n(y,p_n)$$

However, if $c_i = 0 \; \forall$ i, i.e. the utility function (2.3) belongs to the class of homothetic (Bergson family) functions. Then (2.5) reduces to an additive form

(2.6) $$\psi(y,p) = \pi^n_{k=1} (y/p_k)^{bk} / b_0$$

We note that the Samuelson-Hicks result that both direct and indirect utility functions will be additive only in the case of homothetic utility function. Following the duality approach, the indirect utility function in (2.5) can also be expressed as a cost (expenditure) function:

(2.7) $$C(u,p) = \Sigma^n_{j=1} p_j c_j + u \, b_0 \, \pi^n_{k=1} p_k^{bk}$$

Using Roy's (1942) identity for the indirect utility function $\psi(y,p)$ in (2.5), we get the same LES demand equations as an alternative approach. Yet another route would be to use duality theorem known as Sheppard's lemma for the cost function in (2.7). This would yield the Hicksian compensated demand functions corresponding to the LES.[3] The inter-relationship between the indirect utility and cost functions of the LES is obvious:

$$\psi(u,p) = (C(u,p) - \Sigma^n_{j=1} p_j c_j) / (b_0 \, \pi^n_{k=1} p_k^{bk})$$

Elasticities:

Differentiating (2.1) partially w.r.t. income and prices and re-arranging, we get the expressions for income and price elasticities of demand. For commodity i, the income elasticity (η_{i0}) and price elasticity with respect to jth price (η_{ij}) are given by

(2.8) $$\eta_{i0} = b_i \, y / (p_i \, q_i)$$

[3] We will explore this approach in more detail while dealing with the Almost Ideal Demand System in Section 2.3.

(2.9) $$\eta_{ij} = -\delta_{ij} + (\delta_{ij} - b_i)p_j c_j / (p_i q_i)$$

where $\delta_{ij} = 1$ for $i = j$ and 0 otherwise.

Notice that the income and price elasticities are not constant but vary with the income and consumption level as well as prices. If $0 < b_i < 1$ and $c_i > 0$ for all i, then it follows that all commodities must be normal in nature (no inferior good), price inelastic and pair-wise net substitutes. For any demand system linear in income, it can be shown that the income elasticity increases (decreases) towards unity with income for necessary (luxury) goods. This is not in conformity with empirical evidence on the behavior of income elasticity w.r.t. changes in income, particularly for staple items like food. Therefore, this property which stems from linear Engel curves, is viewed as a theoretical limitation of the LES.

2.2 Variants of the Linear Expenditure System:

(a) LES with variable parameters:

The LES can also be made flexible to allow for changes in parameters due to income level differences, rural/urban sector specificity, demographic features, dynamic behavior related to past consumption, shifts in consumer taste & preferences etc. by allowing its parameters to vary with those respective determinant(s). In all these cases, the marginal budget shares and or committed quantities can be postulated to depend on discrete (dummy) variables (and their interactions if necessary) representing income groups, rural/urban sectors, or even continuous variables relating to household characteristics like size, number of adults, children etc. Thus, in general, the vectors b and c can in fact be made into matrices of parameters. The columns of c are unrestricted. But the columns of b should always add-up to zero except one column, say the first one, which adds up to unity because of the budget constraint. This procedure is quite convenient and saves degrees of freedom if the data set is small. It also avoids estimating separate model for specific income/demographic/sector category. The parameters of interest viz. income and price elasticities can however be obtained separately for each category.

More specifically, the LES with variable parameters may be written as

$$p_i q_i = p_i(\Sigma^{k}_{j=1} c_{ij} d_j) + (\Sigma^{l}_{j=1} b_{ij} e_j)[y - \Sigma^{n}_{m=1} p_m (\Sigma^{k}_{j=1} c_{ij} d_j)] \qquad (i=1,2,\ldots,n) \tag{2.10}$$

where d and e are k x 1 and l x 1 vectors of additional dummy/continuous variables; b, c are n x l and n x k matrices of coefficients. The budget constraint along with second order conditions would require,

$$0 < b_{i1} < 1,\ \Sigma^{n}_{i=1} b_{i1} = 1,\ \Sigma^{n}_{i=1} b_{ik} = 0 \text{ for all } k=2,\ldots l \text{ and } y > \Sigma^{n}_{m=1} p_m (\Sigma^{k}_{j=1} c_{ij} d_j)$$

It is easy to identify the direct/indirect utility functions and also the cost function underlying the above model. They are simple generalizations of equations (2.4), (2.5) and (2.7); wherein we replace b_i and c_i with $(\Sigma^{l}_{j=1} b_{ij} e_j)$ and $(\Sigma^{k}_{j=1} c_{ij} d_j)$ respectively. Likewise, the income and price elasticities can be generalized from (2.8) and (2.9). This would render each of them explicitly dependent on these additional dummy/continuous variables included in the model.

For e.g., Stone has suggested that the LES parameters be expressed as $b_{it} = b_i + b_i^* t$ and $c_{it} = c_i + c_i^* t$ to allow for changes in consumer taste & preferences, approximated by the time trend variable, t. However, time trends in b parameters are generally considered to capture changes in consumer taste & preferences. Incorporating this into the demand system. LES model can be written as

$$p_i q_i = p_i c_i + (b_i + b_i^{*} t)\,[y - \Sigma^n_{j=1} p_j c_j] \qquad (i=1,2,\ldots,n) \tag{2.10a}$$

The budget constraint along with second order conditions would require,

$$0 < b_i < 1,\ \Sigma^n_{i=1} b_i = 1,\ \Sigma^n_{i=1} b_i^{*} = 0 \text{ and } y > \Sigma^n_{j=1} p_j c_j$$

This is a special case of the general model presented earlier.

(b) Nasse Expenditure System (NES):

We may note that in the above variant, the underlying utility function continues to be an additive one. A non-additive variant of LES is the Nasse model, which allows specific substitution between commodity groups. In this model, following the suggestion of Stone (1954), the 'committed quantity' parameter for each commodity is postulated to depend on all price ratios in a specific way. This results in a matrix of 'committed quantity' parameters. One advantage of this generalization is that the LES model is obtained as a special case when we restrict all off-diagonal elements of the matrix of 'committed quantity' parameters to zero values. Some forms of separability like group-wise independence (block diagonality) etc. can also be modeled by suitable parametric restrictions.

The Nasse (1970) model has the following form:

$$p_i q_i = p_i c_i(p) + b_i(y - \Sigma^n_{j=1} p_j c_j(p)) \qquad (i = 1,2,\ldots,n) \tag{2.11}$$

where $c_i(p) = \Sigma^n_{j=1} c_{ij} (p_j / p_i)^{1/2}$.

The budget constraint along with second order conditions require that $0 < b_i < 1$ for all i and $\Sigma^n_{j=1} b_j = 1$. The homogeneity property is built into the model specification. The symmetry conditions require $c_{ij} = c_{ji}$ for all $i \neq j$ $(i,j=1,2,...,n)$. Since the 'committed quantity' for any commodity is no longer a constant, but depends on all prices, we can not generalize the Stone-Geary direct utility function to Nasse model. However, we can generalize the indirect utility function of the LES to this model. By duality result, the direct utility function will, however, exist. The indirect utility function underlying the Nasse model can be shown to be as

$$(2.12) \qquad \psi(y,p) = (y - \Sigma^{n}_{i=1}\Sigma^{n}_{j=1} c_{ij} (p_i p_j)^{1/2}) \ ) / (b_0 \pi^{n}_{j=1} p_j^{bj})$$

where $b_0 = \pi^{n}_{j=1} b_j^{-bj}$. Clearly, (2.12) is non-additive except when $c_{ij} = 0$ for all $i,j = 1,2,....,n$, i.e. when $\psi(y,p)$ belongs to Bergson family. Using Roy's identity it can be verified that (2.12) gives rise to the demand system in (2.11).

As in the case of LES, making the b parameters linear functions of time can incorporate shifts in consumer taste & preferences. However, there does not seem to be an obvious way of obtaining the habit formation version for the Nasse model. Like in the LES variants, incorporating additional parameters into the b vector can expand the Nasse model.

Elasticities:

Using partial differentiation of (2.11) w.r.t income and prices and simplifying, the expenditure and price elasticities for the Nasse model can be shown to be

$$(2.13) \qquad \eta_{i0} = y\, b_i / (p_i q_i)$$

$$(2.14) \qquad \eta_{ij} = - \delta_{ij} + \{(\delta_{ij} - b_i)\, p_j c_j(p) + [(c_{ij}(p_i p_j)^{1/2} - \delta_{ij}\, c_i(p)\, p_i)] / 2\} / (p_i q_i)$$

Clearly, these elasticities depend on the income and price structure in a complex way. One may have to compute them at the sample mean level or for some specific year. The expression in (2.14) reduces to its LES counterpart (2.9) when $c_{ij} = 0$ for all $i \neq j$ $(i,j =1,2,...,n)$.

Another demand system which is a variant of the LES and quite similar to the Nasse system but with fewer parameters is known as Simple Non-Additive Model (SNAM). This demand system was proposed by Deaton (1976). Not much empirical work was reported on this model. Coondoo and Majumdar (1987) have developed a modified SNAM.

2.3 Almost Ideal Demand System (AIDS):

The LES and its variants discussed above have some limitation or other. They are theoretically consistent but LES is too restrictive because of additive preferences and hence unrealistic for empirical use involving dis-aggregated items of consumption. Additive preferences do not allow inferior goods into the analysis.

Due to these limitations, efforts in applied demand analysis have centered on specifying demand equations that allow non-linear Engel curves and non-separable preferences. Almost Ideal Demand System is one such functional form proposed by Deaton and Muellbauer (1980). This model has been shown to overcome most of the limitations mentioned above and hence the adjective 'almost ideal'. The AIDS model is a first order approximation to any demand system and it aggregates perfectly over consumers without forcing linearity on the Engel curves.

The AIDS model is a time series generalization of PIGLOG (Price Independent Generalized LOGarithmic) Engel function introduced by Leser (1976), $w_i = \alpha_i + \beta_i \log y$, where w_i is the budget share on the ith item and y is household total expenditure. The time series generalization would require the inclusion of prices explicitly. This can be achieved by making the parameters α and β functions of prices in a number of ways. The AIDS model is one such attempt.

Alternatively, demand systems can also be derived using an appropriate cost function. A general PIGLOG cost function may be specified as,

$$\log C(u;p) = (1-u) \log (a(p)) + u \log (b(p))$$

where u is a specified utility level and a(p) and b(p) are positive linear homogeneous functions of prices and are interpreted as the costs of subsistence and bliss respectively. Deaton and Muellbauer (1980) have chosen the following forms for a(p) and b(p):

$$\log a(p) = \alpha_0 + \Sigma^n_{i=1}\alpha_i \log p_i + (1/2) \Sigma^n_{i=1}\Sigma^n_{j=1} \gamma_{ij}^* \log p_i \log p_j$$

$$\log b(p) = \log a(p) + \beta_0 \pi^n_{j=1} p_j^{\beta j}$$

so that the AIDS cost function becomes

(2.15) $$\log C(u;p) = \alpha_0 + \Sigma^n_{i=1}\alpha_i \log p_i + (1/2) \Sigma^n_{i=1}\Sigma^n_{j=1} \gamma_{ij}^* \log p_i \log p_j u \beta_0 \pi^n_{j=1} p_j^{\beta j}$$

where α, β and γ^* are parameters. The Hicksian demand functions can be derived directly from equation (2.15) using Sheppard's lemma,

(2.16) $$w_i = \alpha_i + \Sigma^n_{j=1} \gamma_{ij} \log p_j + \beta_i u \beta_0 \pi^n_{j=1} p_j^{\beta j}$$

where $\gamma_{ij} = (1/2) (\gamma_{ij}^* + \gamma_{ji}^*)$. For a utility maximizing consumer, total expenditure is equal to the cost and using this relation, we can eliminate u from (2.16) to get the AIDS model as,[4,5]

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[4] As in the case of LES, a quadratic extension of the AIDS model has also been proposed [Blundell et. al (1993)]. There are also several other versions of AIDS like modified AIDS [Cooper et. al. (1992)] and inverse AIDS [Eales and Unnevehr (1994)].

[5] In a series of articles, Lewbel (1987, 1991, 1995) has extended the Gorman's concept of 'rank' of an Engel curve to any demand system. He has introduced the idea of a fractional demand system by unifying all demand systems, which can be expressed in budget share form. According to this approach, the rank of any demand system is defined as the minimum number of functions of income (including the constant) required such that all of the Engel curves can be expressed as linear combinations of these income functions. Rank also equals the minimum number of functions of prices required to express the cost or indirect utility function. Lebel (1991) has also proposed a non-parametric test for finding the rank of a demand system. Based on these definitions, the LES, its variants and AIDS have rank two. The quadratic extensions of the LES and AIDS are shown to have rank three. A rank three demand system is supposed to extract all the information available in budget data. The Engel curves in such a model may exhibit non-monotonicity which some authors [e.g. Meenakshi and Ray (1999)] claim to be a desirable property. Thus, rank of a demand system has implications for specification, separability and aggregability of a demand system.

(2.17) $$w_i = \alpha_i + \Sigma^n_{j=1} \gamma_{ij} \log p_j + \beta_i \log (y/P) \qquad (i=1,2,....,n)$$

where

(2.18) $$\log P = \alpha_0 + \Sigma^n_{i=1}\alpha_i \log p_i + (1/2)\, \Sigma^n_{i=1}\Sigma^n_{j=1} \gamma_{ij} \log p_i \log p_j$$

Equation (2.17) can be thought of as a first order approximation to an unknown relation between budget share and income and prices. The theoretical restrictions on (2.15) translate themselves into restrictions on the parameters of (2.17). These are:

(2.19) $$\Sigma^n_{i=1}\alpha_i = 1;\ \Sigma^n_{i=1}\beta_i = 0;\ \Sigma^n_{i=1} \gamma_{ij} = 0 \qquad (j = 1,2,..,n) \quad \text{(Adding-up)}$$

(2.20) $$\Sigma^n_{j=1} \gamma_{ij} = 0 \qquad (i = 1,2,...,n) \quad \text{(Homogeneity)}$$

(2.21) $$\gamma_{ij} = \gamma_{ji} \quad \text{for } i \neq j \qquad (i,j = 1,2,...,n) \quad \text{(Symmetry)}$$

It is well known that the restrictions (2.19), adding-up condition, are part of a maintained hypothesis of any demand system because of the data construction itself. For the same reason, this hypothesis cannot be tested. Thus, with the help of AIDS one can test only the restrictions implied by homogeneity (2.20) and symmetry (2.21) and any other a priori restrictions like implicit or explicit additivity, homotheticity etc.

Like in other functional forms, negativity cannot be tested through any restriction on the parameters. The negativity conditions are satisfied for the AIDS model if the matrix

$$C_{ij} = \gamma_{ij} + \beta_i\beta_j \log (y/P) - w_i \delta_{ij} + w_i w_j$$

is negative semi-definite.

For the AIDS model, it can be shown that the expenditure (η_{i0}) and price (η_{ij}) elasticities are given by,

(2.22) $$\eta_{i0} = 1 + \beta_i / w_i$$

$$(2.23) \qquad \eta_{ij} = -\delta_{ij} + [\gamma_{ij} - \beta_i (\alpha_j + \Sigma^n_{i=1} \gamma_{ij} \log p_i)] / w_i$$

where $\delta_{ij} = 1$ for $i = j$ and 0 other wise.

The most interesting feature of (2.17) from econometric viewpoint is that it is very close to being linear. Apart from the expression P in (2.17), the parameters can be estimated equation by equation using the OLS. As regards P, the restrictions on α and γ ensure that (2.18) defines P as a linear homogeneous function of the individual prices. In many practical situations, where prices are nearly collinear, P may be approximated by an exogenous price index, for example as that used by Stone, $\Sigma^n_{j=1} w_j \log p_j$. The model using this approximation is called the Linearly Approximated Almost Ideal Demand System (LA-AIDS).[6] In case we do not want to use the approximation for P, then the AIDS model in (2.17) will be non-linear in parameters and therefore requires non-linear estimation methods.

The LA-AIDS (and AIDS) can be expanded to include other explanatory variables in a way exactly similar to the LES. In this case, it is suggested that the α parameters be made to depend on other variables [e.g. Blundell et. al. (1993), Meenakshi and Ray (1999)].

3. Empirical Results

3.1 Data:

For this study, published data by National Sample Survey (NSS) Organization in five quinquennial (full scale surveys) rounds for the period 1972-94 are used. These rounds

[6] Deaton and Muellbauer (1980) on British data have found that the parameter estimates did not vary much between full non-linear estimation and this simple version. However, in a recent paper, Pashardes (1993) argued that Stone's approximation leads to bias in parameter estimates of AIDS. The bias will be more serious for micro level data than aggregate time series. In another recent paper, Moschini (1995) has shown that the Stone's index is not invariant to units of measurement and therefore it is suggested that an improved approximation or the original non-linear form be used in estimating the AIDS model.

correspond to 27 (1972-73), 32 (1977-78), 38 (1983), 43 (1987-88) and 50 (1993-94). In each round, the data consists of average monthly per capita consumer expenditure on about 20 broad groups of commodities separately for rural and urban areas of each state and 'all India'. This particular analysis uses 'all India' data only. The NSS data are made available according to 12 or 14 per capita monthly total expenditure classes in each NSS round. Data on retail prices consistent with NSS commodity classification are taken from Jain and Minhas (1991), and Tendulkar and Jain (1993). The later study has extended the series upto 1988-89. However, such data are not available for specific items and for later years. We have extended the series up to 1993-94 by using the growth rates given in Tendulkar and Jain (1993). This study focuses on 7 broad groups viz. (1) Cereals & substitutes, (2) Pulses & products, (3) Milk & milk products, (4) Edible oils & fats, (5) Meat, eggs & fish, (6) Other food and (7) Total nonfood. The above data have been computerized and broad checks for consistency have been carried out. The database so obtained is treated as a pooled time series of cross-section data, expenditure classes being cross-section and NSS rounds as time points.

3.2 Trends and patterns in consumption:

Before we discuss the model results, it would be useful to look at the broad trends and patterns in consumption expenditure data being used in the empirical work. Table 1 presents weighted average real ('70-71 Rs.) per capita monthly consumption expenditure and budget share (%) for the year 1993-94 on each of the commodity groups separately for rural, urban areas and income (population) groups. The figures for 'all India' are also given. Data on average household size is also included.

From this table, we notice some of the well-known trends and patterns in consumption expenditure and budget shares in a developing country. More specifically, at the 'all India' level, even as recently as in 1993-94, the average consumption on all food items put together has a large share (59.1%) which is typical of a developing country. The nonfood group commands only 40.9% of the average budget of an Indian consumer. Within food group, cereals & substitutes occupy a sizable 22%; other food, a catchall category, stands a close second at 20.6%. Milk & milk products is also picking up a considerable share (8.7%).The average household size is still large at 4.76 persons.

This table also reveals distinct rural-urban and income (population) group differentials in consumption behavior. Lowest and middle income groups in rural areas spend a very high proportion of their budget on food items, ranging between 78-83%; while the highest income group allocates only 61% to food commodities. The corresponding figures for the urban consumer are 67-74% for lowest and middle income brackets; 46.5% for highest income group. Within food, cereals occupy a predominant position (47.4% in lower income rural household's budget) in the budgets of lowest and middle-income groups. The budget shares decline uniformly as we move up the income ladder. The average size of the family also declines sharply from 5.49 persons in rural lowest income household to 3.41 persons in highest income urban family. These patterns portray the wide rural-urban and income disparities that still exist in India.

Table 2 attempts to capture the trends and patterns in consumption behavior over the study period 1972-94 in India. Since NSS data are in current prices, we deflated the same with the corresponding price indices to eliminate the influence of changes in prices over time on consumption patterns. The compound growth rates are computed using weighted average real expenditures, the estimated number of persons in respective total expenditure group being the weight. The annual compound growth rates show interesting patterns.

Contrary to the general belief of declining welfare and levels of living over time in India, the NSS data show rapid increases in real consumption of all commodities and a decline in average size of family, with a few exceptions. The average real per capita monthly total expenditure seems to have gone up by 1.59% per annum. This increase in real income has led to similar, some times even more rapid increases in consumption of all commodities in the basket of goods and services. The average household size seems to have been declining at the rate of 0.16% p.a. This augurs well for a country in which most of the benefits of growth and development are nullified by a more rapid increase in population. However, an opposite trend is witnessed in lowest and middle-income groups of urban India. This could probably be due to rural-urban migration for employment and other socioeconomic reasons.

There appears to be some problem with price deflation to remove the effect of price changes over time from consumer expenditure data, specifically with cereals & substitutes. Table 2 shows an annual increase of .99% in per capita monthly cereals consumption (real expenditure) over the study period 1972-94; where as the NSS data on cereals quantity shows a decline of 0.66% and 0.33% p.a. in rural and urban areas of India [see for e.g., Murty (1999)]. Thus, there is a discrepancy in rates of changes in quantity of cereals consumed between NSS data and our deflated series using price indices from non-NSS sources.[7] This may reflect lower rates of cereals price rise (and perhaps for other items as well) in our price series than those implied by

[7] Despite persistent demand from users of NSS data, for collection and publication of retail price series consistent with consumer expenditure data, NSS could not be persuaded to do so. Incidentally, the price series used here are worked out by well-known experts in the profession who were also closely associated with NSS efforts.

the NSS data. This clearly underscores the need for a comparable price series to the expenditure data from NSS source itself.

However, there appears to be good agreement in the level of cereal consumption between the two series for specific years. For e.g., in Table 1, we have seen that the 'all India' average per capita monthly cereal consumption is Rs. 14.7 in 1993-94, valued at '70-71 prices. The implicit cereal price is Rs 1.2-1.3 per kg in 1972-73, the nearest year immediately accessible to us, from NSS data itself. This gives us a cereal quantity between 11-12 kg per capita per month in 1993-94. The quantity of cereal consumption in 1993-94 according to NSS is 13.40 and 10.27 kg in rural and urban areas respectively. These give an 'all India' weighted average (rural: urban, 70%: 30%) around 12.5 kg per capita per month, which compares quite well with the above figure.

The rates of increase in real consumption for other commodities, especially milk & products, edible oil & fats and other food are also substantial. Table 2 also brings out rural-urban and income group differences in consumption trends over time. The patterns are broadly similar to the ones discussed above on average consumption. It is a bit hard to believe negative growth in real total consumer expenditure of the rich in both rural and urban areas. This requires further investigation.

3.3 Model results:

The methodology given in Section 2 has been implemented for the pooled time series of cross-section data using a FORTRAN program developed by the author himself. It uses iterative Zellner's SURE procedure for linearized demand system. The converged solution is known to be identical with maximum likelihood estimator. For each iteration and for the converged solution, concentrated log-likelihood value is computed. This converged value can be used for testing the empirical validity of a hypothesis or choice of a model vis-à-vis an alternative. The iteration-wise likelihood values confirm whether the likelihood function is being maximized or not.

There are 7 sets of results in total. These include 4 direct variants of the LES, one variant each of the NES, LA-AIDS and AIDS. The direct variants of the LES are (i) LES with 5 dummy variables representing two income groups, rural/urban sectors and their two interactions, called as LES-1, (ii) LES-1 along with household size, named as LES-2, (iii) LES-1 along with time trend, which represents taste changes, abbreviated as LES-3, (iv) combination of (ii) and (iii), called as LES-4. In the case of NES, 11 coefficients of the c matrix are restricted to be zero implying additive separability between the first five commodities and the rest two, other food and nonfood groups. These zero restrictions are necessitated to get negative own-price elasticities. The NES model still failed to fulfill second order conditions of utility maximization. LA-AIDS and AIDS models are estimated with three dummies, but without their interactions. It will be noted that LA-AIDS also violated second order conditions, with a positive own-price elasticity of demand for cereals in three cases, viz. highest 30% population groups in rural and urban India and middle 40% population group in urban India. Additive separability assumptions can be attempted to correct the situation here as well. The other two variables, time trend and household size also could not be incorporated in the last three models due to some computational problems. In what follows, we discuss the empirical results under three heads- goodness of fit, marginal budget shares, income & price elasticities, and tests of hypotheses. Brief conclusions are given at the end.

3.3.1 Goodness of fit and choice of the model:

We present in Appendix Tables 1-25 the parameter estimates, observed and estimated budget shares, income and own-price elasticities, along with three goodness of fit measures, viz. (a) squared correlation coefficients between observed/estimated expenditures, (b) adjusted R^2, and (c) Theil's information inaccuracy for each commodity. These are given separately for rural-urban sectors, income groups, and 'all India'. In all the three flexible models, symmetry restrictions are imposed to ensure the existence of an underlying utility function. Parameter estimates and t-ratios are therefore omitted for upper triangle of the parameter matrix. Also, due to space limitation, the full matrices of own- and cross-price elasticities are not included. All the estimated models have high goodness of fit statistics indicated by the above three measures. The adjusted R^2 is unity in most cases, partly because we estimated budget share, rather than expenditure equations. The only over-all (across all equations) measure of goodness of fit computed here is Theil's average information inaccuracy. Its magnitude is found to be close to zero, the 'best' value.

For each of the models, a large proportion of the estimated coefficients are found to have t-ratio exceeding 2 in magnitude, implying statistical significance at 5% or lower level (Appendix Tables 1-4). In several cases, the t-ratios are very large indicating high precision. This is the gain due to use of dummy variables rather than splitting the data series into several subsets. Looking at the closeness of the observed and estimated budget shares of the LES vis-a-vis others (Appendix Tables 5-25), one finds that the simpler LES is a strong contender of choice. The often mentioned limitation of the LES viz., linear Engel curves and its inability to capture the non-linearity/curvature in budget data ceases to be a formidable problem when rural-urban and income-group differentials are reasonably taken care off through the use of dummy variables as shown here. Models like LA-AIDS are only marginally better in terms of pure goodness of fit.

The other claimed reason for preference of models like AIDS over LES, viz. 'theoretical superiority in capturing price responses better' also suffered a set back. Probably due to 'too much' flexibility, the own-price elasticities of demand became positive for several items. Also, it is found that the second order conditions of utility maximization are violated. For these reasons, we choose the LES model for discussion of empirical results and further analysis. Accordingly, household size and time trend variables are incorporated into the MBS of the LES model only (LES-2 and LES-3 models).

In LES-2, the coefficients of the household size variable in the MBS are significant and negative for milk & products, other food and total nonfood, but positive for all other commodities. In LES-3, the coefficients of the time trend variable are significant and negative for cereals, pulses, but positive for all other commodities. This shows consumer taste & preferences are changing significantly over time and consumers seem to move away from consumption of cereals and pulses to the other food and non-food items. The shift in consumer preferences away from cereals is consistent with the declining trend in average cereal consumption over time.

3.3.2 Marginal budget shares:

Tables 3-6 contain estimated marginal budget shares (MBS) for four different models. The estimates are presented by income groups and separately for rural and urban areas. The MBS are also computed for 'all India, combined' by ignoring rural/urban and income group differentials. From these tables, we notice that the marginal budget shares exhibit well-known pattern. It is very interesting that the MBS are larger for cereals & substitutes, a basic 'staple' food item, in rural areas than urban for each of the income groups. The opposite is true for all other items or commodities groups. For the same item, the MBS decline with rise in income in both the regions of the country. The nonfood group exhibits exactly the opposite pattern. All the other food items show a mixed pattern- initial increase and a decline or the opposite.

The magnitudes of the MBS are also quite revealing. Lowest 30% population groups in rural India still spend half their marginal income on 'staple' item, cereals. In a contrasting way, the highest 30% population group in urban region, spend half their marginal income on nonfood group. Their rural counter parts spend about 43% on this commodity group.

The rural-urban differences in the MBS for any item are relatively smaller compared to across income group differentials. For e.g., the MBS on cereals varied from 0.498 to 0.383 for the lowest 30% population group as we move from rural areas to urban sector. But, within the rural sector, the MBS for the same item, cereals, varied from 0.498 to 0.194 as we move from lowest 30% to highest 30% population groups. Thus, these results clearly bring out the rural-urban and income group differentials typical of a developing country. We notice further that the MBS are somewhat 'robust' across model specifications. However, minor differences do exist between model specifications. Broadly, LES model and its non-additive generalization NES, seem to over (under) estimate the MBS for food (nonfood) commodities when compared with the LA-AIDS and AIDS specifications. The extent of over (under) estimation appears larger for lower income groups. There is practically not much difference in the MBS between LA-AIDS and its non-linear generalization. As will be seen later, even the concentrated log-likelihood values are identical.

3.3.3 Household size effects:

The effects of changes in household size on consumption patterns in general and the MBS in particular, can be quantified by comparing the two variants LES-1 and LES-2 (Results for LES-2, LES-3 and LES-4 could not be included due to space constraint). The differences in the MBS between LES-2 and LES-1 are attributable to household size effects on the MBS. These are presented in Table 7. The magnitudes of the changes in the MBS are relatively large only for two commodities, the 'staple' item cereals and the 'catch all' nonfood group. At the 'all India' level, increase in household size, ceteris paribus, seems to decrease the money income allocated to cereals at the margin, implying economies of scale. The opposite seems to happen in the case of nonfood group. The direction of change is similar for all the other food commodities as well.

However, sizable differences exist across population groups and rural-urban sectors. The magnitude of effects is large for all the three population groups in both the sectors for cereal item; and only in the case of lowest 30% for the other food group. The effects are relatively small for the middle 40% population group for all items in rural areas. It is interesting to notice that the direction of household size effects reverse between lowest 30% and highest 30% population groups as well as between cereals and nonfood commodities. More specifically, as in the 'all India' case, cereals exhibit economies of scale for lowest 30% group; whereas the opposite is true for nonfood commodity in both the sectors. The highest 30% population group shows exactly the reverse pattern. All other commodities exhibit mixed pattern. Meat, fish & eggs seem to indicate diseconomies of scale for rural poor.

3.3.4 Consumer taste & preferences effects:

The effects of changes in consumer taste & preferences on the MBS are presented in Table 8 by comparing LES-3 with LES-1. As noted earlier, use of time trend is only a crude way of measuring taste change. In the absence any better measure, we used this variable. Because of the way time trend variable is used, the changes in the MBS are to be interpreted as annual changes. At the 'all India' level, once again, the taste effects are large for the two commodity groups, cereals and nonfood. Changes in consumer taste & preferences would result in lower allocation for cereals (.35% p.a.) and higher for nonfood (.19% p.a.). This implies, at the margin, quite in agreement with the average level trends (particularly in cereal quantity consumed), tastes seem to reduce the money allocated to cereals and increase that of nonfood. Pulses and products also experience a negative, but negligibly small, effect due to incorporation of taste change. All other food items seem to go the nonfood way, increase in the MBS due to taste change (.01% and .08% p.a.). Unlike in the case of household size variable, the taste change effects seem to be more uniform across population groups. In this case, middle 40% group also exhibit sizable effects. Probably, as an artifact, the direction of changes in the MBS are similar between rural-urban sectors and across population groups. The magnitudes of the effects however differ. Broadly, the magnitudes of taste effects seem to dampen as we move across population groups, with some exceptions. From the enlarged LES-4 model, it is possible to compute household size and taste elasticities, which we have not done. These elasticities will depend on income level.

Table 9 gives the concentrated log-likelihood and chi-square statistic values for different model alternatives. It can be seen that both the flexible models, NES and AIDS, have larger likelihood values compared to any of the LES variants. But, a formal chi-square test is possible for nested hypotheses only. There are 4 such nested hypotheses among the LES variants. In each of these cases, the restricted model is rejected against the corresponding unrestricted alternative at 1% level of significance. This shows the need for inclusion of income group and sectoral dummies, their interactions, household size and consumer taste variables in the demand model to quantify the consumption behavior adequately in India. For non-nested hypotheses, a separate statistical test called Akaike Information Criteria (AIC) is possible. This has not been attempted here. Also, due to computational problems arising from the large number of parameters (including the income group and sectoral dummy variables) already present in the basic NES and AIDS models, household size and taste variables could not be included in them. Efforts are continuing to get over this problem.

3.3.5 Income and price elasticities:

In view of the bulkiness of results and to economize space, we are presenting the main results which include income and own-price elasticities only. The full matrices of elasticities are available on request. We will briefly comment on them. Only broad features in terms of similarities/dissimilarities will be mentioned. The estimated demand elasticities for all the commodities along with average budget shares (observed and estimated), and three goodness of fit measures are presented in Appendix Tables 5-25 for each of the selected models, separately for rural-urban areas and income groups. Such estimates are also presented for 'all India' under each model.

It is somewhat puzzling that the income elasticities of demand are quite on the higher side, exceeding unity in many cases, even for staple item like cereals. The elasticities seem to decline (increase) marginally for food (nonfood) items across income levels. It is not clear whether this is due to the way, the MBS are allowed to vary. Normally, one would have estimated separate models for each income category and rural-urban areas. The approach followed here is different. However, as already discussed, the MBS have varied substantially and depicted expected patterns. On the other hand, own-price elasticities of demand are more sensitive to the use of dummies and model specification. In terms of capturing price responses adequately, the simple generalization of the LES viz., the NES has a good claim. It has similar disadvantages as that of AIDS. It may be necessary to restrict the utility interaction or specific substitution between goods to get empirically meaningful own- and cross-price elasticities of demand. In this sense, restrictive models like the LES are easy to handle.

We notice that the expenditure elasticity of demand for food items like cereals, pulses, milk, and edible oil declines with rise in income, i.e. as we move from lowest 30% income group to highest 30% income group. The opposite pattern is noticed for other food and nonfood groups. But, the own-price elasticity of demand (in absolute value) seem to exhibit the opposite pattern. This contradicts the direct relationship between income and own-price elasticities of demand that one comes across in empirical results. Due to the introduction of taste variable, all the elasticities, income elasticities in particular, seem to vary in a narrower range than in earlier studies [e.g. Murty (1997, 1998)]. This may imply better stability (less volatility) for the elasticity coefficients.

The own-price effects vary across income groups and rural-urban sectors. They are relatively larger for highest income group, which suggests that for this section of population the price of commodity play an important role than for others. The income and own-price elasticities are uniformly smaller (larger) in the case of food (nonfood) for urban population than their rural counter parts. This shows that the urban consumer is less (more) responsive to income and price changes in the case of food (nonfood) consumption than in rural sector. The income and own-price effects show similar pattern across model alternatives, although the magnitudes are different. The LES model seem to over estimate the own-price effects for some items and underestimate for others compared to flexible models viz. NES and AIDS.

Thus, in conclusion, the empirical results show wide variation in marginal budget shares and demand elasticities across income groups, rural-urban sectors and alternative models. The household size and consumer taste & preferences are found to be statistically significant. It is confirmed that the linear expenditure system, despite its limitations of linearity and additivity, could provide a good description of consumption patterns in India, i.e. able to capture curvature in Engel curves, provided adequate care is taken to distinguish a few meaningful income categories and rural-urban sectors. The results also show that flexible models that are theoretically superior gave unacceptable positive price responses for some commodities and have violated the second order conditions of utility maximization. Imposition of ad-hoc separability restrictions could get negative own-price responses, but has not ensured fulfillment of second order conditions in these models. The tests of nested hypotheses also confirmed the need for inclusion of household size, consumer taste, income group and rural-urban dummies along with their interaction variables in the demand system.

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References:

Bhattacharya, N. (1975). Studies on Consumer Behavior in India. In Survey of Research in Economics - Econometrics, ICSSR Vol. 7, eds. Bhattacharya, N. and Iyengar, N.S., pp. 176-232.

Blundell, R., P. Pashardes and G. Weber (1993). What do we learn about Consumer Demand Patterns from Micro Data? American Economic Review 83: 570-97.

Brown, J.A.C. and A.S. Deaton (1972). Surveys in Applied Economics -Models of Consumer Behavior. Economic Journal 82: 1145-1236.

Coondoo, D. and Majumdar, A (1987). A System of Demand Equations based on Price Independent Generalized Linearity. International Economic Review 28: 213-28.

Cooper, R.J. and K.R. McLaren (1992). An Empirically Oriented Demand System with Improved Regularity Properties. Canadian Journal of Economics 25:

Deaton, A.S. (1976). A System of Simple Non-additive Model of Demand. In L. Solari and J.N. DuPasquier (eds.) Private and Enlarged Consumption: North-Holland Publishing Co. pp. 55-72.

______________ (1997). The Analysis of Household Surveys: A Micro-Econometric Approach to Development Policy. The Johns Hopkins Press, Baltimore and London.

Deaton, A.S. and J. Muellbauer (1980). An Almost Ideal Demand System. American Economic review 70: 313-24.

Eales, J.S. and L.J. Unnevehr (1994). The Inverse Almost Ideal Demand System. European Economic Review 38: 101-15.

Jain, L.R. and B.S. Minhas (1991). Rural and Urban Consumer Price Indices by Commodity Groups. Sarvekshana 15: 1-21.

Leser, C.E.V. (1976). Income, Household Size and Price Changes 1953-73. Oxford Bulletin of Economics and Statistics 38: 1-10.

Lewbel, A. (1987). Fractional Demand Systems. Journal of Econometrics 36: 311-37.

______________ **(1991).** The Rank of Demand Systems: Theory and Nonparametric Estimation. Econometrica 59: 711-30.

______________ **(1995).** Utility Functions and Global Regularity of Fractional Demand Systems. International Economic Review 36: 943-61.

Meenakshi, J.V. (1996). How Important Are Changes in Taste? A State-Level Analysis of Food Demand. Economic and Political Weekly, December 14, pp. 3265-9.

Meenakshi, J.V. and Ranjan Ray (1999). Regional Differences in India's Food Expenditure Pattern: A complete Demand Systems Approach. Journal of International Development 11: 47-74.

Moschini, G. (1995). Units of Measurement and the Stone Index in Demand System Estimation. American Journal of Agricultural Economics 77: 63-8.

Murty, K.N. (1997). Trends in Consumption and Estimates of Income and Price Elasticities of Demand for Major Crops in the Semi-Arid Tropics of India- A Compendium. Progress Report-123, SEPD, ICRISAT, Patancheru, India.

Murty, K.N. (1998). Demand and Supply Projections of ICRISAT Mandate and Competing Crops in SAT India Progress Report- 124, SEPD, ICRISAT, Patancheru, India.

Murty, K.N. (1999). Decomposition of Changes in Cereals Demand into its Components in Semi-Arid Tropical India. Arthavijnana (forthcoming issue).

Nasse, P.H. (1970). Analyse des effects de substitution dans un system complet de functions de demand. Annales de l'Insee 5: 81-110.

Pashardes, P. (1993) Bias in Estimating the Almost Ideal Demand System with the Stone Index Approximation. The Economic Journal 103: 908-15.

Pollak, R.A. and T.J. Wales (1992). Demand System Specification and Estimation. Oxford University Press, New York.

Radhakrishna, R. and C. Ravi (1992). Effects of Growth, Relative Price and Preferences on Food and Nutrition. Indian Economic Review, Special Number, pp. 303-23.

Radhakrishna, R. and K.N. Murty (1999). Econometrics of Complete Demand Systems with Illustrations for India. In Econometric Applications in India, (ed.) K.L. Krishna, Oxford University Press, Delhi.

Roy, R. (1942). De l'Utilite. Contribution a'la Theorie des Choix, Hermann.

Stone, J.R.N. (1954). Linear Expenditure System and Demand Analysis: An Application to the Pattern of British Demand. Economic Journal 64: 511-27.

Tendulkar, S.D. and L.R. Jain (1993). An Analysis of Inter-State and Inter-Commodity Group Rural-Urban Consumer Price Indices in India, 1983-1988-89. Journal of Indian School of Political Economy 5: 267-99.

Table 1: Observed weighted average expenditure ('70-71 Rs), budget share (%), total expenditure and household size for different income groups in 1993-94

S.No.	Commodity Group	Rural India			Urban India			All India Combined
		Lowest 30%	Middle 40%	Highest 30%	Lowest 30%	Middle 40%	Highest 30%	
1	Cereals & Substitutes	14.13 [46.8]	17.55 [36.5]	19.51 [21.5]	7.34 [25.6]	13.83 [24.3]	15.53 [11.5]	15.67 [26.2]
2	Pulses & Products	0.71 [2.4]	1.05 [2.2]	1.55 [1.7]	0.81 [2.8]	1.23 [2.2]	1.70 [1.3]	1.13 [1.9]
3	Milk & Milk Products	1.27 [4.2]	3.89 [8.1]	9.37 [10.3]	2.34 [8.1]	6.02 [10.6]	13.35 [9.9]	5.34 [8.9]
4	Edible Oil & Fats	1.47 [4.9]	2.34 [4.9]	3.60 [4.0]	1.91 [6.6]	3.15 [5.5]	4.95 [3.7]	2.69 [4.5]
5	Meat, Fish & Eggs	0.46 [1.5]	0.94 [2.0]	1.72 [1.9]	0.82 [2.9]	1.51 [2.7]	2.80 [2.1]	1.22 [2.0]
6	Otherfood	6.84 [22.7]	11.68 [24.3]	20.72 [22.8]	6.97 [24.3]	12.08 [21.3]	26.08 [19.3]	13.29 [22.2]
7	Total Nonfood	5.29 [17.5]	10.63 [22.1]	34.39 [37.9]	8.55 [29.7]	19.01 [33.4]	70.81 [52.4]	20.42 [34.2]
8	Total Expenditure	30.17 [100]	48.08 [100]	90.86 [100]	28.74 [100]	56.84 [100]	135.20 [100]	59.76 [100]
9	Household Size	5.46	4.84	4.14	5.51	4.79	3.49	4.77

Table 2: Estimated annual compound growth rate* in per capita monthly real consumption expenditure ('70-71 Rs) and household size for different income groups during 1972-94

S.No.	Commodity Group	Rural India			Urban India			All India Combined
		Lowest 30%	Middle 40%	Highest 30%	Lowest 30%	Middle 40%	Highest 30%	
1	Cereals & Substitutes	1.47	0.63	-0.19	0.96	0.02	0.24	0.14
2	Pulses & Products	2.11	0.42	-2.58	3.09	-0.25	-1.12	-0.28
3	Milk & Milk Products	5.78	3.98	-0.62	5.09	1.41	-1.25	1.56
4	Edible Oil & Fats	4.86	3.92	0.72	5.80	2.74	1.27	2.93
5	Meat, Fish & Eggs	0.67	0.82	-1.61	3.33	0.98	-1.56	0.50
6	Otherfood	3.81	3.69	0.53	3.12	1.82	-0.82	2.24
7	Total Nonfood	3.31	3.36	-2.39	4.60	2.99	0.23	2.68
8	Total Expenditure	2.50	2.16	-1.13	2.90	1.57	-0.21	1.67
9	Household Size	-0.18	-0.12	-0.31	0.27	0.52	-0.43	-0.39

* Uses weighted average time series data

Table 3: Estimated marginal budget shares for different income groups: LES-1

S.No.	Commodity Group	Rural India			Urban India			All In: Comb:
		Lowest 30%	Middle 40%	Highest 30%	Lowest 30%	Middle 40%	Highest 30%	
1	Cereals & Substitute	0.4980	0.3470	0.1936	0.3829	0.1979	0.0832	0.299
2	Pulses & Products	0.0426	0.0441	0.0329	0.0482	0.0416	0.0242	0.039
3	Milk & Milk Products	0.0341	0.0821	0.1093	0.0574	0.1099	0.1049	0.07
4	Edible Oil & Fats	0.0456	0.0490	0.0368	0.0569	0.0594	0.0402	0.04
5	Meat, Fish & Eggs	0.0222	0.0331	0.0289	0.0324	0.0391	0.0326	0.030
6	Otherfood	0.1846	0.1939	0.1676	0.1987	0.2171	0.2096	0.19
7	Total Nonfood	0.1729	0.2508	0.4308	0.2236	0.3351	0.5053	0.309

LES-1 Linear Expenditure System with 3 dummies and their interactions

Table 4: Estimated marginal budget shares for different income groups: NES

S.No.	Commodity Group	Rural India			Urban India			All India Combine
		Lowest 30%	Middle 40%	Highest 30%	Lowest 30%	Middle 40%	Highest 30%	
1	Cereals & Substitute	0.5002	0.3272	0.1931	0.3850	0.2120	0.0779	0.2991
2	Pulses & Products	0.0458	0.0419	0.0289	0.0442	0.0402	0 0273	0.0385
3	Milk & Milk Products	0.0403	0.0921	0.1021	0.0517	0.1035	0.1135	0.0790
4	Edible Oil & Fats	0.0462	0.0480	0.0337	0.0549	0.0567	0.0423	0.0469
5	Meat, Fish & Eggs	0.0257	0.0339	0.0280	0.0313	0.0395	0.0336	0.031
6	Otherfood	0.1788	0.1930	0.1754	0.2042	0.2184	0.2008	0.1940
7	Total Nonfood	0.1630	0.2638	0.4387	0.2289	0.3297	0.5046	0.311

NES: Nasse Expenditure System with 3 dummies and otherfood, nonfood separability

Table 5: Estimated marginal budget shares for different income groups: LA-AIDS

S.No	Commodity Group	Rural India			Urban India			All India Combined
		Lowest 30%	Middle 40%	Highest 30%	Lowest 30%	Middle 40%	Highest 30%	
1	Cereals & Substitutes	0.4334	0.3074	0.1835	0.3271	0.1964	0.0437	0.2613
2	Pulses & Products	0.0422	0.0456	0.0332	0.0395	0.0429	0.0317	0.0389
3	Milk & Milk Products	0.0377	0.0826	0.0995	0.0493	0.0961	0.1160	0.0756
4	Edible Oil & Fats	0.0436	0.0516	0.0383	0.0498	0.0573	0.0465	0.0472
5	Meat, Fish & Eggs	0.0240	0.0321	0.0276	0.0289	0.0365	0.0334	0.0297
6	Otherfood	0.1552	0.1616	0.1440	0.1931	0.1931	0.1809	0.1712
7	Total Nonfood	0.2638	0.3191	0.4741	0.3124	0.3778	0.5480	0.3759

LA-AIDS: Linearly Approximated Almost Ideal Demand System with 3 dummies

Table 6: Estimated marginal budget shares for different income groups: AIDS

S.No	Commodity Group	Rural India			Urban India			All India Combined
		Lowest 30%	Middle 40%	Highest 30%	Lowest 30%	Middle 40%	Highest 30%	
1	Cereals & Substitutes	0.4323	0.3077	0.1835	0.3253	0.1958	0.0425	0.2605
2	Pulses & Products	0.0423	0.0459	0.0334	0.0393	0.0431	0.0317	0.0390
3	Milk & Milk Products	0.0379	0.0831	0.0997	0.0491	0.0963	0.1160	0.0759
4	Edible Oil & Fats	0.0437	0.0519	0.0384	0.0496	0.0574	0.0465	0.0472
5	Meat, Fish & Eggs	0.0240	0.0322	0.0277	0.0288	0.0366	0.0334	0.0297
6	Otherfood	0.1559	0.1623	0.1448	0.1937	0.1938	0.1814	0.1719
7	Total Nonfood	0.2640	0.3169	0.4726	0.3141	0.3771	0.5484	0.3758

AIDS: Nonlinear Almost Ideal Demand System with 3 dummies

Table7: Estimated effects of a one person increase in household size on marginal budget shares for different income groups

S.No.	Commodity Group	Rural India			Urban India			All India Combined
		Bottom 30%	Middle 40%	Top 30%	Bottom 30%	Middle 40%	Top 30%	
1	Cereals & Substitutes	-0.0068	-0.0055	-0.0014	-0.0129	-0.0017	0.0070	-0.0047
2	Pulses & Products	-0.0002	-0.0005	-0.0002	-0.0011	-0.0005	0.0005	-0.0004
3	Milk & Milk Products	0.0005	-0.0012	-0.0010	0.0000	-0.0018	-0.0009	-0.0007
4	Edible Oil & Fats	-0.0002	-0.0005	-0.0001	-0.0009	-0.0007	0.0003	-0.0004
5	Meat, Fish & Eggs	0.0004	-0.0002	0.0000	-0.0002	-0.0004	0.0000	0.0000
6	Otherfood	-0.0031	-0.0007	0.0005	0.0023	-0.0003	-0.0002	-0.0007
7	Total Nonfood	0.0094	0.0086	0.0023	0.0129	0.0054	-0.0067	0.0068

Table 8: Estimated effects of a unit increase in consumer tastes/preferences per annum on marginal budget shares for different income groups

S.No.	Commodity Group	Rural India			Urban India			All India Combined
		Bottom 30%	Middle 40%	Top 30%	Bottom 30%	Middle 40%	Top 30%	
1	Cereals & Substitutes	-0.0035	-0.0028	-0.0041	-0.0042	-0.0032	-0.0035	-0.0035
2	Pulses & Products	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	Milk & Milk Products	0.0005	0.0004	0.0006	0.0006	0.0004	0.0005	0.0005
4	Edible Oil & Fats	0.0003	0.0002	0.0003	0.0003	0.0002	0.0002	0.0002
5	Meat, Fish & Eggs	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
6	Otherfood	0.0008	0.0007	0.0010	0.0010	0.0008	0.0009	0.0008
7	Total Nonfood	0.0019	0.0015	0.0021	0.0021	0.0016	0.0018	0.0018

Table 9: Estimated concentrated log-likelihood and chi-square statistic values for different models

Model Type	LES-1	LES-2	LES-3	LES-4	NES	LA-AIDS	AIDS
Concentrated Log-likelihood Value	2509.7 [43]	2564.1 [49]	2553.4 [49]	2616.8 [55]	2522.9 [73]	2571.3 [72]	2570.8 [72]
Null vs Alternative Hypothesis		LES-1 vs LES-2	LES-1 vs LES-3	LES-1 vs LES-4	LES-3 vs LES-4		
Chi-square Statistic Value		108.8 [6]	87.4 [6]	214.2 [12]	126.8 [6]		
Chi-square Statistic Critical Value at 1% Significance level		16.8	16.8	26.2	16.8		
Test Decision		Rejection	Rejection	Rejection	Rejection		

LES-1: Linear Expenditure System with 3 dummies and their interactions
LES-2: LES-1 along with household size variable
LES-3: LES-1 along with time trend variable
LES-4: LES-1 along with household size and time trend variables
NES: Nasse Expenditure System with 3 dummies
LA-AIDS: Linearly Approximated Almost Ideal Demand System with 3 dummies
AIDS: Nonlinear Almost Ideal Demand System with 3 dummies

Figures in parentheses are degrees of freedom.

Appendix Table 1: Parameter estimates of the Linear Expenditure System: LES-1

S.No.	Commodity Group	Committed Quantities [c]	Income Related Coefficients [Marginal Budget Shares, b]					
			Intercept	Income Group 1	Income Group 2	Rural/Urban Sector	Interaction 1	Interaction 2
1	Cereals & Substitutes	3.7320 [14.93]	0.0832 [4.753]	0.2996 [11.53]	0.1147 [4.108]	0.1104 [4.546]	0.0047 [0.1258]	0.0387 [0.964]
2	Pulses & Products	0.1874 [11.3]	0.0242 [17.99]	0.0241 [12.09]	0.0174 [8.143]	0.0088 [4.706]	-0.0144 [-4.993]	-0.0063 [-2.04]
3	Milk & Milk Products	0.2475 [7.46]	0.1049 [26.22]	-0.0476 [-8.009]	0.0049 [0.7684]	0.0044 [0.7898]	-0.0277 [-3.218]	-0.0321 [-3.49]
4	Edible Oil & Fats	0.2538 [11.28]	0.0402 [23.57]	0.0166 [6.551]	0.0191 [6.999]	-0.0035 [-1.46]	-0.0078 [-2.117]	-0.0069 [-1.76]
5	Meat, Fish & Eggs	0.1663 [13.81]	0.0326 [30.88]	-0.0001 [-9.039]	0.0065 [3.836]	-0.0037 [-2.49]	-0.0066 [-2.814]	-0.0023 [-0.9684]
6	Otherfood	1.6490 [17.32]	0.2096 [35.2]	-0.0109 [-1.233]	0.0075 [0.7914]	-0.0420 [-5.072]	0.0279 [2.176]	0.0188 [1.374]
7	Total Nonfood	1.7340 [12.94]	0.5053 [31.21]	-0.2817 [ ]	-0.1702 [ ]	-0.0744 [ ]	0.0237 [ ]	-0.0098 [ ]

LES-1: Linear Expenditure System with 3 dummies and their interactions

Appendix Table 2: Parameter estimates of the Nasse Expenditure System: NES

S.No.	Commodity Group	Price Related Coefficients							Income Coefficient
		Cereals & Substitutes	Pulses & Products	Milk & Milk Products	Edible Oils & Fats	Meat, Fish & Eggs	Other food	Total Nonfood	
1	Cereals & Substitutes	6.4410 [11.5]							0.0779 [5.518]
2	Pulses & Products	-1.0760 [-10.40]	0.6834 [6.319]						0.0273 [20.36]
3	Milk & Milk Products	0.1468 [0.3589]	-0.2321 [-2.553]	0.4144 [1.484]					0.1135 [30.83]
4	Edible Oil & Fats	-1.0830 [-6.709]	0.6814 [8.521]	-0.1205 [-1.089]	0.5443 [3.631]				0.0423 [34.14]
5	Meat, Fish & Eggs	0.0601 [0.5245]	0.0000 [0.0001]	0.1453 [1.967]	0.1068 [1.244]	-0.0929 [-.9537]			0.0336 [34.58]
6	Otherfood	0.0000 [6.155]	0.0000 [6.151]	0.0000 [-.0155]	0.0000 [3.385]	0.0000 [4.514]	1.8490 [3.916]		0.2008 [37.98]
7	Total Nonfood	0.0000 [6.162]	0.0000 [6.095]	0.0000 [0.1525]	0.0000 [3.549]	0.0000 [4.604]	0.0000 [-5.097]	1.9200 [1.662]	0.5046 [36.81]

NES: Nasse Expenditure System with 3 dummies

Figures within parentheses are approximate t-ratios. The coefficients of the dummy variables are not included.

Appendix Table 3: Parameter estimates of the Almost Ideal Demand System: LA-AIDS

S.No.	Commodity Group	Price Related Coefficients							Income Coefficient	Intercept
		Cereals & Substitutes	Pulses & Products	Milk & Milk Products	Edible Oils & Fats	Meat, Fish & Eggs	Other food	Total Nonfood		
1	Cereals & Substitutes	0.2737 [10.27]							-0.0502 [-5.232]	0.3394 [9.168]
2	Pulses & Products	-0.0273 [-4.450]	0.0032 [0.3272]						0.0031 [1.971]	0.0113 [1.403]
3	Milk & Milk Products	-0.0558 [-5.027]	-0.0347 [-3.190]	0.0202 [0.9997]					0.0062 [1.955]	0.0889 [6.387]
4	Edible Oil & Fats	-0.0432 [-7.523]	-0.0105 [-1.408]	-0.0135 [-1.474]	0.0179 [2.326]				0.0036 [2.474]	0.0206 [2.892]
5	Meat, Fish & Eggs	-0.0231 [-5.947]	-0.0251 [-4.306]	0.0093 [1.24]	-0.0014 [-.2606]	0.0029 [0.3544]			-0.0001 [-.1762]	0.0389 [7.573]
6	Otherfood	-0.0480 [-3.495]	0.0244 [2.368]	0.0623 [3.646]	0.0270 [2.834]	0.0144 [1.838]	-0.0583 [-2.320]		-0.0288 [-8.883]	0.3124 [22.34]
7	Total Nonfood	-0.0763 [-2.298]	0.0700 [3.332]	0.0123 [0.3275]	0.0235 [1.16]	0.0231 [1.236]	-0.0218 [-.6329]	-0.0308 [-.3165]	0.0662 [5.686]	0.1885 [4.08]

LA-AIDS: Linearly Approximated Almost Ideal Demand System with 3 dummies

Figures within parentheses are approximate t-ratios. The coefficients of the dummy variables are not included.

Appendix Table 4: Parameter estimates of the Almost Ideal Demand System: AIDS

Appendix Table 4: Parameter estimates of the Almost Ideal Demand System: AIDS

S.No.	Commodity Group	Price Related Coefficients							Income Coefficient	Intercept
		Cereals & Substitutes	Pulses & Products	Milk & Milk Products	Edible Oils & Fats	Meat, Fish & Eggs	Other food	Total Nonfood		
1	Cereals & Substitutes	0.2635 [9.965]							-0.0508 [-5.458]	0.3403 [9.830]
2	Pulses & Products	-0.0269 [-4.327]	0.0037 [0.377]						0.0032 [2.096]	0.0108 [1.347]
3	Milk & Milk Products	-0.0542 [-4.822]	-0.0330 [-3.017]	0.0237 [1.162]					0.0063 [2.023]	0.0884 [6.425]
4	Edible Oil & Fats	-0.0426 [-7.327]	-0.0097 [-1.292]	-0.0121 [-1.310]	0.0187 [2.417]				0.0037 [2.602]	0.0201 [2.826]
5	Meat, Fish & Eggs	-0.0230 [-5.917]	-0.0242 [-4.166]	0.0095 [1.272]	-0.0007 [-.1322]	0.0034 [0.418]			-0.0001 [-0.142]	0.0384 [7.572]
6	Otherfood	-0.0518 [-3.672]	0.0247 [2.399]	0.0604 [3.534]	0.0272 [2.85]	0.0142 [1.815]	-0.0607 [-2.383]		-0.0281 [-8.644]	0.3089 [22.19]
7	Total Nonfood	-0.0651 [-2.027]	0.0653 [3.097]	0.0057 [0.152]	0.0191 [0.935]	0.0208 [1.115]	-0.0142 [-.4125]	-0.0316 [-.3264]	0.0659 [5.92]	0.1932 [4.615]

AIDS: Nonlinear Almost Ideal Demand System with 3 dummies

Figures within parentheses are approximate t-ratios. The coefficients of the dummy variables are not included.

Appendix Table 5: Budget shares, income & own-price elasticities and goodness of fit measures: LES-1, Rural Income Group I

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.4883	0.4582	1.0870	-0.7163	0.9829	1.0000	0.0148
2	Pulses & Products	0.0367	0.0364	1.1700	-0.4907	0.9920	1.0000	0.0007
3	Milk & Milk Products	0.0279	0.0328	1.0410	-0.4364	0.9075	1.0000	0.0041
4	Edible Oil & Fats	0.0394	0.0392	1.1650	-0.4904	0.9954	1.0000	0.0008
5	Meat, Fish & Eggs	0.0234	0.0241	0.9204	-0.3823	0.9414	1.0000	0.0004
6	Otherfood	0.1827	0.1962	0.9412	-0.4917	0.9960	1.0000	0.0028
7	Total Nonfood	0.2017	0.2131	0.8111	-0.4413	0.9941	1.0000	0.0038

Appendix Table 6: Budget shares, income & own-price elasticities and goodness of fit measures: LES-1, Rural Income Group II

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.3667	0.3623	0.9577	-0.8324	0.9696	1.0000	0.0115
2	Pulses & Products	0.0420	0.0419	1.0530	-0.8252	0.9899	1.0000	0.0001
3	Milk & Milk Products	0.0703	0.0712	1.1540	-0.9040	0.9452	1.0000	0.0025
4	Edible Oil & Fats	0.0459	0.0461	1.0640	-0.8342	0.9861	1.0000	0.0003
5	Meat, Fish & Eggs	0.0319	0.0320	1.0320	-0.8075	0.9959	1.0000	0.0001
6	Otherfood	0.1943	0.1955	0.9922	-0.8147	0.9976	1.0000	0.0016
7	Total Nonfood	0.2490	0.2511	0.9990	-0.8317	0.9876	1.0000	0.0038

Appendix Table 7: Budget shares, income & own-price elasticities and goodness of fit measures: LES-1, Rural Income Group III

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.2220	0.2182	0.8874	-0.8352	0.7641	1.0000	0.0178
2	Pulses & Products	0.0332	0.0329	1.0020	-0.9015	0.8783	1.0000	0.0009
3	Milk & Milk Products	0.1017	0.1013	1.0790	-0.9708	0.8682	1.0000	0.0022
4	Edible Oil & Fats	0.0368	0.0366	1.0040	-0.9037	0.8701	1.0000	0.0006
5	Meat, Fish & Eggs	0.0288	0.0286	1.0100	-0.9079	0.8923	1.0000	0.0006
6	Otherfood	0.1716	0.1710	0.9799	-0.8989	0.8981	1.0000	0.0025
7	Total Nonfood	0.4059	0.4113	1.0470	-0.9653	0.9398	1.0000	0.0269

Appendix Table 8: Budget shares, income & own-price elasticities and goodness of fit measures: LES-1, Urban Income Group I

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.3732	0.4145	0.9237	-0.6439	0.9719	1.0000	0.0156
2	Pulses & Products	0.0385	0.0392	1.2310	-0.5847	0.9920	1.0000	0.0003
3	Milk & Milk Products	0.0463	0.0401	1.4300	-0.6744	0.9756	1.0000	0.0038
4	Edible Oil & Fats	0.0467	0.0465	1.2230	-0.5848	0.9951	1.0000	0.0012
5	Meat, Fish & Eggs	0.0297	0.0286	1.1340	-0.5349	0.9795	1.0000	0.0005
6	Otherfood	0.2231	0.2088	0.9516	-0.5478	0.9971	1.0000	0.0018
7	Total Nonfood	0.2426	0.2223	1.0060	-0.5811	0.9939	1.0000	0.0057

Appendix Table 9: Budget shares, income & own-price elasticities and goodness of fit measures: LES-1, Urban Income Group II

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.2374	0.2355	0.8406	-0.7614	0.9590	1.0000	0.0058
2	Pulses & Products	0.0404	0 0403	1.0330	-0.8689	0.9835	1.0000	0.0002
3	Milk & Milk Products	0.0960	0.0963	1.1410	-0.9586	0.9940	1.0000	0.0003
4	Edible Oil & Fats	0.0558	0.0557	1.0650	-0.8968	0.9818	1.0000	0.0001
5	Meat, Fish & Eggs	0.0370	0.0370	1.0550	-0.8860	0.9973	1.0000	0.0000
6	Otherfood	0.2180	0.2182	0.9953	-0.8683	0.9979	1.0000	0.0004
7	Total Nonfood	0.3155	0.3171	1.0570	-0.9223	0.9904	1.0000	0.0037

Appendix Table 10: Budget shares, income & own-price elasticities and goodness of fit measures: LES-1, Urban Income Group III

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.1072	0.1063	0.7834	-0.7529	0.6975	1.0000	0.0058
2	Pulses & Products	0.0250	0.0248	0.9745	-0.9109	0.7627	1.0000	0.0012
3	Milk & Milk Products	0.1001	0.0997	1.0520	-0.9833	0.8998	1.0000	0.0017
4	Edible Oil & Fats	0.0404	0.0401	1.0050	-0.9392	0.8078	1.0000	0.0015
5	Meat, Fish & Eggs	0.0323	0.0322	1.0120	-0.9455	0.9340	1.0000	0.0004
6	Otherfood	0.2110	0.2106	0.9954	-0.9431	0.9544	1.0000	0.0022
7	Total Nonfood	0.4840	0.4864	1.0390	-0.9844	0.9741	1.0000	0.0160

Appendix Table 11: Budget shares, income & own-price elasticities and goodness of fit measures: LES-1, All India, Combined

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.3115	0.3134	0.9565	-0.7558	0.8498	1.0000	0.0126
2	Pulses & Products	0.0358	0.0358	1.1020	-0.7601	0.8822	1.0000	0.0006
3	Milk & Milk Products	0.0696	0.0692	1.1360	-0.7913	0.9259	1.0000	0.0027
4	Edible Oil & Fats	0.0436	0.0434	1.1040	-0.7635	0.8866	1.0000	0.0008
5	Meat, Fish & Eggs	0.0298	0.0297	1.0330	-0.7124	0.9408	1.0000	0.0004
6	Otherfood	0.2000	0.1994	0.9716	-0.7271	0.9832	1.0000	0.0020
7	Total Nonfood	0.3097	0.3091	1.0020	-0.7809	0.9707	1.0000	0.0101

Appendix Table 12: Budget shares, income & own-price elasticities and goodness of fit measures: NES, Rural Income Group I

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.4883	0.4519	1.1070	-0.5688	0.9812	1.0000	0.0132
2	Pulses & Products	0.0367	0.0370	1.2390	-0.0048	0.9966	1.0000	0.0018
3	Milk & Milk Products	0.0279	0.0376	1.0710	-0.3033	0.9094	1.0000	0.0052
4	Edible Oil & Fats	0.0394	0.0404	1.1420	-0.3093	0.9978	1.0000	0.0002
5	Meat, Fish & Eggs	0.0234	0.0260	0.9893	-0.7007	0.9578	1.0000	0.0006
6	Otherfood	0.1827	0.1950	0.9170	-0.4224	0.9958	1.0000	0.0031
7	Total Nonfood	0.2017	0.2122	0.7682	-0.3710	0.9929	1.0000	0.0040

Appendix Table 13: Budget shares, income & own-price elasticities and goodness of fit measures: NES, Rural Income Group II

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.3667	0.3465	0.9444	-0.7284	0.9695	1.0000	0.0101
2	Pulses & Products	0.0420	0.0414	1.0100	-0.5747	0.9964	1.0000	0.0003
3	Milk & Milk Products	0.0703	0.0784	1.1750	-0.8717	0.9463	1.0000	0.0029
4	Edible Oil & Fats	0.0459	0.0472	1.0180	-0.7407	0.9917	1.0000	0.0001
5	Meat, Fish & Eggs	0.0319	0.0322	1.0520	-0.9480	0.9971	1.0000	0.0002
6	Otherfood	0.1943	0.1947	0.9917	-0.7911	0.9976	1.0000	0.0016
7	Total Nonfood	0.2490	0.2596	1.0160	-0.8229	0.9879	1.0000	0.0039

Appendix Table 14: Budget shares, income & own-price elasticities and goodness of fit measures: NES, Rural Income Group III

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.2220	0.2204	0.8761	-0.7706	0.7590	1.0000	0.0165
2	Pulses & Products	0.0332	0.0295	0.0814	-0.7628	0.9078	1.0000	0.0012
3	Milk & Milk Products	0.1017	0.0945	1.0810	-0.9536	0.8680	1.0000	0.0025
4	Edible Oil & Fats	0.0368	0.0343	0.0822	-0.8459	0.8906	1.0000	0.0006
5	Meat, Fish & Eggs	0.0288	0.0279	1.0070	-0.9608	0.8851	1.0000	0.0006
6	Otherfood	0.1716	0.1783	0.0842	-0.8922	0.8970	1.0000	0.0026
7	Total Nonfood	0.4059	0.4153	1.0570	-0.9625	0.9410	1.0000	0.0263

Appendix Table 15: Budget shares, income & own-price elasticities and goodness of fit measures: NES, Urban Income Group I

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.3732	0.4160	0.9254	-0.5016	0.9711	1.0000	0.0143
2	Pulses & Products	0.0385	0.0393	1.1240	-0.1430	0.9919	1.0000	0.0009
3	Milk & Milk Products	0.0463	0.0373	1.3860	-0.5083	0.9745	1.0000	0.0044
4	Edible Oil & Fats	0.0467	0.0463	1.1840	-0.4044	0.9957	1.0000	0.0004
5	Meat, Fish & Eggs	0.0297	0.0274	1.1400	-0.7290	0.9832	1.0000	0.0005
6	Otherfood	0.2231	0.2117	0.9646	-0.5031	0.9971	1.0000	0.0018
7	Total Nonfood	0.2426	0.2220	1.0310	-0.5385	0.9941	1.0000	0.0063

Appendix Table 16: Budget shares, income & own-price elasticities and goodness of fit measures: NES, Urban Income Group II

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.2374	0.2496	0.8495	-0.6793	0.9567	1.0000	0.0056
2	Pulses & Products	0.0404	0.0404	0.9941	-0.6744	0.9890	1.0000	0.0003
3	Milk & Milk Products	0.0960	0.0898	1.1520	-0.9339	0.9943	1.0000	0.0005
4	Edible Oil & Fats	0.0558	0.0545	1.0410	-0.8318	0.9842	1.0000	0.0002
5	Meat, Fish & Eggs	0.0370	0.0369	1.0700	-0.9686	0.9966	1.0000	0.0000
6	Otherfood	0.2180	0.2191	0.9967	-0.8531	0.9980	1.0000	0.0004
7	Total Nonfood	0.3155	0.3097	1.0650	-0.9112	0.9907	1.0000	0.0036

Appendix Table 17: Budget shares, income & own-price elasticities and goodness of fit measures: NES, Urban Income Group III

S.No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.1072	0.1033	0.7542	-0.6514	0.7000	1.0000	0.0053
2	Pulses & Products	0.0250	0.0284	0.9602	-0.8172	0.7804	1.0000	0.0014
3	Milk & Milk Products	0.1001	0.1071	1.0590	-0.9777	0.8983	1.0000	0.0020
4	Edible Oil & Fats	0.0404	0.0426	0.9939	-0.9092	0.8209	1.0000	0.0015
5	Meat, Fish & Eggs	0.0323	0.0330	1.0180	-0.9799	0.9313	1.0000	0.0004
6	Otherfood	0.2110	0.2025	0.9917	-0.9329	0.9550	1.0000	0.0024
7	Total Nonfood	0.4840	0.4831	1.0440	-0.9826	0.9747	1.0000	0.0156

Appendix Table 18: Budget shares, income & own-price elasticities and goodness of fit measures: NES, All India, Combined

S. No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.3115	0.3122	0.9580	-0.6753	0.8460	1.0000	0.0115
2	Pulses & Products	0.0358	0.0358	1.0730	-0.5584	0.8747	1.0000	0.0011
3	Milk & Milk Products	0.0696	0.0695	1.1360	-0.7368	0.9122	1.0000	0.0032
4	Edible Oil & Fats	0.0436	0.0436	1.0760	-0.6742	0.8867	1.0000	0.0005
5	Meat, Fish & Eggs	0.0298	0.0298	1.0490	-0.7834	0.9324	1.0000	0.0004
6	Otherfood	0.2000	0.1999	0.9702	-0.6946	0.9646	1.0000	0.0021
7	Total Nonfood	0.3097	0.3091	1.0070	-0.7554	0.9718	1.0000	0.0102

Appendix Table 19: Budget shares, income & own-price elasticities and goodness of fit measures: LA-AIDS, Rural Income Group I

S. No.	Commodity Group	Observed Budget Share	Expected Budget Share	Income Elasticity	Own-price Elasticity	Sq Corr Coef between Obs/Exp Expenditures	R-bar Square	Information Inaccuracy
1	Cereals & Substitutes	0.4883	0.4836	0.8963	-0.3834	0.9955	1.0000	0.0082
2	Pulses & Products	0.0367	0.0391	1.0790	-0.9207	0.9876	1.0000	0.0011
3	Milk & Milk Products	0.0279	0.0316	1.1960	-0.3642	0.9293	1.0000	0.0025
4	Edible Oil & Fats	0.0394	0.0400	1.0900	-0.5565	0.9972	1.0000	0.0004
5	Meat, Fish & Eggs	0.0234	0.0241	0.9940	-0.8808	0.9583	1.0000	0.0004
6	Otherfood	0.1827	0.1840	0.8435	-1.2880	0.9966	1.0000	0.0012
7	Total Nonfood	0.2017	0.1976	1.3350	-1.2230	0.9949	1.0000	0.0165

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