ENGEL CURVE ESTIMATION FROM BUDGET DATA RELATING TO SHORT REFERENCE PERIODS

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Preface

The main motivation of the present dissertation is the estimation of engel elasticities of certain items of consumption after eliminating the possible effects of seasonal and other short-run fluctuations from household budget data. Indian budget data provided by the National Sample Survey Organization (NSSO), mainly relating to the 38th round (January – December, 1983), has been utilized for the study. Such data generally relate to a moving reference period of 'last 30 days' preceding the date of interview (also referred to as the *last month* reference period). The use of such a reference period introduces errors in observation in both the regressor and the regressand leading to biased estimates in the standard method of engel curve estimation. This problem has been largely ignored in the econometric literature.

Some literature relevant to this analysis is surveyed in Chapter 1. NSS data utilized in this analysis is described in Chapter 2. In Chapters 3 and 4, first, a number of frequently applied engel functions were fitted to the data to find out, on the basis of certain statistical criteria, which engel curve forms fit the data best. Then the effect of the length of the reference period, used for collection of data, on the estimated elasticities has been examined in detail utilizing NSS data collected for last month and last year reference periods. Last year based estimates are found to be appreciably different from last month based estimates. The results highlight the need for alternative methods of estimating engel elasticities from budget data relating to short reference periods like *last month.*

In Chapters 5 and 6 the problem is treated in an errors-in-variables (EIV) framework. However, the standard techniques of dealing with the EIV problem offer no easy solution in this case, especially because the errors in the regressor and the regressand are correlated. The possibilities of Instrumental Variable (IV) estimation and Method of Moments estimation have been tried out in Chapter 5 and Chapter 6, respectively. Section 6.6 of Chapter 6 concludes this dissertation with some remarks on the main findings and the shortcomings of this analysis.

I take this opportunity to express my humble gratitude to my supervisor Professor Nikhilesh Bhattacharya. I consider myself privileged to have had the opportunity of preparing my thesis under his guidance.

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Contents

Chapter 1

Survey of Literature

1.1 Introduction

The main motivation of this dissertation is to estimate the engel elasticities of some items of the household budget like clothing, footwear, durable goods, medical care and education, after eliminating the possible effects of seasonality and short-run fluctuations, from Indian budget data provided by the National Sample Survey Organization (NSSO), Govt. of India.

In this study a number of frequently applied engel functions are first fitted to the data. The elasticities are then estimated from the forms of engel functions which fit the data best.

Seasonal and short-run fluctuations are likely to affect data collected for short reference periods (like 'last 30 days', which is typically employed by the NSSO), particularly for items whose consumption is seasonal in nature or for durable and semi-durable items of the budget. Short reference periods may result in over-estimation of engel elasticities of these items.

However, employing a longer, say annual ('last 365 days') reference period may not always yield ideal results since the data may then suffer from the presence of recall biases and other related problems.

A good part of this dissertation examines the effect of reference period used for budget data collection. Detailed comparisons are made between engel elasticities based on 'last month' data and the same elasticities based on 'last year' data, which is available for items like clothing.

The last two chapters of this dissertation are devoted to finding alternative methods of engel elasticity estimation when a short reference period like last month is used for collection of household budget data. The problem is treated in an errors-in-variables framework and Instrumental Variables and Method of Moments estimation procedures have been tried out.

This survey of literature is organized as follows. Section 1.2 makes a brief survey on the various functional forms for engel curves found in the literature. This includes a discussion on some related issues in engel curve analysis like incorporation of demographic variables and the treatment of heteroscedasticity and zero expenditures in the data. Section 1.3 discusses the effect of the reference or recall period and the related problem of the presence of seasonal or transitory factors in the data. It actually presents some results from Indian empirical studies. Section 1.4 gives a brief introduction to the literature on Errors-in-Variables Models (EVM) and also on Instrumental Variables and Method of Moments estimation in such models.

1.2 Engel Curve Analysis

Demand analysis is concerned with the study of consumer responses to changes in the factors affecting the demand for commodities. According to the nature of data used demand analysis may be classified as cross-section analysis, time series analysis and analysis of panel data.

The analysis of cross-section budget data is perhaps the oldest. As early as 1857, Ernst Engel, on the basis of Belgian household budget data formulated his celebrated laws of consumer behaviour. Subsequently, any statistical analysis that examines the relationship between item expenditure and the corresponding income or total expenditure of households has been called Engel curve analysis.

If the demographic factors affecting preferences of different households are ignored and if prices are absorbed into the functional form, then demand functions of the form

$$y_i = g_i(x) \tag{1.2.1}$$

are obtained, where y_i is consumption of the i-th item and x, total income or expenditure of the household, which are the engel curves, the basic relations to be estimated from cross-section budget data. The estimation of parameters of a function of the form of (1.2.1) is based on the assumption that on an average differences in consumption patterns of rich and poor households can be solely attributed to their current income differences. Other differences in the consumption patterns of individual households are regarded as stochastic and describable by a selected probability distribution (*vide* Brown and Deaton, 1972). In such analyses, it is also reasonable to assume prices are constant since large price variations across sample households should normally be absent as the surveys are conducted within a relatively short period, say an year — also regional and seasonal price variations, although present, may not be large.

Different algebraic forms of engel curves have been discussed in the literature — these are briefly reviewed here. Some other issues related to engel curve analysis like incorporation of demographic effects, the problems of heteroscedasticity and zero expenditures are also discussed. A few empirical studies on the choice of curve form based on Indian data are also mentioned in this section.

1.2.1 Forms of Engel Functions

From the economic-theoretic point of view any algebraic form of the engel curve ought to be able to satisfy some empirically useful restrictions imposed on any demand function by the theory of consumer behaviour (Deaton and Muellbauer, 1980). The adding-up restriction (AUR), which is implied by a linear budget constraint, states that if the demand function is of the form

$$y_i = g_i(x, p) \tag{1.2.2}$$

with total expenditure x, prices p and item consumption (quantity) y, then a budget constraint of the form

$$x = \sum_k y_k p_k \tag{1.2.3}$$

immediately places a constraint on the functions g_i, which is of the form

$$\sum_k p_k g_k(x, p) = x \tag{1.2.4}$$

The AUR implies that for $i = 1, 2, \ldots, n$

$$\sum_k p_k \frac{\delta g_k}{\delta x} = 1 \ ; \ \sum_k p_k \frac{\delta g_k}{\delta p_i} + y_i = 0 \tag{1.2.5}$$

The two parts of (1.2.5) above give the Engel and Cournot aggregation conditions, respectively. Writing (1.2.5) in the budget share form yields the Engel and Cournot aggregation conditions as :

$$\sum_k w_k e_k = 1 \ ; \ \sum_k w_k e_{ki} + w_i = 0 \tag{1.2.6}$$

where $w_i = \frac{p_i y_i}{x}$ and e_i and e_{ij} $(i, j = 1, 2, \ldots, n)$ are the total expenditure and price elasticities of item i. Adding-up is an important restriction for engel curves since it places restrictions on the total expenditure elasticities.

Ideally, any functional form of an engel curve should be flexible enough to allow for realistic variation of the engel elasticity along the curve, *i.e*, it should be able to represent luxuries, necessities and inferior goods. Observation of an individual consumer's behaviour as one moves up the income scale shows that for most commodities there is a positive threshold income at which the commodity is introduced into the budget — thus at the threshold income the commodity concerned is a luxury which is just coming within the consumer's reach; with income rising expenditure on it first increases steeply — to accommodate this the engel elasticities of the already present commodities must decline — the income elasticity of this good is however affected in a similar manner by new entrants as income rises further. Thus the widespread evidence that engel elasticities for various items show a tendency to decline with rising income (Houthakker, 1953; Cramer, 1969; Brown and Deaton, 1972).

Also the existence of a saturation level of demand, whatever be the level of income is a consideration (Cramer, 1969; Brown and Deaton, 1972). The absolute saturation hypothesis (which is more realistic when demand is in physical terms) implies the existence of a finite level of demand which is never exceeded either as income rises or as prices fall indefinitely. The relative saturation hypothesis, which may be more appropriate if demand is expressed by expenditure, states that consumption tends to a saturation level as income rises at a given price; however, the saturation level itself is a function of prices. The relative saturation hypothesis is quite relevant where broad groups of commodities are concerned. Such consideration leads to a curve form which is necessarily sigmoid in shape, passing through the origin and representing luxuries in the lower income range and necessities in the upper income range.

While considering the appropriate form of the engel curve analysts have also been depending on certain statistical criteria of goodness of fit like the R^2 or the $\bar{R}^2$ to measure the smallness of residuals, and the DW statistic to measure the randomness of residuals, when different curve forms are fitted to available household budget data. Sargan (1964), Aneuryn-Evans and Deaton (1980) and Deaton (1986) discuss some of the problems of comparing different curve forms on the basis of the statistical criteria.

Among the classical works which explored the forms of engel curves are those of Allen and Bowley (1935), Wold and Jureen (1953) and Prais and Houthakker (1955).

Allen and Bowley (1935) considered linear engel curves:

$$y_i = \alpha_i + \beta_i x \qquad (1.2.7)$$

This form satisfies the AUR. However, as may be expected, linear engel curves are not found to fit actual data well, on the basis of statistical measures of goodness of fit.

Prais and Houthakker (1955) considered two simple properties as important in guiding the formulation of the engel curve for broad groups of commodities: (*a*) there is an initial income (threshold) below which a commodity is not purchased and (*b*) there is a satiety level. They held the view that while examining the algebraic form of the engel curve for a particular item, one should not restrict the choice of the functional form by imposing a single form, satisfying the AUR, on all items — they thus advocated the choice of different curve forms for different items of the budget. They considered five two-parameter forms of engel functions, including the constant elasticity or double-log form and the linear form which had been widely used in earlier applications. The forms considered were:

$$y = \alpha + \beta x \quad \text{(the linear form)} \tag{1.2.8}$$

$$\ln y = \alpha + \beta \ln x \quad \text{(the log linear or double logarithmic form)} \tag{1.2.9}$$

$$y = \alpha + \beta \ln x \quad \text{(the semi-logarithmic form)} \tag{1.2.10}$$

$$y = \alpha - \beta x^{-1} \quad \text{(the hyperbolic form)} \tag{1.2.11}$$

$$\ln y = \alpha - \beta x^{-1} \quad \text{(the log inverse or log reciprocal form)} \tag{1.2.12}$$

The choice among these alternative forms could be regarded as choosing from alternative hypotheses about the variation in income elasticity or the marginal propensity to consume along the engel curve. Thus, forms (1.2.9), (1.2.12) and (1.2.10) express the hypotheses, respectively, that income elasticity is constant, is inversely proportional to the level of income and inversely proportional to the level of item consumption. Again, forms (1.2.8), (1.2.10) and (1.2.11) are equivalent to the hypotheses that marginal propensity to consume is constant, varies inversely with income and varies inversely with the square of income, respectively.

The choice of curve form becomes important not only because each form expresses a different hypothesis about the variation in engel elasticity with change in the independent variable but also because the estimated elasticity may vary considerably across different forms fitted to the same data.

From their analysis, based on British family expenditure data, Prais and Houthakker found, generally, that over the range in which elasticity is greater than unity the double log form gives the best results. In the region where elasticity is around unity, the linear form is a good approximation since it implies that income elasticity for all goods tends to unity as income rises. In the first part of the range of necessities the semi log form gives a good fit, since although this form does not possess a saturation value, its elasticity decreases towards zero. The semi log form also always gives a positive initial income. For commodities where the demand approaches a saturation level, the log reciprocal form is found to be the best approximation — it has a sigmoid shape passing through the origin and having an upper asymptote. For the hyperbola, the initial income is given by β/α and the hyperbola also allows for a saturation level of consumption. For this curve elasticity diminishes steadily and equals unity at one point; to the left of this point the commodity is a luxury and to its right a necessity. On the whole, Prais and Houthakker conclude that the semi log gave the best results for food items and the double log for the non-food items. They used the correlation coefficient to judge the closeness of fit and to judge the linearity of fit they used the λ coefficient based on the number of runs of like sign in the sequence of regression residuals.

The forms considered by Prais and Houthakker are linear functions of the original variables or some transformations (logarithmic/ reciprocal) of them — the linearity of the forms in parameters ensures that the least squares method of estimation can be conveniently used. Other realistic specifications which have been suggested and lack this simplicity of estimation are the lognormal curves (Aitchison and Brown, 1954):

$$y = \kappa\Lambda(\alpha x^{\beta}) \tag{1.2.13}$$

where $\alpha = e^{-\mu/\sigma}$ and $\beta = 1/\sigma$, with parameters κ, μ and σ, and the general hyperbolic forms suggested by Tornqvist (1941) and used by Wold and Jureen (1953). The Tornqvist forms are given by

$$y = \alpha x^{\delta}\frac{x-\beta}{x-\gamma} \tag{1.2.14}$$

One must also mention the forms suggested by Champernowne (1969) which are

$$y = a - \frac{b}{x+c} \tag{1.2.15}$$

$$y = -a + bx + \sqrt{(a-bx)^2 + cx} \tag{1.2.16}$$

and a more general form given by

$$y = AF(Cx^{B}) \tag{1.2.17}$$

with parameters A, B and C, where $F(\cdot)$ is some given monotonic increasing function with a finite upper bound, like :

$$F(x) = \frac{1}{\pi}\tan^{-1}(\ln x) + \frac{1}{2} \tag{1.2.18}$$

$$F(x) = \frac{x}{1+x} \tag{1.2.19}$$

However, none of the above-mentioned forms except the linear one satisfies the AUR, making them theoretically less justifiable (*vide* Brown and Deaton, 1972; Phlips, 1974; Deaton, 1986).

Houthakker's (1960) indirect addilog engel curves based on the indirect utility function $\psi(x,p)$ and given by

$$\psi(x,p) = \sum_i \frac{\alpha_i}{\beta_i}(\frac{x}{p_i})^{\beta_i} \tag{1.2.20}$$

with $\beta_i > 0$, have formed the basis of much empirical work (see, Brown and Deaton, 1972, for discussions).

An engel function in which a budget share varies in arithmetic progression as income (or total expenditure) varies in geometric progression was proposed by Working (1943) as a statistical law of family expenditures while investigating the relationship between income and item expenditures of US households. The function is:

$$w_i = \alpha_i + \beta_i \ln x \tag{1.2.21}$$

w_i being the budget share of the i-th item ($i = 1, 2, \ldots, n$), with parameters α_i and β_i, which are generally functions of prices. This form satisfies the AUR provided $\sum \alpha_i = 1$ and $\sum \beta_i = 0$. This model allows for luxuries ($\beta_i > 0$) and necessities and inferior goods ($\beta_i < 0$). Leser (1963) while analyzing Irish household budget data for 1951-52, used a more flexible, three-parameter, generalization of this function:

$$w_i = \alpha_i + \beta_i \ln x + \gamma_i x^{-1} \tag{1.2.22}$$

These functional forms, known as the Working-Leser forms, have been found to describe the data well for a wide range of items or item groups, whether luxuries, necessities or inferior. Interestingly, the budget-share functions generated in some well-known demand systems are of the Working-Leser form (Deaton and Muellbauer, 1980b; Majumder,1984; Deaton, 1986). The integrability conditions (conditions necessary for demand functions to be consistent with utility maximization) have been discussed in Deaton and Muellbauer (1980b), Jorgenson, Lau and Stoker (1982) and Hoa (1983).

The theory of consumer behaviour usually formalizes the behaviour of an *individual* optimizing rational consumer. The applicability of this theory to empirical analysis of observed *aggregate* data or per capita data is not automatically guaranteed. It is only under appropriate theoretical restrictions that a set of micro demand functions would aggregate over consumers without giving rise to aggregation bias. A study of these restrictions is an important consideration in the functional form specifications for engel curves. Under *exact* aggregation the form of the micro demand functions should be such that these, when aggregated over consumers, would give an aggregate demand function relating aggregate demand to aggregate income or expenditure. Gorman (1953) examined the conditions for this — which turned out to be rather stringent — viz, the micro demand functions should all have linear engel curves with identical slopes. Muellbauer (1975) introduced the notion of consistent aggregation to generate a much wider class of demand functions that would aggregate without resulting in any aggregation bias. Here aggregate expenditure shares, interpreted as expenditure shares of a representative consumer, may depend on prices and a representative level of total expenditure (say, x^*, which itself can be a function of individual expenditures and prices). Muellbauer's definition of aggregation leads to a class of budget share functions of the form

$$w_i = a_i(p) + b_i(p)g(x,p) \quad i = 1,\ldots,n \tag{1.2.23}$$

with parameters $a_i(p)$ and $b_i(p)$ such that $\sum a_i(p) = 1$ and $\sum b_i(p) = 0$ in view of the AUR. This form known as Generalized Linearity implies that pairs of budget share functions must be linearly related. This gives as special cases — when the representative level of expenditure does not depend on prices — the PIGL and the PIGLOG demand systems with budget share equations of the form:

$$w_i = a_i(p) + b_i(p)x^\epsilon \quad \text{where } \epsilon \neq 0 \tag{1.2.24}$$

$$w_i = a_i(p) + b_i(p)\ln x \quad \text{if } \epsilon = 0 \tag{1.2.25}$$

Muellbauer's analysis assumes that individual consumers possess identical preferences. Jorgenson, Lau and Stoker (1982) discuss a theory of exact aggregation that can be made to incorporate the differences in individual attributes — they demonstrate the derivation of (1.2.21) from the translog indirect utility function. The theory of aggregation thus provides an economic-theoretic justification for the Working-Leser forms of engel functions.

Some very general results for engel curve specification were put forward by Gorman (1981) (see also Russell, 1983; Deaton, 1986; Lewbel, 1987). Gorman considers general polynomial engel curves with expenditures related to powers of income, and shows that if engel curves of the form

$$w_i = \sum_{r\in R} a_{ir}(p)\phi_r(\ln x) \tag{1.2.26}$$

where R is some finite set and $\phi_r()$ a series of functions, are to be consistent with theory then there must exist a cost function of the form

$$\frac{\delta \ln c(u,p)}{\delta \ln p_i} = \sum_{r \in R} a_{ir}(p)\phi_r[\ln c(u,p)] \tag{1.2.27}$$

and for these to have a solution the conditions are that (a) the rank of the matrix, formed from the coefficients $a_{ir}(p)$, linking each demand to each power of income, cannot be greater than 3 and (b) that the functions $\phi_r()$ must take specific restricted forms.

Gorman's results generate, as special cases, a number of important functional forms including the linear engel curves which correspond to the LES implemented by Stone (1954), the Working-Leser forms, and the log quadratic form given by

$$w_i = a_i(p) + b_i(p)\ln x + d_i(p)(\ln x)^2 \tag{1.2.28}$$

and also the general polynomial engel curves which include the QES of Pollack and Wales (1978) and Howe, Pollack and Wales (1979). However, because of the rank condition the quadratic specification is the most general polynomial possible.

Equation (1.2.24) in a Box-Cox form has been used by Hoa et al. (1983). It is given by

$$w_i = \alpha_i x^{\gamma-1} + \frac{\beta_i}{\gamma - 1}(x^{\gamma-1} - 1) \tag{1.2.29}$$

This has been called the generalized Working form of the engel curve. Here AUR is satisfied provided $\sum \alpha_i = 1$ and $\sum \beta_i = 1 - \gamma$. The income elasticities are given by

$$\eta_i = \beta_i / w_i + \gamma \tag{1.2.30}$$

Also $\sum w_i \eta_i = \sum \beta_i + \gamma \sum w_i = 1 - \gamma + \gamma = 1$. Hence this satisfies the Engel aggregation condition. As $\gamma \to 1$, (1.2.29) tends to (1.2.21) with $\eta_i = \beta_i / w_i + 1$. For $\gamma = 0$, (1.2.29) reduces to

$$y_i = (\alpha_i - \beta_i) + \beta_i x \tag{1.2.31}$$

i.e., the LES with $(\alpha_i - \beta_i) = 0$ and $\eta_i = \beta_i / w_i$, with α_i as the budget share at zero supernumerary income. For $\gamma = 2$, (1.2.29) reduces to

$$y_i = -\beta_i x + (\alpha_i + \beta_i) x^2 \tag{1.2.32}$$

i.e., the QES of Pollack and Wales (1978) with $\eta_i = \beta_i / w_i + 2$.

Finally, one must mention that non-parametric regression analysis is also being used for functional form specification for engel curves (see Silverman, 1986; Härdle, 1991; Härdle and Linton, 1994 and Deaton, 1997). Since they allow the data to determine the functional form without any prior restrictions, these methods like kernel regression are preferred. See, for example, Bierens and Pott-Buter (1990), who found that linear engel curves were very much supported by their non-parametric regression results. Nicol (1993) estimated engel functions for food and rent from Canadian FES data for the years 1978 and 1986, using the kernel regression method. The estimated engel curves were compared with some parametrically estimated engel functions, namely, the two-parameter Working-Leser form (1.2.21) and the log quadratic form (1.2.28). It was found that the non-parametrically estimated forms provided better fit. The most suitable parametric form differed across goods and so did the shape of the estimated non-parametric model. Engel elasticities were also estimated. When compared to the best fitting parametric model chosen on the basis of goodness of fit criteria, the estimates of elasticities from the two methods were fairly close. They concluded that although the non-parametrically estimated engel functions provide a better fit, the implications of this for estimated elasticities are qualitatively of minor importance.

1.2.2 Indian Studies

A number of empirical studies have been carried out with Indian NSS data in order to determine, on the basis of statistical criteria, which algebraic specifications of the engel curve fit such data best. Some of these are mentioned in this section (see Bhattacharya, 1978a, for detailed discussions).

Roy and Dhar (1960) compared the constant elasticity or DL form with Tornqvist forms, the latter turning out to be superior to the DL in many cases, judging by the residual sum of squares. However, the elasticity given by the DL was close to the elasticity at the mean of PCE given by the best fitting Tornqvist curve.

Sinha (1966) fitted six curve forms, the linear, semi log (SL), double log (DL), log inverse (LI), hyperbola and log log inverse (LLI) to extensive NSS data and judged the goodness of fit by comparing $\bar{R}^2$ and the DW statistic. No single form was found suitable for all the items, but, on the whole, the LLI was found to be the most satisfactory specification.

Bhattacharya and Maitra (1969) fitted four curve forms, namely, the hyperbola, SL, DL and LLI, to data on 14 to 15 item groups. Data from as many as 14 NSS rounds from the 7th (Oct.1953-Mar.1954) to the 22nd (Jul.1967-Jun.1968), excepting the 20th and the 21st, were covered in their analysis. They compared the goodness of fit on the basis of the R^2 and the DW statistic, together with other tests based on the sequences of signs of the least squares residuals. Here also, the LLI appeared to be the best form of engel function particularly on the basis of randomness of the regression residuals. The SL and DL forms were sometimes nearly as good.

The superiority of the LLI form was also established by Maitra (1969) who fitted the hyperbola, SL, DL and LLI forms to state level NSS data on foodgrains consumption in rural areas.

Gupta (1970) tried eight forms to regionwise data on foodgrains and clothing consumption for both rural and urban India from NSS rounds 11 and 12 and chose, among the two-parameter forms, the DL and the LI for his analysis.

Jain and Tendulkar (1972) compared six two-parameter forms on the basis of $\bar{R}^2$ for the engel curves fitted to NSS 19th round data for both rural and urban India. The SL appeared as the best for many items with elasticity less than 1 and the DL for items with elasticity above 1. The linear form also appeared to be best in a number of cases in their analysis.

Iyengar and Rao (1968) emphasized the advantages of Houthakker's (1960) indirect addilog engel curves and presented formulae for projecting demand from such curves (see also Iyengar and Jain, 1969). Jain (1972) showed that the indirect addilog form gives a better fit to Indian data, compared to any of the other two-parameter forms, when all items of the budget are considered together.

1.2.3 Incorporation of Demographic Variables

Socio-demographic variables play an important role in determining a household's demand for a particular commodity. Some of these variables are household size, age-sex composition, geographical region, educational level of members, especially the earners, their occupation etc. In this section the incorporation of the demographic variables, namely, household size and composition into engel curve analysis is discussed.

If the vector of a household's demographic characteristics is taken to be a, then for household h, with prices p, the demand for the i-th item ${y_i}^h$ may be expressed as:

$$ {y_i}^h = y_i(x^h, p, a^h) \qquad (1.2.33) $$

A functional form of (1.2.33) is usually estimated, say,

$$ \ln {y_i}^h = \alpha_i + \beta_i \ln x^h + \gamma_i \ln n^h \qquad (1.2.34) $$

where n^h is the number of members in the h-th household. Tests are then carried out for household size effects i.e., to find out whether $(\gamma_i + \beta_i - 1)$ is negative ($\Longrightarrow$ economies of scale exist), is zero ($\Longrightarrow$ constant returns) or is positive ($\Longrightarrow$ diseconomies of scale exist), (see Cramer, 1969; Deaton, 1986, for discussions). Such examination was carried out by Iyengar, Jain and Srinivasan (1968) from NSS 17th round data – and they found economies of scale for cereals and for fuel and light and, roughly, constant returns to scale for milk and milk products and for clothing.

One of the most frequently used ways of incorporating household size into engel curve analysis is the *per capita* formulation of the engel curve where one deflates both item expenditure and total expenditure by household size such that in per capita terms consumption pattern depends on total consumption expenditure (per capita).

Prais and Houthakker (1955) pointed out that the above formulation assumes that there are no economies or diseconomies of scale in household consumption. For many non-food items like fuel and light and rent, there seem to be substantial economies of scale but for food the economies are quite small (see also Crockett, 1960; Houthakker, 1957). Chaudhuri (1970) used budget data from NSS 18th round and considering items like cereals and cereal substitutes, milk products, meat, fish and egg, and fuel and light showed that the usual approach ignoring economies or diseconomies of scale gave biased estimates of elasticities.

Prais and Houthakker (1955) considered a more general form

$$y/n^{\theta_y} = f(x/n^{\theta_x}) \qquad (1.2.35)$$

where θ_x, $\theta_y \neq 1$ necessarily. Here $1 - \theta_y$ represents specific economies in the consumption of the particular item and $1 - \theta_x$, the overall economy. They obtained an estimate of 0.87 for θ_x for British data. (See also Coondoo, 1970; Bhattacharya, 1978a.)

The above formulations ignore the variation in needs with age, sex etc. Such formulations are therefore not readily acceptable from the point of view of welfare comparisons (*vide* Deaton, 1997). One obvious solution is therefore a system of weights whereby children (also women) count as a fraction of an adult (male) (the fraction depending on age), so that effective household size is the sum of these fractions — this being the concept of adult equivalents. Equivalence scales are index numbers through which welfare or real income is compared across households with different sizes and compositions. Household equivalence scales are thus improved deflators, compared to the head count, by which budgets of different households are converted to a needs corrected basis. There are many such scales like the Amsterdam scale used by Stone (1954). These scales are usually based on the nutritional/physiological requirements suggested by experts; however, they may also be derived from (optimizing) market behaviour.

A generalized formulation for such models has been given in Deaton and Muellbauer (1980a, 1986) and Deaton (1986, 1997) in terms of utility theory. If it is supposed that the cost function of a household h depends on its demographic characteristics a^h, then for a utility maximizing household total expenditure x^h is the minimum cost of reaching its utility level u^h, i.e.,

$$C^h(u^h, p, a^h) = m(a^h, u^h)C(u^h, p) \tag{1.2.36}$$

where $C^h(u^h, p)$ is the cost function for some reference household type (for which $m(a, u)$ is taken to be unity). From (1.2.36)

$$w_i{}^h = \frac{\delta \ln C^h(u^h, p)}{\delta \ln p_i} \tag{1.2.37}$$

which is independent of a^h. Hence, if two households face the same prices, then those with the same consumption pattern w_i have the same welfare level u^h, so that by comparing their outlays the ratio of their costs are obtained — this is the equivalence scale $m(a^h, u^h)$.

The pioneering work in determining equivalence scales from budget studies dates back to Engel (1895). The method rests on Engel's observations that the share of food in the budget declines as income or total outlay increases and that holding resources constant, the food share increases with the number of children and on Engel's identifying assumption that the food share correctly indicates the comparative welfare of households of different demographic compositions. Thus two households with the same food share must have the same level of real income irrespective of their demographic characteristics. Hence comparison of their money incomes at the same food share will yield an index of cost of maintaining the larger family relative to the smaller (reference) household — and this is the equivalence scale in Engel's method. In practice, the scale is calculated by estimating a food share engel curve. For example, Deaton and Muellbauer (1986) use an extension of the Working-Leser form of engel curve to incorporate demographic effects, namely,

$$w_f = \alpha + \beta \ln(x/n) + \sum_{j=1}^{J} \gamma_j n_j + \epsilon \tag{1.2.38}$$

where w_f is the budget share for food, n_j is the number of persons in category j $(j = 1, \ldots, J)$ and n is the total number of members in the household. They find that for many Third World surveys the per capita term $\ln(x/n)$ provides a high degree of explained variation, and by comparison the γ parameters are rather small.

A similar type of equivalence scale is due to Rothbart (1943) who used expenditure on adult goods as an indicator of welfare, instead of food share (see also Nicholson, 1949). Nicholson (1976) argues that Engel's identifying assumption that food share identifies welfare is not readily supported and Engel's child equivalence scales are overestimated (see Deaton, 1997).

A single equivalence scale for all items of the budget implies that needs of children and the economies of scale in consumption are the same for every commodity. However, this is not readily acceptable. A generalization to commodity specific scales was first suggested by Sydenstricker and King (1921) and independently rediscovered by Prais and Houthakker (1955). Here the household demand function is of the form

$$\frac{p_i y_i}{m_i} = f_i(\frac{x}{m_o}) \tag{1.2.39}$$

where m_i and m_o are commodity specific and general scales, respectively, that are functions of household composition. Thus, a household with children is expected to have large commodity specific scales for children's food, clothing, education etc. Since the budget constraint must hold, the general scale may be defined as

$$\sum m_i f_i(\frac{x}{m_o}) = x \tag{1.2.40}$$

Another formulation of commodity specific scales, which was in fact the first to use the utility theoretic approach, is due to Bartèn (1964). Here the direct utility function is given by

$$u = v(y_1/m_1, \ldots, y_n/m_n) \tag{1.2.41}$$

where the m_i's are the same commodity specific scales as in the Prais and Houthakker model. If the scaled quantities are defined as $y_i^* = y_i/m_i$ and the scaled prices as $p_i^* = p_i m_i$, then the consumer maximizes $v(y^*)$ subject to $p^* y^* = x$, so that the demand functions are

$$\frac{y_i}{m_i} = g_i(x, m_1 p_1, \ldots, m_n p_n) \tag{1.2.42}$$

This model incorporates the important fact that changes in household composition act to modify also the relative prices of goods and hence cause substitution away from the child goods (which become relatively more expensive) with additional children. This model, however, seems to suffer from excessive substitution effects. A modification was suggested by Gorman (1976), where a fixed cost which varies with household characteristics is added to the Barten (1964) formulation, giving the cost function as

$$C(u, p, a) = \sum \gamma_i(a) p_i + \hat{C}(u, p^*) \tag{1.2.43}$$

where $p_i^* = p_i m_i(a)$.

These procedures for incorporating demographic variables into the demand systems are empirically compared in Pollack and Wales (1979) (see also Pollack and Wales, 1981).

In empirical estimation from budget data using only a single cross-section it is found that for both the Prais and Houthakker model and the Barten model equivalence scales for each commodity are identified only relatively to each other and not in absolute terms (see Forsyth, 1960; Cramer, 1969; Coondoo, 1975a; Deaton, 1986, 1997). Empirical analyses of equivalence scales are carried out in Deaton, Ruiz-Castillo and Thomas (1989) and Nicol (1994), who also discuss the inherent difficulties in estimation.

1.2.4 Heteroscedasticity

While estimating an engel curve from household budget data one of the problems to be tackled is that of heteroscedasticity. One of the assumptions of classical least-squares regression is that conditional upon the independent variables the regression disturbances are identically distributed. The assumption of homoscedastic disturbances given by

$$\mathrm{V}(u) = \sigma^2 I_n \tag{1.2.44}$$

where I_n is an identity matrix of order $n \times n$, n being the number of individual observations, is often violated in reality. For example, in engel curve analysis, if y is item expenditure and x refers to income/total expenditure, then the variation about the engel curve is likely to increase with the size of x, and in that case

$$\begin{aligned} \mathrm{V}(u_i) &= diag(\sigma_1{}^2, \ldots, \sigma_n{}^2) = \Omega \\ \text{or } \mathrm{V}(u_i) &= \sigma_i{}^2 \quad (i = 1, 2, \ldots, n) \end{aligned} \tag{1.2.45}$$

which is the standard case of heteroscedasticity. In this case if the variances are known up to a multiplicative constant, e.g., if

$$\begin{aligned} y_i &= \alpha + \beta x_i + u_i \\ \text{with } \mathrm{V}(u_i) &= \sigma^2 \lambda_i \end{aligned} \tag{1.2.46}$$

where the λ_i's are known, then the standard solution is to modify the OLS procedure, by reweighting the observations, that is, by attaching multiplicative weights that are inversely proportional to $\sqrt{\lambda_i}$ to the i-th observation. This is equivalent to a transformation of the observations which gives

$$\frac{y_i}{\sqrt{\lambda_i}} = \alpha\frac{1}{\sqrt{\lambda_i}} + \beta\frac{x_i}{\sqrt{\lambda_i}} + v_i \tag{1.2.47}$$

where $v_i = u_i/\sqrt{\lambda_i}$ has a constant variance σ^2. Such a situation arises if one only has grouped data for a number of (say, m) classes and group means are used for the regressions, i.e.,

$$\begin{aligned} \bar{y}_i &= \alpha + \beta\bar{x}_i + \bar{u}_i \\ \text{and } \mathrm{V}(\bar{u}_i) &= \frac{\sigma^2}{n_i}, \quad i = 1, \ldots, m \end{aligned} \tag{1.2.48}$$

In this case also the WLS method can easily be used by estimating

$$\begin{aligned} \sqrt{n_i}\bar{y}_i &= \alpha\sqrt{n_i} + \beta\sqrt{n_i}\bar{x}_i + v_i \\ \text{with } v_i &= \sqrt{n_i}\bar{u}_i \end{aligned} \tag{1.2.49}$$

Cramer (1964) (and also Haitovsky, 1973) studied the efficiency of least-squares estimators from grouped and ungrouped data. The estimator from grouped data is always found to be less efficient than the estimator from ungrouped data. The loss of efficiency can however be minimized by minimizing within-group variation and maximizing the between-group variation. Thus the usual practice of grouping households into income classes minimizes the loss in efficiency.

Deaton (1997) explains that even if, at the individual level, household i $(i = 1, \ldots, n)$ has the homoscedastic regression function

$$\begin{aligned} \mathrm{E}(y_i \mid x_i, \beta_i) &= \beta' x_i \\ \text{with } \mathrm{V}(y_i \mid x_i, \beta_i) &= \sigma^2 \end{aligned} \tag{1.2.50}$$

but with different coefficients β_i and if these β_i's are treated as randomly distributed across households with mean β and variance-covariance matrix Ω, then (1.2.50) *generates the heteroscedastic regression model*

$$\begin{aligned} \mathrm{E}(y_i \mid x_i) &= \beta' x_i \\ \text{with } \mathrm{V}(y_i \mid x_i) &= \sigma^2 + x_i'\Omega x_i \end{aligned} \tag{1.2.51}$$

As is well-known, if heteroscedasticity exists, the GLS estimator is the minimum variance unbiased estimator of β. In the presence of heteroscedasticity, the OLS estimator though unbiased is inefficient; however, more importantly, the estimated covariance matrix of the parameters is inconsistent, rendering the usual formulas for standard errors incorrect. Such considerations have motivated the standard test procedures for heteroscedasticity. The Breusch-Pagan (1979) test is easy to implement since it is based on the OLS regression residuals.

White (1980) presents a parameter covariance matrix estimator which is consistent even when the disturbances of a linear regression model are heteroscedastic:

$$\begin{aligned} \tilde{\mathrm{V}}(\hat{\beta}) &= (X'X)^{-1}\hat{\mathrm{V}}(X'X)^{-1} \\ \text{where } \hat{\mathrm{V}} &= \sum e_i^2 x_i x_i' \\ \text{with } e_i &= y_i - x_i\hat{\beta}_{\mathrm{OLS}} \end{aligned} \tag{1.2.52}$$

Comparing the elements of $\sigma^2(X'X)^{-1}$ and $\hat{\mathrm{V}}$ yields a direct test for heteroscedasticity since in the absence of heteroscedasticity the two estimates will be approximately equal, but will generally diverge otherwise. White's estimator does not necessitate the specification of the structure of heteroscedasticity; this makes the test widely applicable. If efficiency is not the prime concern then OLS may be applied, even in the presence of heteroscedasticity, since White's covariance matrix estimator allows correct inferences to be drawn. White (1982) extends this analysis for the case of Instrumental Variable estimation.

1.2.5 The Treatment of Zero Expenditures in Survey Data

In household budget survey data values of item expenditure (y_i) may often be encountered which are zero or very nearly zero.

Prais and Houthakker (1955) discussed this problem of occurrence of zero expenditures in the context of logarithmic transformation of variables while estimating a constant elasticity engel curve.

A zero expenditure on a particular commodity by a particular household may result from any of the following three broad reasons : First, a household may not at all purchase a certain commodity and would thus always report a zero expenditure on it. Second, there might be an error of observation or misreporting, i.e., the expenditure has not been recorded (either willfully or by mistake) by either the respondent or the enumerator. Third, zero expenditures might arise due to infrequent purchasing of certain (particularly non-food items); thus it might so happen that the length of the reference or reporting period is short and hence in that limited period no expenditure on the item under study may have been incurred.

Prais and Houthakker (1955) ignored the zeros resulting from the first cause, on the argument that the households which never buy a particular item can in any case be treated separately.

If zeros are regarded as an error of observation, Prais and Houthakker suggest that the zero be replaced by some small positive quantity as if the zero has occurred through rounding-off an item whose true value was less than half the least significant recorded figure. The average value of such items would then be a quarter of an unit, any value between zero and half being equally likely; thus the zeros on the regression may be replaced by a quarter. Further, in order to keep the average value of the variable unchanged, items recorded as a unit may be reduced by an appropriate amount. However, they point out that this method is not very satisfactory since it leads to biased estimates.

An alternative procedure suggested by Prais and Houthakker takes into account the last reason for occurrence of zeros, i.e., infrequency of purchase. As the reference period is lengthened the number of zero item expenditures diminishes; thus they suggest a method based on averaging zero expenditures with the expenditures of households in similar circumstances. They averaged item expenditure values for households having the same total expenditure and household size and treated these as the fundamental variables. If in spite of this grouping, a few zeros were still left the observations were ignored, though this might lead to a slightly upward bias in the general height of the curve.

Many different formulations have been tried out in the recent literature for modeling zero item expenditures. A few of these are described below. Some of the models are equivalent to the Tobit specification (Tobin, 1958), which is essentially a linear regression model in which non-positive observations on the dependent variable are replaced by zero. It is given by

$$\begin{aligned} y_i^* &= x_i'\beta + u_i \\ y_i &= y_i^* \quad \text{if } y_i^* \geq 0 \\ &= 0 \quad \text{otherwise} \end{aligned} \tag{1.2.53}$$

Deaton (1986) outlines some of the problems of this sort of modeling. Zero expenditures in more than one commodity at a time can not be taken into account by the Tobit model. Again, for zeros resulting from infrequent purchases the Tobit specification may not be the correct one. Deaton and Irish (1984) consider a model where the standard Tobit specification is supplemented by the operation of a binary censor. A second censoring process is added that randomly replaces observations, generated by the Tobit model, by zeros:

$$
\begin{aligned}
y_i^* &= x_i'\beta + u_i \qquad (1.2.54)\\
y_i &= y_i^*/p_i \quad \text{with probability } p_i\\
&= 0 \quad \text{with probability } (1-p_i)
\end{aligned}
$$

With constant p this is termed the p-Tobit model. In this model an observed zero can occur either because the household genuinely does not purchase the good or because of various types of misreporting and purchase infrequency. Since the normality assumption for the Tobit and the p-Tobit models is unlikely to be supported by the data, non-parametric estimation is also carried out. However, their empirical exercises based on British FES data were not very successful in distinguishing between genuine non-consumption and misreporting or purchase infrequency.

The model (1.2.54) in another form is the double-hurdle model proposed by Cragg (1971). This may be written as

$$
\begin{aligned}
y_i^* &= x_i'\beta + u_i\\
\text{and } t_i &= s_i'\alpha + v_i \qquad (1.2.55)\\
\text{with } (u,v) &\sim N(0,\Sigma)
\end{aligned}
$$

where y_i^* is notional demand, t_i is a non-observable indicator which determines whether the household i is a consumer or not, x_i' and s_i' are vectors of conditioning factors, i.e., economic and socio-demographic characteristics of household i, with $y_i = y_i^*$ if both $y_i^* > 0$ and $t_i > 0$ and $y_i = 0$, otherwise, and Σ a diagonal matrix. Such models are characterized by abstentions, i.e., if the household is a genuine non-consumer any value of the independent variable will be irrelevant and second, by corner solutions, i.e., for certain levels of the relevant variables the household may not consume the item. See, for example, Garcia and Labega (1996) for an analysis of tobacco consumption from Spanish data.

Keen (1986) (see also Kay, Keen and Morris, 1984) has considered the case where zeros occur essentially due to purchase infrequency. Treating it as a measurement error problem where the underlying income (consumption) variable is unobservable but expenditure is observable, Keen derives a consistent estimator for the case of linear engel curves using IV techniques. This is also a special case of the double-hurdle or p-Tobit models mentioned above.

Wales and Woodland (1983) attempted to model more than one commodity at a time. They estimated a three-commodity system maximizing a direct utility function subject to the budget and non-negativity constraints. The Lee and Pitt (1986) approach is a dual of the Wales and Woodland approach and uses indirect utility and cost functions like the translog. However, these procedures are complicated and Deaton (1986) notes that in the literature there is not yet any theoretically satisfactory and empirically implementable method for modeling zeros for more than a few commodities at once.

1.3 Effect of the Reference Period

1.3.1 The Choice of the Reference Period

The main motivation of the present study is to estimate the engel elasticities for clothing and some other items of consumption after eliminating the possible effects of seasonality and other short-run fluctuations from NSS budget data. As already mentioned the problem relates to the length of the reference period (or reporting period or recall period) which is the period for which information on consumption expenditure is collected from each household.

Accounting periods shorter than one year are discussed in the literature on poverty and economic inequality, and it is recognized that income or consumption for short periods are unreliable indices of economic status (Atkinson, 1975, Chapter 3). The degree of inequality is exaggerated if such accounting periods are used. Even one year may be rather short for measurement of inequality, because individual households are influenced by economic cycles and life cycle factors.

The optimal length of the reference or recall period is a much discussed topic. It has greater importance for sample surveys in developing countries since, most of the respondents would be unable to maintain proper records of their household expenditures and would have to report all information from memory.

Two types of recall errors, which depend on the length of the reference period, may affect the data. The first is omission whereby the respondent fails to recall certain information when the length of the reference period is long. The second type of recall error is termed event displacement — here some events are thought by the respondent to have occurred either earlier than they actually did or later (referred to as telescoping). Thus certain expenditures are reported which are displaced into the reference period and some are unreported due to being displaced out of the reference period (also known as end effects). While a shorter reference period may result in fewer omissions and more accurate reporting, it may at the same time be subject to relatively more serious end effects and in addition there is a larger sampling variability of the results when a shorter reference period is used (United Nations, 1982; Zarkovich, 1966).

In the Indian context, in the first round of the National Sample Survey, a fixed reference period of one year was used for collecting data on several items. However, this reference period was found to be unsatisfactory for recording expenditures on food items, so experiments were done to evaluate the performance of one week and one month as reference period for these items through comparison with results of direct observation (weighment). This experiment showed that for food items, to the extent that results from the weighings were accurate, the interview data based on one month reference period gave the most accurate results. The week reference period led to overestimation of expenditure on food consumption (*vide* Mahalanobis and Sen, 1954; see also Chatterjee and Bhattacharya, 1975; Zarkovich, 1966; United Nations, 1982 and Casley and Lury, 1981). Again another experiment by Ghosh (1953) showed that if the direct measurement was accurate then a reference period of one year for the interview would be the most appropriate for several food items.

Deaton (1997) points out that if the aim of the survey is to estimate, say, average consumption over an year then either an annual reference period can be used for all households, or a very short reference period like a day may be used and the interviews spread evenly over the year. The first method would yield the true picture of each household's consumption but would be likely to suffer from problems like recall lapses. The second method would yield data that are more or less accurate, on the average, but the data for any single household would in no way depict the true consumption pattern of that household. Short recall periods are also not found to be immune to recall lapses and may suffer from boundary or start-up biases whereby respondents include expenditures incurred just before the reference period, in an attempt to be helpful. Scott and Amenuvegbe (1990) have cited a number of studies showing that the reported rates of consumption diminish with the length of the recall period. They also report from their own studies from Ghanaian Living Standards Survey which shows that for 13 frequently purchased items, reported expenditures fell at an average rate of 29% for every day added to the recall period. They however found no evidence of the start-up bias.

However, very short reference periods like one day are rarely used unless repeated visits are made. Usually frequently purchased items like food have a recall period of a week or a month, whereas durables etc can be asked on an annual basis. Surveys typically run for a calendar year with interviews evenly spread over the survey period would suffer from a variability across households which is essentially seasonal and would not occur in genuine annual data. In such cases, Deaton notes, seasonal patterns may be estimated from the results and corrections made. Deaton also suggests repeat visits on a seasonal basis so that a short recall period can still be used. Considering random nonseasonal variation across households Scott (1992) gives an example where standard deviation of annual expenditures is overestimated by 36 per cent from a survey that collects consumption data on a monthly basis.

Casley and Lury (1981), while discussing the length of the reference period, point out that a longer reference period like a year may lead to a response produced by assuming a monthly average and multiplying by 12.

1.3.2 Empirical Evidence from Indian Data

For its enquiries on household consumer expenditure, the NSS generally employs a moving reference period of 'last 30 days' preceding the date of interview (also known as the 'last month' reference period) and staggers the interviews evenly over the survey period, usually one year. Different households thus furnish information for different periods of 30 days and it is likely that this introduces seasonality and other short-run factors into the data for any particular household. While the average consumption over sample households should give a fair approximation to annual levels of consumption, seasonal and other short-run fluctuations get superimposed on the true variation across households exaggerating the inequality in the size distribution of population by PCE (per capita total consumer expenditure), the widely used measure of level of living. Also, engel curves (strictly, expenditure-consumption curves) may get distorted, especially for items like clothing which are considerably affected by seasonality and other transitory factors.

Some recent evidence has been cited in Appendix B of the present dissertation to show the effect of the reference period on average PCE and measures like Lorenz curves and Lorenz ratios.

Regarding possible distortions of the bivariate relationship, Bhattacharya (1967, 1978a) drew attention to this problem citing two pieces of evidence from Indian empirical research on estimation of engel elasticities. The first evidence was from the work of Biswas and Bose (1962). Bhattacharya (1967) noticed that there was a sudden jump in the engel elasticities for clothing presented by Biswas and Bose from NSS 7th round onwards as compared to NSS 4th and 5th rounds. Biswas and Bose (1962) had fitted the constant elasticity engel curve to NSS data based on the last month reference period and obtained the following elasticities for clothing:

round				elasticity	
				rural	urban
4	Apr.	-	Sep. '52	0.87	1.02
5	Dec. '52	-	Mar. '53	0.92	0.98
7	Nov. '53	-	Mar. '54	1.66	1.72
9	May	-	Nov. '55	1.56	1.63
10	Dec. '55	-	May '56	1.66	1.63

Biswas and Bose noticed the large variation in clothing elasticity across rounds but had no idea about the cause of such variation, thinking that the last month reference period had been used uniformly for all these rounds. Actually, in rounds 4 and 5, NSS had employed the 'last month' reference period for food and many other item groups, but the 'last year' reference period (i.e.,the last 365 days preceding the date of interview) for clothing, footwear and durables. For these two rounds, the elasticities for clothing were around 1. But from the 7th round onwards the 'last month' reference period was used for all items of the budget and the elasticities jumped to higher values above 1.5.

Secondly, Bhattacharya (1978a) also pointed out that the 1st Indian Agricultural Labour Enquiry (Ministry of Labour, Govt. of India, 1954) using an annual reference period (where, in fact, for each sample household data were collected through 12 monthly visits) had shown that the proportion of income spent on food and other item groups did not change appreciably with rising income, implying that the engel elasticities for food etc. were fairly close to 1. However, the 2nd ALE (1956-57) and later Rural Labour Enquiries conducted by NSS using the 'last month' reference period showed marked shifts in engel ratios with rising PCE implying that the engel elasticities for food etc. were relatively far from 1 compared to the findings from the 1st ALE.

Another evidence is found in a recent study undertaken by the NCAER (1986, 1987) with a view to analyzing changes in the extent of poverty and the pattern of household consumption, based on two sample surveys covering rural India, one conducted in 1970–71 and a resurvey conducted in 1981–82. This study which used a fixed annual reference period gave, among other things, elasticities of clothing which were once again very close to 1. Their estimates of elasticities from the constant elasticity form were as follows:

year	elasticity
1970 - 71	0.92
1981 - 82	1.04

Majumder (1992) who developed a quadratic demand system (the QVariant) used published NSS data for the 38th round (Jan.-Dec.1983) (relating to the last month reference period) to judge the empirical performance of this system and some other demand systems, namely, the AIDS (Deaton and Muellbauer,1980b), QAIDS (Deaton, 1984) and Variant systems (Coondoo and Majumder, 1987). For the sake of interest her estimates of engel elasticities for clothing, for rural and urban India are presented below:

QVariant		*QAIDS*		*Variants*		*AIDS*	
R	U	R	U	R	U	R	U
1.96	1.71	2.23	1.70	1.80	1.69	1.86	1.73

1.4 Errors-in-Variables Models and their Estimation

1.4.1 Introduction

In the present dissertation, in Chapters 5 and 6, Instrumental Variable (IV) estimation and Method of Moments estimation have been applied to a bivariate errors-in-variables model (EVM), in the context of engel curve analysis based on disaggregated NSS household budget data. NSS data, as explained earlier, is collected from sample households through interviews spread uniformly over the survey period, usually, one year, where any sample household furnishes information on consumption expenditure for a reference period of 'last 30 days' (or 'last month') preceding the date of interview. As a result, seasonal and other short-run fluctuations are superimposed on the true between household variation of both total consumer expenditure and item expenditure. However, conceptually, in engel curve analysis, interest lies in estimating the relationship between the permanent or stable components of these expenditures (*vide* Friedman, 1957). But the observed values contain the permanent components, which may be taken as the true values, as well as the transitory components, which may be taken as the errors-in-variables (EIV's). The EIV's exist not only because there are seasonal and other short-run fluctuations but also because of non-sampling errors which creep into the data. These errors are by no means negligible (*vide* De Janosi, 1961; Adams and De Janosi, 1966; Morgenstern, 1963; Cochran, 1968; Langaskens and Rijckghem, 1967, 1974; Mukherjee, 1969; Murray, 1972; Hunter, 1980; Pierce, 1981; Pal, 1981; Minhas, 1988, and a bibliography for response errors given in Dalenius, 1977a-c).

Friedman (1957) brought out the distortions that transitory components of income and consumption may produce in empirical estimates of the consumption function. As is well-known, Friedman treated these transitory components as EIV's in a standard two-variable linear regression model (Malinvaud, 1972, Chapter 4; Johnston, 1963, pp. 148-149; see also Attfield, 1980, who used 1952 Oxford Saving Survey data to test the assumptions of the Permanent Income Hypothesis, in an EIV framework).

That engel relations estimated from household budget data may yield underestimates of elasticities because of errors of measurement in the determining variable was noted by Prais and Houthakker (1955, pp. 62-63) and the problem was later dealt with by Liviatan (1961), Cramer (1969) and also Deaton (1997). All these authors examined the matter in the light of various EVM's.

1.4.2 The Errors-in-Variables Model

The standard EVM is given by

$$y = X\beta + v \tag{1.4.1}$$

where X is the $n \times k$ matrix of the true (but unobserved) values of the explanatory variables; y is the $n \times 1$ vector of observations on the dependent variable; β is the $k \times 1$ vector of coefficients of the true model and v is the $n \times 1$ vector of disturbances which may include a component representing measurement error in the dependent variable (Johnston, 1984, Ch.10; Fuller, 1987).

The matrix of observed values x is given by

$$x = X + u \tag{1.4.2}$$

where u is the $n \times k$ matrix of measurement errors. Thus,

$$y = x\beta + (v - u\beta) \tag{1.4.3}$$

and the OLS estimate of β is given by

$$\hat{\beta}_{\mathrm{OLS}} = (x'x)^{-1}x'y = \beta + (x'x)^{-1}x'(v - u\beta) \tag{1.4.4}$$

The standard assumptions about the error terms are:

$$\begin{aligned}
(1)\ \mathrm{plim}(\frac{1}{n}X'u) &= 0 && (1.4.5)\\
\text{and so } \mathrm{plim}(\frac{1}{n}x'x) &= \mathrm{plim}(\frac{1}{n}X'X) + \mathrm{plim}(\frac{1}{n}u'u) \\
&= \Sigma + \Omega \quad \text{(say)} && (1.4.6)\\
(2)\ \mathrm{plim}(\frac{1}{n}u'v) &= 0 \quad \text{and } \mathrm{plim}(\frac{1}{n}X'v) = 0 && (1.4.7)
\end{aligned}$$

Thus

$$\mathrm{plim}\ \hat{\beta}_{\mathrm{OLS}} = \beta - (\Sigma + \Omega)^{-1}\Omega\beta \tag{1.4.8}$$

(1.4.8) above shows that the correlation between the observed x matrix and the composite disturbance term $(v - u\beta)$ leads to inconsistency of the OLS estimator. For example, in an EVM with a single explanatory variable

$$\mathrm{plim}\ \hat{\beta}_{\mathrm{OLS}} = \beta - \beta(\sigma_X^2 + \sigma_u^2)^{-1}\sigma_X^2 \tag{1.4.9}$$

Thus, for the bivariate model with independent measurement errors in x, the regression coefficient is biased towards zero.

The classical EVM is not identifiable (see Reiersol,1950; Madansky, 1959; Fisher, 1966; Maravall and Aigner, 1977; Anderson and Cheng, 1980; Pal, 1981; Fuller,1987, for discussions). Consistent estimation is possible if one of the following conditions is satisfied:

i) some additional *apriori* information is available, like knowledge about the two error variances or their ratio;[1]

ii) instrumental variables with appropriate properties are available for use;

iii) it is assumed that X, the true value of the regressor x, is stochastic and is non-normal or at least the third order cumulant of X is non-zero.

The problem of estimation is further aggravated if the errors in the determining and dependent variables are correlated. This is often a real problem. Deaton (1997, pp. 99-100) (see also Prais and Houthakker, 1955, pp. 62-63) presents the following results for the general case where the correctly measured variables satisfy (1.4.1) — the OLS parameter estimates have the probability limit given by

$$\text{plim}\, \hat{\beta}_{\text{OLS}} = (M+\Omega)^{-1}M\beta + (M+\Omega)^{-1}\gamma \qquad (1.4.10)$$

where M is the moment matrix of the true X's, Ω is the covariance matrix of the measurement errors in x, and γ is the vector of covariances between the measurement errors in x and the measurement error in y. The second term of eqn.(1.4.10) captures any additional bias from a correlation between the measurement errors in the dependent and independent variables. In such cases the upward bias from correlated errors may outweigh the downward attenuation bias from measurement error in total expenditure (x), leading to a net upward bias (see, for example, Bouis and Haddad, 1992).

1.4.3 Instrumental Variable (IV) Estimation

IV estimation requires a matrix (Z) of observations which are correlated with the true X but uncorrelated in the limit with the measurement errors.

The IV estimator is given by

$$\hat{\beta}_{\text{IV}} = (Z'x)^{-1}Z'y \qquad (1.4.11)$$

[1] If either σ_v^2 or σ_u^2 or their ratio is assumed to be known *apriori* it is possible to construct an unbiased estimator of β.This was discussed by Koopmans, 1937; Madansky, 1959; Kendall and Stuart, 1979, Ch. 29; Fuller, 1980. The existence of bounds, the direction of bias etc., are discussed in Theil, 1961 and Fuller, 1987. Klepper and Leamer, 1984 discuss the multivariate case. See also Pal, 1981 for a survey.

If the above assumptions are correct then

$$\text{plim}\, \hat{\beta}_{\text{IV}} = \beta \tag{1.4.12}$$

$$\text{and asy var}\, (\hat{\beta}_{\text{IV}}) = \hat{\sigma}_v{}^2 (Z'x)^{-1} Z'Z(x'Z)^{-1} \tag{1.4.13}$$

IV estimation has been discussed in Geary (1942), Sargan (1958), Liviatan (1961), Carter and Fuller (1980), Pal (1981) and Deaton (1997).

However, in many applications it may not always be possible to find appropriate IV's, which is in fact the case with engel curve analysis. Liviatan (1961) suggested the use of recorded income as IV. But recorded income is hardly available in survey data from developing countries. Again EIV's may have a definite relationship with recorded income.

The well-known grouping methods of Wald (1940) and Bartlett (1949) or Durbin's (1954) method based on ranks are special cases of the IV method (Pal, 1981; Fuller, 1987, p. 74). However, it must be recognized that these estimators are inconsistent if the errors in the X values affect the grouping or ranking of the regressor values.

It has been found that the OLS estimator of β in the EVM has a smaller variance compared to the IV estimator; however, OLSE is biased, hence Feldstein (1974) considered the following estimator

$$\text{WAIVE} = \lambda(\text{OLSE}) + (1 - \lambda)\text{IVE} \tag{1.4.14}$$

Feldstein's estimator is a weighted average of the OLS estimator and the IV estimator in which the weights are estimated from the sample; λ is chosen so as to minimize the mean-squared error (MSE) of WAIVE. Feldstein used the additional information that the covariance of the measurement errors is zero. He presented a Monte Carlo study where the observed MSE of his estimator was smaller than that of the IV estimator. Carter and Fuller (1980) discussed this and presented modified ML estimators and other weighted estimators.

The small sample properties of the IV estimators have been studied by several authors. Phillips (1983) gives a general review of the available results. Deaton (1997) discusses the issue and cautions that the distributional theory for IV estimates is asymptotic and that the asymptotic approximations may be a poor guide to the finite sample performance with which one is concerned.

Finite sample distributions for IV estimators compared to the OLS estimators or their own asymptotic distributions would be more dispersed with more mass in the tails. In fact, if there is one instrument for one suspect independent variable then the IV estimate will be so dispersed that its mean does not exist (Davidson and MacKinnon, 1993, pp. 220-4). As a result, one might obtain extreme estimates whose asymptotic standard errors are no indication of how extreme they are. In the extreme case if there are as many instruments as the number of observations the IV and OLS estimates are identical. Given sufficient overidentification and the existence of moments, IV estimates have been found to be biased towards the OLS estimates. Nelson and Startz (1990b) (see also Maddala and Jeong, 1992) considered the univariate regression with a single instrument. They compared the small sample distribution of the IV estimates with the asymptotic distribution and with that of the OLS estimator. They found that the central tendency of the IV estimator is biased away from the true value; it is biased towards the probability limit of the OLSE, also when the regressor is uncorrelated with the regression error, i.e., when OLS is the appropriate estimator then asymptotic approximation to the distribution of the IV estimator gives the exact distribution. Most importantly, they find that the asymptotic distribution is a poor approximation to the true distribution when the instruments are poor in the sense of being not highly correlated with the regressor. This problem is also discussed in Basmann (1974), Mariano and MacDonald (1979) and Anderson (1982). Nelson and Startz (1990a) carried out some Monte Carlo studies to examine the distribution of the test statistics based on IV estimation. They found that it is possible to generate parameter estimates whose asymptotic t-value may be entirely misleading (see also Deaton, 1997; Subramanian and Deaton, 1994).

1.4.4 Method of Moments Estimation

If it is assumed that X, the true value of the regressor, is non-normal then some estimators based on moments and cumulants are available, which are not optimal but may have moderately high efficiency.

Consider a bivariate model given by

$$Y_i = \alpha + \beta X_i + \epsilon_i \tag{1.4.15}$$

where X and Y are the true but non-observable magnitudes of the regressor and the regressand respectively. The observed values of the regressor and the regressand are given by

$$\begin{aligned} x_i &= X_i + u_i & (1.4.16) \\ \text{and } y_i &= Y_i + v_i & (1.4.17) \end{aligned}$$

where u_i and v_i are EIVs with

$$\mathrm{E}(u_i) = \mathrm{E}(v_i) = 0, \quad \mathrm{V}(u_i) = \sigma_u^2, \quad \mathrm{V}(v_i) = \sigma_v^2 \tag{1.4.18}$$

$$\text{and } \mathrm{E}(\epsilon_i) = 0, \quad \mathrm{V}(\epsilon_i) = \sigma_\epsilon^2 \tag{1.4.19}$$

Geary (1942) suggested the estimator

$$\hat{b} = \frac{K(c_1, c_2 + 1)}{K(c_1 + 1, c_2)}, \quad c_1, c_2 > 0 \tag{1.4.20}$$

where $K(c_1, c_2)$ is the sample cumulant of the order (c_1, c_2) of (x, y). This is a consistent estimator for β if $\text{plim}K(c_1 + 1, c_2) \neq 0$. Thus, there is an infinite class of consistent estimators. However, the sampling errors of the sample cumulants (or moments) generally increase rapidly with their order (Geary, 1942; Madansky, 1959) — hence one should confine one's estimates to those based on cumulants (or moments) of the lowest feasible order. Thus, if X is asymmetric one should not go beyond third order moments.

Other estimators of the above type were suggested by Scott (1950) and Drion (1951). Durbin's (1954) estimator also reduces to a moment estimator since the IV suggested by him is some power of the regressor x.

Pal (1980a,b, 1981) proposed some moment estimators of the kind considered by Geary (1942) for the bivariate setup given by (1.4.15).

The sample moments may be written as

$$\begin{aligned} m_{rs}(x,y) &= \frac{1}{n}\sum_i (x_i - \bar{x})^r (y_i - \bar{y})^s \\ \text{and } m'_{rs}(x,y) &= \frac{1}{n}\sum_i x_i^r y_i^s \\ \text{also } m_{io}(x,y) &= m_i(x), \quad m_{oj}(x,y) = m_j(y) \end{aligned}$$

Correspondingly the true moments are denoted by μ_{rs}, μ'_{rs}, $\mu_i(X)$ and $\mu_j(y)$.

Under very general conditions the sample moments are consistent estimators of the corresponding true moments which are functions of the parameters α, β, the variances σ_u^2, σ_v^2, σ_ϵ^2 and the true moments of X. Pal used the following five equations based on first and second order moments to estimate seven unknown parameters, namely, α, β, ${\sigma_u}^2$, ${\sigma_v}^2$, ${\sigma_\epsilon}^2$, $\mu'_1(X)$ and $\mu'_2(X)$. However, since ${\sigma_v}^2$ and ${\sigma_\epsilon}^2$ always appear in the form of ${\sigma_v}^2 + {\sigma_\epsilon}^2$, so, in effect, there are the following five equations for six unknown quantities :

$$m'_1(x) = \mu'_1(X) \tag{1.4.21}$$

$$m'_1(y) = \alpha + \beta\mu'_1(X) \tag{1.4.22}$$

$$m'_2(x) = \mu'_2(X) + {\sigma_u}^2 \tag{1.4.23}$$

$$m_2'(y) = \alpha + 2\alpha\beta\mu_1'(X) + \beta^2\mu_2'(X) + {\sigma_v}^2 + {\sigma_\epsilon}^2 \quad (1.4.24)$$

$$m_{11}'(x,y) = \alpha\mu_1'(X) + \beta\mu_2'(X) \quad (1.4.25)$$

Since there are more unknowns than the number of equations, it is not possible to solve for all the parameters of the model without further assumptions. It is thus assumed that X is non-normal and that the third order central moment of X is non-zero.

Pal considered four equations based on third order moments, assuming zero third-order moments for u and v, in order to estimate β :

$$m_3(x) = \mu_3(X) \quad (1.4.26)$$

$$m_{21}(x,y) = \beta\mu_3(X) \quad (1.4.27)$$

$$m_{12}(x,y) = \beta^2\mu_3(X) \quad (1.4.28)$$

$$m_3(y) = \beta^3\mu_3(X) \quad (1.4.29)$$

Thus, there are a number of estimates for β. Pal's general class of estimators is defined as :

$$\hat{\beta}_s = f(\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3) \quad (1.4.30)$$

such that,

$$f(c\hat{\beta}_1, c\hat{\beta}_2, c\hat{\beta}_3) = c.f(\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3) \quad \forall\, c \neq 0$$

$$\text{and } f(1,1,1) = 1$$

where $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$ are three basic moment estimators defined by

$$\hat{\beta}_1 = \frac{m_{03}}{m_{12}} \quad (1.4.31)$$

$$\hat{\beta}_2 = \frac{m_{12}}{m_{21}} \quad (1.4.32)$$

$$\hat{\beta}_3 = \frac{m_{21}}{m_{03}} \quad (1.4.33)$$

Every consistent estimator based only on third order moments must be a member of this class. The estimators of Geary (1942), Scott (1950), Drion (1951) and Durbin (1954) are members of this more general class of moment based estimators.

The asymptotic efficiencies of the estimators $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$ along with three other estimators of this class were studied relative to the OLSE (Pal, 1980b, 1981). This has been done assuming lognormality of the regressor which is realistic in applications like engel curve analysis in many countries. The estimators were found to be fairly efficient even when OLS is fully valid. These estimators are computationally simple and require milder assumptions compared to ML or IV estimators.

Equations (1.4.21) and (1.4.23) can be replaced or augmented by other moment estimators (or even Maximum Likelihood (ML) estimators) if specific distributional assumptions are made. In Pal (1981) specific distributional assumptions have been made, for estimating first the univariate model (1.4.16). The regressor X is assumed to be two-parameter lognormal and the conditional distribution of the error term $u \mid X$ is assumed to follow the normal or Pearsonian type II distribution. Monte Carlo experiments suggested that some of the moment estimators were nearly as efficient as the ML estimator.

In the bivariate model different two-parameter algebraic forms of engel functions have been considered. For the regression equation

$$Y = \alpha + \beta f(X) + \epsilon \tag{1.4.34}$$

Pal suggests the moment equations

$$\begin{aligned} m_{11} &= \beta \operatorname{cov}(X, f(X)) + \lambda a^2 \operatorname{E}(X^b) && (1.4.35) \\ m_{21} &= \beta \operatorname{cov}(X^2, f(X)) - 2\beta \operatorname{E}(X) \operatorname{cov}(X, f(X)) \\ &\quad + a^2 \beta \operatorname{cov}(X^b, f(X)) + 2\lambda a^2 \operatorname{cov}(X, X^b) && (1.4.36) \end{aligned}$$

which has the solution

$$\hat{\beta} = \frac{2 m_{11} \widehat{\operatorname{cov}}(X, X^b) - m_{21} \operatorname{E}(X^b)}{2 \widehat{\operatorname{cov}}(X, f(X)) \widehat{\operatorname{cov}}(X, X^b) - \operatorname{E}(X^b)[\widehat{\operatorname{cov}}(X^b, f(X)) - 2 \hat{\operatorname{E}}(X) \widehat{\operatorname{cov}}(X, f(X)) + a^2 \widehat{\operatorname{cov}}(X^b, f(X)} \tag{1.4.37}$$

It was, however, not possible to undertake Monte Carlo studies for comparing these estimators with the ML estimator.

Chapter 2

Data Analyzed

2.1 Introduction

The present study on the effect of reference period used in the collection of household budget data on estimates of engel elasticities of consumption of certain item groups is mainly based on the disaggregated household budget data of the 38th round of the Indian National Sample Survey (NSS), relating to the period from January to December 1983. To be precise, the study is based on a retabulation of the NSS 38th round data from the 'Central Sample' canvassed by Central Government staff – it excludes the 'State Sample' canvassed by the staff of different State/Union Territory Governments. This data was made available in the form of updated computer tapes by the NSS Organization, Govt. of India, to the Data Archive of the Computer and Statistical Service Center at ISI, Calcutta.

The NSS is a multi-subject integrated socio-economic enquiry covering the entire country, carried out in the form of successive rounds. An enquiry on consumer expenditure was carried out in each of the rounds from the 1st (Oct. '50 - Mar. '51) to the 28th (Oct. '73 - Jun. '74). Thereafter, for some time, this enquiry was conducted at intervals of four or five years (during 1977-78 and 1983). In 1986-87, the NSS reverted to the earlier practice of conducting this enquiry every year, to get continuous time series data on level of living and poverty. However, one now has quinquennial enquiries on larger scale and annual enquiries on a smaller scale.

The present chapter gives a brief account of the nature of the NSS 38th round household budget data and similar data from earlier NSS rounds that have been used in this dissertation.[1] Section 2.2 describes the NSS 38th round consumer expenditure data including its geographical coverage, sample design, sub-round formation, estimation procedure and some important definitions and concepts adopted in the

[1] It may be mentioned again that all data utilized in this dissertation relate to the Central Sample as explained above.

NSS enquiry. Section 2.3 briefly discusses the data from the earlier NSS rounds. Section 2.4 examines the reliability and validity of NSS budget data.

2.2 NSS 38th Round Consumer Expenditure Data

Following the usual procedure of the NSSO, the 38th round household budget data were collected by the interview method from a countrywide probability sample of households, through canvassing a 'Consumer Expenditure Schedule' (Schedule 1.0).

From each sample household information was collected on certain household characteristics used as classificatory variables, such as location/residence of the household – state or union territory, sector (rural or urban), district etc. to which the household belonged, its size and composition, principal occupation etc., along with information on the household's expenditure on various items of domestic consumption. A broad summary of the consumption expenditure data collected in the NSS 38th round consumption expenditure enquiry is available in NSS Report No. 332 : *Pattern of Consumption Expenditure of SC and ST Households (Jan. – Dec., 1983)*, Govt of India, Dept. of Statistics, New Delhi, which gives estimates for different states/union territories and sectors (rural/urban) as well as for all-India.

2.2.1 Coverage

The NSS 38th round enquiry on household consumption expenditure covered the population of almost the entire Indian Union excluding (i) Ladakh and Kargil districts of Jammu & Kashmir and (ii) rural areas of Nagaland. The survey covered about 123 thousand households spread over 8,035 villages and 4,379 urban blocks.

2.2.2 Sampling Design

The sampling design adopted for the survey was a stratified two-stage one. For the rural areas census villages were taken as the first stage units (fsu's); similarly, in urban areas the NSS urban frame survey (UFS) blocks were taken as the fsu's. Households constituted the second stage units (ssu's) in both rural and urban areas. In the rural sector, the fsu's were selected with probability proportional to size (population) and with replacement (PPSWR) in the form of independent and interpenetrating sub-samples (IPNS). In the urban sector, sample blocks were selected with equal probability, again in the form of two IPNS. The sample households, i.e., the ssu's (10 from each fsu) were selected circular systematically after arranging all the households of the fsu's in a specified manner.

Stratification

The selection procedures outlined above were used separately for each stratum.

The country was first divided into 77 agro-economic regions by grouping contiguous districts, similar in respect of population density and cropping pattern. Within each region, basic strata were formed in such a way that they did not cut across district boundaries. (However, for Gujarat, some districts were split considering the location of dry areas and the distribution of tribal population in the state.) Further, the strata were so formed that each district with less than 1.8 million rural population, according to the 1981 census, formed one basic stratum by itself. A district with more than 1.8 million rural population was divided into two or more basic strata, depending on its rural population, by grouping contiguous *tehsils* (subdivisions in Bihar, Orissa and West Bengal) which were almost homogeneous with respect to rural population density and cropping pattern. In Gujarat, in the case of districts which extended over more than one region, the part of the district falling in each region constituted a separate stratum by itself, even if its rural population was less than 1.8 million.

For the urban sector, the cities and towns of each state/U.T. were divided into four population size classes on the basis of their 1981 census population. The population size classes were : (i) less than 50,000, (ii) 50,000 to 1,99,999, (iii) 200,000 to 999,999 and (iv) 1,000,000 and above. For the first three classes, each population class within each NSS-FOD sub-region[2] formed an urban stratum. For the highest class, i.e., the metropolitan cities, each city belonging to the class constituted a stratum by itself.

Allocation of Sample Size

The total sample of fsu's (villages/ urban blocks) were first allocated to each state or U.T. in proportion to the net investigator strength of FOD. This was further allocated to rural and urban sectors within each state/U.T. considering the relative size of its rural and urban population. All state-sector allocations were rounded off to multiples of 8, in order to have equal sample size in each of the four sub-rounds (*vide* Section 2.3 below) for either of the two sub-samples into which the total sample was divided. The rural/urban allocations at state level were reallocated to strata in proportion to their rural/urban population ensuring that the region level allocations were multiples of 8.

[2]These are areas under the jurisdiction of different field offices of the NSSO Field Operation Division (FOD).

2.2.3 Sub-round Formation

The field work for the 38th round survey started in January 1983 and ended in December 1983. The entire survey period of one year was divided into four sub-round periods, each of 3 months duration, coinciding approximately with the four agricultural seasons. The four sub-round periods were:

sub-round 1 : Jan. – Mar. 1983
sub-round 2 : Apr. – Jun. 1983
sub-round 3 : Jul. – Sep. 1983
sub-round 4 : Oct. – Dec. 1983

The sample villages and blocks were distributed equally over the four sub-rounds in such a manner that valid estimates for each of the sub-rounds could be obtained separately.

TH 525

2.2.4 Estimation Procedure

It should be clear from the above account that the sample design adopted was not self-weighting. Each sample household represented a different number of households in the population. Since these numbers or probability weights, which are colloquially called *multipliers*, are different for different households, estimates of any population aggregate should be a weighted sum of the sample observations, the weights being the *multipliers*.

The estimation procedure adopted in the NSS 38th round enquiry on consumer expenditure is outlined below:

Let θ be any population total of interest. Denoting by $\hat{\theta}$ the unbiased estimate of θ (say, the state/region total of any variate like expenditure on food), we have

$$\hat{\theta} = \sum_s \frac{P_s}{n_s} \sum_i \frac{D_{si} H_{si}}{p_{si} e_{si} h_{si}} \sum_j \theta_{sij}$$

for the rural sector, and

$$\hat{\theta} = \sum_s \frac{N_s}{n_s} \sum_i \frac{D_{si} H_{si}}{h_{si}} \sum_j \theta_{sij}$$

for the urban sector, where,

i) the subscripts s, i and j stand for serial number of stratum, sample village/urban block within stratum and sample household within fsu or hamlet group/sub-block, respectively;

ii) P_s, N_s and n_s give the stratum values of population, number of villages/blocks in population (frame) and number of villages/blocks in sample, respectively;

iii) D_{si}, e_{si} and p_{si} stand, respectively, for the number of hamlet groups/sub-blocks formed within the fsu, the number of census villages contained in a larger revenue village actually surveyed and the population of the sample village;
iv) H_{si} and h_{si} stand for the total number of households in the selected village (hamlet group) or block (sub-block) and the number of sample households selected for the enquiry; and
v) θ_{sij} is the observed value of the variate for a sample household.
$\sum$ is the sum over all households in selected villages/hamlet groups/blocks/sub-blocks.

Estimates of θ for a sub-sample (sub-round) can be obtained in the same manner by restricting the calculations and the summation ($\sum$) to units belonging to the concerned sub-sample (sub-round).

Estimates of ratios, such as percentages, averages etc, were calculated by first obtaining the unbiased estimates of the numerators and the denominators separately and then by division.

All estimates of the parameters used in this dissertation have been calculated by using the appropriate *multipliers* as weights.

2.2.5 Estimation of Standard Errors

Since the sampling design adopted by the NSSO was a complex one, direct estimation of the standard errors of the estimates is difficult. However, the fact that the sample was divided into some independent sub-samples (replicates of the same basic design) makes the estimation of standard errors fairly easy (see Murthy, 1977, Ch.5, p.158).

Suppose the combined sample consists of r replicates or interpenetrating sub-samples. Denote the estimates of a parameter θ obtained separately from the r replicates by $\hat{\theta}_1, \hat{\theta}_2, \ldots, \hat{\theta}_r$. Then the usual estimator of θ combining all the sub-samples is the simple average of all these estimates :

$$\hat{\theta} = \sum_{i=1}^{r} \hat{\theta}_r$$

The sampling variance of $\hat{\theta}$ ($\hat{V}(\hat{\theta})$) can be estimated as

$$\hat{V}(\hat{\theta}) = \frac{1}{r(r-1)} \sum_{i=1}^{r} (\hat{\theta}_i - \hat{\theta})^2$$

The above method of estimation of the sampling variance of an estimator has some obvious advantages. First of all, no special computer software is necessary. Secondly, it imposes no parametric or non-parametric estimation problem.

2.2.6 Some Definitions and Concepts Adopted in the NSS Household Budget Enquiry

The concepts and definitions followed in the consumer expenditure enquiry of the 38th round were broadly the same as those followed in earlier NSS rounds. Some of the important concepts and definitions relevant to this dissertation are given below:

Household : A household is a group of persons normally living together and taking food from a common kitchen. In case of a boarding house, hotel or hostel etc. each boarder with his dependents (or guests, if any) was considered to constitute a separate household. Households maintained and fed directly by the government, such as those in prisons, police quarters, cantonments, asylums, relief camps etc. were, however, excluded from the scope of the survey.

Household Member : Any person who is a normal resident of the sample household is considered to be a member of the household. The normally resident members include temporary stay-aways but exclude temporary visitors or guests. If a person lives in one place and takes food from another, then he is considered to be a resident of the place where he lives.

Household Size : The total number of members (as defined above) of a household is considered to be the size of the household.

Household Consumer Expenditure : Household consumer expenditure, in Indian rupees (Rs.), comprises all expenditure incurred by the household exclusively on the domestic account. This includes domestic consumption of goods and services out of (i) monetary purchases (cash or credit), (ii) receipts in exchange of goods and services, (iii) home-grown stock and (iv) (a) transfer receipts like gifts, loans etc., and (b) free collections. Non-monetized consumption was imputed at producer's/local retail prices. Any expenditure on household enterprise like animal husbandry was excluded from consumer expenditure. While consumption out of transfer receipts is included, transfer payments of all kinds (loans, gifts, charities etc., monetary as well as in kind, like grain loans)were excluded. The imputed rental of owner-occupied houses or of free/subsidized quarters provided by employers was excluded from data on consumer expenditure. Expenditure on purchase and construction of residential houses was considered to be expenses on the capital account and was therefore excluded; but the expenditure towards maintenance of residential buildings was included. Monetary value of food articles consumed during the reference period was taken to represent expenditure on food. For semi-durable and durable goods, the actual expenditure incurred towards purchase of these articles acquired during the reference period was considered as the expenditure on such articles. However, for items of clothing and footwear, the monetary value of the articles acquired and *brought into first use* during the reference period was considered.

Reference Period : The reference period for collection of data on all items of consumer expenditure was the 'last 30 days' ('last month'), ending on the day preceding the date of enquiry. In addition, for items of clothing, footwear, durable goods and also for expenses on medical care and education, data were collected for a reference period of 'last 365 days' ('last year'). This was done in view of the seasonal nature of these items and the fact that large amounts are spent on them at relatively long intervals of time.

Household Monthly Per Capita Consumption Expenditure : The total household expenditure, for a period of 30 days, on all items of consumption divided by the household size is taken as the total monthly per capita expenditure of the household and is denoted PCE (or MPCE). Household expenditure, for a period of 30 days, on each item/item-group divided by the household size is taken as the monthly itemwise per capita expenditure.

2.2.7 Data Analyzed versus Results in NSS Report No.332

For this dissertation NSS 38th round data for 13 major states, namely, Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal, separately for the rural and urban sectors, are analyzed together with all-India data. For all-India data, besides the combined sample, the two half-samples were also separately analyzed.

The results presented in NSSO Report No.332 were based on data relating to the 'last month' reference period for all item groups. Table 2.1 compares the sample size and average PCE for different states (and sectors) extracted from the NSS Report with those obtained in the present retabulation of the NSS 38th round ungrouped data based on the 'last month' reference period. As Table 2.1 shows there are some discrepancies between the two sets of results. Fortunately, these discrepancies are generally small and should not vitiate the main findings of this dissertation which is concerned with the estimation of engel relations and engel elasticities.

Table 2.1 : Comparative figures for sample size and average PCE based on NSS 38th round (Jan.-Dec. 1983) household budget enquiry (i) presented in NSS Report No. 332 and (ii) obtained in the present study, for selected states and all-India.

state	rural				urban			
	sample size (no. of hhs.)		average PCE per 30 days (Rs.)		sample size (no. of hhs.)		average PCE per 30 days (Rs.)	
	NSS report	present study	NSS report	present study	NSS report	present study	NSS report	present study
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Andhra Pradesh	6023	5492	115.58	114.60	3423	2625	159.55	156.27
Bihar	7967	7923	93.76	93.79	2115	2126	139.58	138.74
Gujarat	2734	2489	119.25	121.13	2251	1732	164.06	162.90
Karnataka	3329	3331	118.12	117.70	2354	2271	168.11	166.18
Kerala	3129	3057	145.24	140.28	1414	1328	178.31	179.56
Madhya Pradesh	5806	5728	101.78	100.80	2708	2455	148.39	143.71
Maharashtra	5577	5578	110.98	110.17	5447	5150	187.56	184.72
Orissa	3087	3086	97.48	97.32	920	901	151.35	148.63
Punjab	2623	2152	170.30	169.93	1797	1641	184.38	184.69
Rajasthan	3572	3551	127.52	124.43	1728	1611	159.96	163.69
Tamil Nadu	4566	4391	112.19	118.18	4099	3678	164.15	158.74
Uttar Pradesh	10559	10554	104.25	103.12	4350	4310	137.84	136.01
West Bengal	5044	5012	104.60	105.71	3397	3361	169.94	169.22
all-India	79692	76797	112.31	111.93	43410	40010	165.80	163.72

2.3 NSS Data from the Earlier Rounds

Grouped data from earlier rounds are also analyzed in this dissertation but only for rural and urban India. Data for rounds 4, 5, 7, 9, 10 and 28 were obtained from NSS Report Nos. 20, 40, 47 and 240 (*vide* References cited at the end). For the 18th round, the data was based on a special tabulation at ISI, Calcutta, by Chatterjee and Bhattacharya (1974). We present below the sample size, reference periods used and the number of sample households for each round relevant to this analysis.

NSS round	survey period	reference period used	no. of sample households	
			rural India	urban India
4	Apr. – Sept. 1952	month, year*	2388	1074
5	Dec. 1952 – Mar. 1953	month, year*	1361	618
7	Nov. 1953 – Mar. 1954	month	1413	558
9	May – Nov. 1955	month	1616	2099
10	Dec. 1955 – May 1956	month	1616	1326
18	Feb. 1963 – Jan. 1964	month	21776	4296
28	Oct. 1973 – Jun. 1974	month	15467	7881
38	Jan. – Dec. 1983	month, month & year*	79692	43410

*These reference periods are used for some items of the budget, like clothing, footwear etc.

The items analyzed were clothing and foodgrains up to the 10th round; footwear and durables were added for the 18th and 28th rounds. The analysis was also done half-samplewise for these rounds (except for the 28th round).

The concepts, definitions and procedures used in the consumer expenditure enquiry remained more or less uniform over the rounds; the following changes must, however, be noted:

(1) The reference period to which the expenditures relate varied to some extent in the first six survey rounds. From the 7th round onward, the 'last month' reference period was used uniformly for all items of consumer expenditure. From the 32nd round (1977-78) onward both 'last month' and 'last year' were used simultaneously for some durable and semi-durable items like clothing, footwear, durables etc., while 'last month' alone was used for all other items and item groups. However, the available estimates are fully based on the 'last month' reference period.

(2) Consumption of home-grown produce was imputed at local retail prices up to the 8th round (Jul. '54 - Mar. '55) but at ex-farm or ex-factory prices thereafter.

(3) The NSS consumer expenditure data was generally collected through a 'Consumer Expenditure Enquiry' schedule in most of the rounds. However, a major change was made from the 19th round (Jul. '64 - Jun. '65) through the 25th round (Jul. '70 - Jun. '71), whereby an 'Integrated Household Survey' schedule was

canvassed for collecting comprehensive data on various productive activities of the household along with data on consumer expenditure, employment-unemployment etc. The blocks for recording consumer expenditure in this schedule were also somewhat different from the corresponding blocks of the usual Consumer Expenditure Enquiry schedule. The usual schedule was brought back from the 26th round onwards. Also during rounds 10 (Dec. '55 - May '56) to 14 (Jul. '58 - Jun. '59), the consumer expenditure enquiry schedule was expanded to an 'Income and Expenditure' schedule by adding a few blocks for recording receipts and disbursements of the household. Such changes in the data collection procedures must have vitiated the high degree of intertemporal comparability of NSS consumer expenditure data to some extent. However, this point has little relevance to the NSS data analyzed in this dissertation.

2.4 Reliability and Validity of NSS Budget Data

2.4.1 Introduction

NSS consumption expenditure data is the single most important body of nationwide data available on household consumer expenditure in India. They have been used extensively for studies on consumer behaviour, level of living, inequality and poverty and on incidence of taxation on different sections of population. They have produced sensible results in almost all of these studies (*vide* Govt. of India, Planning Commission, 1969; Bhattacharya, 1978a,b). The Expert Group (Lakdawala Group) of the Planning Commission (1993) clearly recommended that this body of data be solely relied upon for the estimation of (absolute) poverty in India.

2.4.2 Reliability of the Data

Sampling errors affecting survey estimates are measured by standard errors (s.e.). Sampling errors do not usually introduce sizable biases in the estimates, so the s.e.'s can be taken as the index of reliability or precision of the survey estimates. These s.e.'s expressed as percentages of the estimates themselves are termed the relative standard errors (r.s.e.).

Reliability of NSS consumer expenditure data has been ensured by the large sample size in most of the rounds. Occasional calculation of s.e.'s shows that these are reasonably small, even when the sample size is not too large.

The method of Fractile Graphical Analysis (FGA) was introduced by Mahalanobis (1960) for comparing and testing the divergence between two populations in respect of fractile group means of some characteristic under study. This method is particularly useful for comparing income and expenditure data across NSS rounds (*vide* Mahalanobis, 1960). For any one round, the area between the fractile graphs of the two half-samples (hs1 and hs2), bounded by ordinates at the two extreme fractile group numbers, indicates the error or margin of uncertainty associated with the combined sample fractile graph. Fractile graphs based on NSS consumer expenditure data, examined in this manner, generally point to the reliability of the combined sample graph.

Sarma and Rao (1980) used the data of NSS 28th round where the sample size was relatively small compared to the recent rounds (about 23,000 households), to estimate s.e.'s for food and non-food groups and a large number of subgroups and individual items, for 17 major states (see also Minhas, 1988). Their statewise estimates of r.s.e.'s are quite reasonable, particularly for the states with the highest population. Minhas (1988) presented estimates of projected values of r.s.e.'s for the 32nd NSS round based on the estimates by Sarma and Rao (1980). Projected values for the 32nd round were even smaller since the sample size was much larger for that round (about 158,000 households). Minhas observed that the 28th round results can safely be assumed to provide the outer limits to the magnitudes of the relative standard errors of the estimates of consumer expenditure for all aggregates and almost all subgroups of items in the 32nd round, or any other recent round where the set of strata and the sampling scheme might be similar to the 28th round. The values of the r.s.e.'s for the 17 states pooled together for the 28th round and the projected values for the 32nd round are as follows :[3]

item	r.s.e.'s(28th round)	r.s.e.'s(32nd round)
	rural	
food	0.68%	0.40%
non-food	1.42%	0.90%
total exp.	0.74%	0.47%
	urban	
food	1.29%	0.74%
non-food	1.98%	1.30%
total exp.	1.29%	0.87%

A study by Pal and Bhattacharya (1989), on the areal distribution of poverty in rural India, based on the NSS 28th round data, showed the s.e.'s of the *head-count ratios*, based on half-sample estimates, to be rather small. These s.e.'s were generally lower for a state/region for which the sample size was larger. The s.e. of the head-count ratio was about 2 per cent, on the average, for regions with

[3]Reproduced from Minhas (1988).

sample size 300 households or more and 3 per cent for regions with sample size 200 household or more. The statewise estimates were found to be fairly dependable when the sample size was 500 households or more.

For the purposes of the present analysis from NSS 38th round data half-samplewise estimates were calculated for per capita total expenditure (PCE) per 30 days, and different items of consumption for all-India rural and urban data, based on both the *last month* (last 30 days) and *last year* (last 365 days) reference periods of data collection. Estimates of s.e.'s and r.s.e.'s based on the half-samplewise estimates are presented below. It may be mentioned that in this case

$$\text{s.e. (combined estimate} = \frac{|\, hs1\ est. - hs2\ est.\,|}{2}$$

$$\text{and r.s.e.} = \frac{|\, hs1\ est. - hs2\ est.\,|\ /2}{(hs1\ est. + hs2\ est.)/2} \times 100.$$

These s.e.'s and r.s.e.'s are presented according to size classes of PCE in Tables 2.2R through 2.3U. It may be noted that, on the whole, the s.e.'s and the r.s.e.'s are generally small.

Table 2.2R : Standard errors (s.e.) (Rs.) and relative standard errors (r.s.e.) (%) for average per capita expenditures on different items, based on last 30 days data, by PCE class, all-India, rural, NSS 38th round.

PCE	PCE		foodgrains		clothing		footwear		durables		medical care		education	
class (Rs.)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
0–30	0.120	0.49	0.140	1.15	0.055	18.03	0.025	55.56	0.000	0.00	0.100	32.26	0.025	45.45
30–40	0.035	0.10	0.175	0.92	0.055	12.36	0.015	27.27	0.000	0.00	0.450	8.41	0.030	50.00
40–50	0.040	0.09	0.125	0.54	0.005	0.68	0.015	14.28	0.000	0.00	0.040	4.70	0.010	11.11
50–60	0.020	0.03	0.110	0.04	0.020	1.70	0.000	0.00	0.005	4.00	0.050	3.97	0.005	3.03
60–70	0.030	0.05	0.205	0.07	0.075	4.06	0.000	0.00	0.005	2.04	0.000	0.00	0.040	13.79
70–85	0.005	0.01	0.160	0.05	0.065	2.40	0.015	4.11	0.000	0.00	0.070	2.99	0.015	4.22
85–100	0.010	0.01	0.025	0.07	0.070	1.63	0.015	2.66	0.010	1.92	0.080	2.54	0.015	2.86
100–125	0.020	0.02	0.150	0.38	0.150	2.28	0.005	0.54	0.025	2.65	0.170	3.55	0.025	3.31
125–150	0.130	0.10	0.040	0.10	0.210	1.97	0.035	2.51	0.000	0.00	0.180	2.72	0.185	13.75
150–200	0.115	0.07	0.230	3.85	0.650	3.79	0.135	5.86	0.210	6.52	0.205	2.12	0.025	1.38
200–250	0.035	0.02	0.005	0.01	0.015	0.05	0.105	3.09	0.160	2.55	0.020	0.132	0.135	4.99
250–300	0.695	0.26	0.160	0.33	1.455	3.25	0.420	8.00	1.045	10.79	0.550	3.10	0.250	6.81
300–	16.395	3.55	0.420	0.67	6.905	8.72	1.125	12.86	0.720	1.46	0.415	1.23	0.075	1.07
all classes	0.025	0.22	0.115	0.32	0.135	1.50	0.040	3.54	0.015	0.63	0.015	0.29	0.025	2.65

Table 2.2U : Standard errors (s.e.) (Rs.) and relative standard errors (r.s.e.) (%) for average per capita expenditures on different items, based on last 30 days data, by PCE class, all-India, urban, NSS 38th round.

PCE class	PCE		foodgrains		clothing		footwear		durables		medical care		education	
	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
0–30	0.270	1.32	1.770	19.69	0.085	51.52	0.025	16.13	1.230	93.89	0.090	19.15	0.085	20.48
30–40	0.225	0.62	1.535	10.16	0.015	17.65	0.130	72.22	0.005	1.00	0.220	30.99	0.015	9.09
40–50	0.260	0.57	0.360	1.88	0.160	37.21	0.000	0.00	0.055	57.90	0.040	4.94	0.075	27.27
50–60	0.020	0.04	0.090	0.43	0.170	29.82	0.020	8.33	0.055	44.00	0.030	2.52	0.055	14.67
60–70	0.045	0.07	0.005	0.02	0.040	4.44	0.010	5.88	0.075	45.45	0.070	4.46	0.070	13.72
70–85	0.030	0.04	0.105	0.39	0.070	5.30	0.010	3.22	0.015	9.09	0.095	5.09	0.000	0.00
85–100	0.070	0.08	0.050	0.170	0.225	9.24	0.010	1.89	0.030	11.11	0.105	3.97	0.060	6.38
100–125	0.330	0.30	0.535	1.72	0.015	0.55	0.035	4.44	0.060	10.71	0.165	5.02	0.55	3.68
125–150	0.190	0.14	0.165	0.34	0.065	1.51	0.010	0.81	0.010	1.14	0.015	0.31	0.095	4.25
150–200	0.110	0.06	0.190	0.55	0.200	1.95	0.145	8.17	0.025	1.14	0.170	2.77	0.075	2.13
200–250	0.220	0.10	0.245	0.62	0.455	2.71	0.075	0.02	0.115	4.01	0.190	2.21	0.215	3.84
250–300	0.560	0.20	0.031	0.84	1.340	5.74	0.310	7.43	0.515	9.20	1.635	15.15	0.045	0.63
300–	6.120	1.32	0.305	0.76	2.905	4.87	0.870	10.20	0.340	1.33	2.160	9.87	0.585	4.39
all classes	0.895	0.55	0.080	0.25	0.410	3.54	0.085	0.110	2.92	0.075	1.23	0.010	0.30	

Table 2.3R : Standard errors (s.e.) (Rs.) and relative standard errors (r.s.e.) (%) for average per capita expenditures on different items, based on last 365 days data, by PCE class, all-India, rural, NSS 38th round.

PCE class	PCE		foodgrains		clothing		footwear		durables		medical care		education	
	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
0–30	0.375	1.53	0.275	2.37	0.010	0.50	0.030	33.33	0.010	11.11	0.090	18.75	0.010	12.50
30–40	0.020	0.06	0.135	0.77	0.010	0.78	0.030	20.00	0.010	5.88	0.035	6.20	0.005	5.26
40–50	0.005	0.01	0.125	0.57	0.010	0.30	0.020	4.54	0.035	13.21	0.025	2.89	0.000	0.00
50–60	0.100	0.18	0.040	0.16	0.015	0.37	0.005	1.64	0.035	8.86	0.060	5.40	0.005	2.56
60–70	0.015	0.02	0.085	0.30	0.025	0.53	0.000	0.00	0.015	2.70	0.005	0.36	0.045	3.57
70–85	0.065	0.08	0.280	0.86	0.015	0.27	0.005	1.00	0.025	3.40	0.030	1.75	0.020	6.17
85–100	0.045	0.05	0.065	0.18	0.035	0.53	0.025	3.76	0.035	3.76	0.005	0.23	0.025	4.50
100–125	0.040	0.04	0.040	0.10	0.040	0.50	0.020	2.22	0.045	2.72	0.050	1.84	0.020	2.44
125–150	0.085	0.06	0.220	0.52	0.000	0.00	0.020	1.59	0.035	1.28	0.135	3.67	0.000	0.00
150–200	0.195	0.11	0.360	0.78	0.055	0.42	0.025	1.46	0.065	1.43	0.005	0.10	0.035	2.08
200–250	0.040	0.02	0.690	1.36	0.650	3.76	0.020	1.18	0.005	0.06	0.035	0.49	0.100	4.39
250–300	0.595	0.22	2.060	3.84	0.595	2.83	0.065	2.44	0.825	7.02	0.355	3.92	0.510	15.84
300–	21.865	5.03	0.365	0.51	0.960	3.08	0.015	0.41	0.325	1.49	0.285	2.48	0.135	3.38
all classes	0.020	0.02	0.110	0.30	0.065	0.82	0.010	1.15	0.020	0.93	0.010	0.37	0.000	0.00

Table 2.3U : Standard errors (s.e.) (Rs.) and relative standard errors (r.s.e.) (%) for average per capita expenditures on different items, based on last 365 days data, by PCE class, all-India, urban, NSS 38th round.

PCE class	PCE		foodgrains		clothing		footwear		durables		medical care		education	
	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)	s.e.	r.s.e. (%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
0–30	0.825	3.98	1.995	23.02	0.695	33.33	0.220	66.67	0.165	62.26	0.005	1.23	0.100	41.67
30–40	0.620	1.72	0.050	0.37	0.050	1.69	0.060	15.38	0.020	8.70	0.135	1.38	0.070	18.92
40–50	0.085	0.19	0.730	4.15	0.010	0.30	0.070	21.21	0.030	7.50	0.015	1.52	0.015	3.53
50–60	0.140	0.25	0.310	1.51	0.035	0.92	0.015	4.00	0.035	13.21	0.030	2.46	0.000	0.00
60–70	0.070	0.11	0.555	2.39	0.210	4.84	0.020	4.76	0.030	8.33	0.035	2.64	0.020	3.85
70–85	0.000	0.00	0.085	0.317	0.050	0.95	0.000	0.00	0.025	5.15	0.035	2.32	0.010	1.30
85–100	0.060	0.06	0.015	0.05	0.070	1.10	0.005	0.68	0.070	10.00	0.085	4.56	0.015	1.42
100–125	0.090	0.08	0.400	1.30	0.055	0.67	0.005	0.48	0.010	0.92	0.125	5.18	0.005	0.30
125–150	0.100	0.07	0.150	0.45	0.245	2.37	0.005	0.37	0.095	5.54	0.140	4.78	0.175	7.04
150–200	0.080	0.05	0.370	1.07	0.045	0.34	0.030	1.55	0.160	5.06	0.020	0.52	0.030	0.82
200–250	0.485	0.22	0.055	0.15	0.215	1.23	0.010	0.39	0.075	1.33	0.145	2.76	0.305	5.53
250–300	0.215	0.08	0.435	1.17	0.110	0.50	0.080	2.48	0.605	7.56	0.035	5.80	0.135	2.03
300–	5.910	1.37	0.620	1.56	0.060	0.18	0.020	0.42	1.055	5.59	1.150	11.40	0.080	0.70
all classes	0.535	0.33	0.080	0.25	0.045	0.37	0.005	0.30	0.055	1.51	0.100	2.80	0.060	1.82

2.4.3 Validity of the Data

Some doubts may obviously be raised about the validity of NSS budget data, especially since they are collected by the interview method and factors like willful misreporting as well as unconscious recall biases are likely to distort the data. In consequence, apart from the internal validation of survey estimates, several studies have been carried out where external checks were applied to NSS data, by comparing NSS based estimates with corresponding estimates based on the National Accounts Statistics (NAS) produced by the CSO over different years (*vide* Mahalanobis, 1960; Rudra, 1972; Mukherjee and Chatterjee, 1974; Srinivasan *et al*, 1974; Chatterjee and Bhattacharya, 1975; Mukherjee and Saha, 1981; Chatterjee, 1982; Roy, 1985; Vaidyanathan, 1986; Suryanarayana and Iyengar, 1986; Minhas *et al.*, 1986; Minhas and Kansal, 1989; Bhattacharya *et al.*, 1991, Appendix A).

Note that the two above-mentioned series, NSS and NAS, are based on completely independent bodies of data; the former relies on individual consumer responses to NSS questionnaires whereas the latter is mainly derived from the production statistics computed by the product flow method. The question of comparability of the two series has been discussed in detail (Minhas *et al.*, 1986; Minhas, 1988). The credibility of the NAS estimates as an external validator set is also in question. Many researchers have pointed out that the NAS estimates do not have any particular claims to superior scientific value (Rudra, 1972) and any close agreement between the NAS and NSS series does not necessarily indicate the absence of bias in either series; nor does the divergence between the two indicate the presence of such bias in any one of the two series.

The NSS budget data has acquired enormous importance in connection with absolute poverty estimation in the country. The Expert Group (Lakdawala Group) of the Planning Commission (1993) recommended complete reliance on NSS budget data for poverty estimation in India. The Expert Group noted that the NAS data suffer from lack of reliable direct data on production for a sizable proportion of the economy, and the adjustments made in NAS for deriving private consumption are often subjective and based on obsolete and scanty data; they also do not take into account differences in prices across states. In any case, the NAS cannot throw light on distributions across households nor even between rural and urban areas. The NSS gives estimates based on information provided by households on quantities and prices for a large number of goods and services consumed by them. The NSS surveys are carefully organized and use uniform concepts and procedures across the country. In any case, the pro-rata adjustments sometimes made to NSS-based size distributions of consumption to raise the NSS aggregate of consumption to the NAS aggregate are totally unjustified.

Some pioneering studies which compared aggregate private consumption expenditure from the two series are first briefly discussed in subsection 2.4.3a. Minhas *et al.* (1986), Minhas (1988) and Minhas and Kansal (1989) compared the two series for the years 1972-73, 1977-78 and 1983 in detail and have identified the factors responsible for most of the observed differences. Their findings are discussed in subsection 2.4.3b. In subsection 2.4.3c some studies on itemwise differences between the two series are reviewed.

2.4.3a. *External Checks on Aggregate Household Consumption Expenditure*

A pioneering attempt to check the validity of NSS data was made by Mukherjee and Chatterjee (1974) using the NAS estimates as an external validator set. They obtained all-India estimates, for the rural and urban sectors, of aggregate household consumption expenditure from NSS data by blowing up the all-India rural and urban estimates of average per capita expenditure by corresponding census-based projections of population. They, of course, made certain adjustments to make the two series more or less comparable. This work was continued in Mukherjee and Saha (1981). Table 2.4 reproduced from Mukherjee and Saha (1981) shows the results from this kind of external check. The discrepancies are found to be generally small, except for the years when the much longer Integrated Household Survey Schedule (Sch. 16) was used — the NSS estimates of household consumption seem to have been depressed by this method of data collection. The discrepancies are seen to narrow again when the conventional enquiry schedule was readopted after 1970-71.

The NSS estimates of aggregate household consumption expenditure were generally higher than the NAS estimates of private consumption up to the early sixties; thereafter the former were always lower. Mukherjee and Chatterjee (1974) also found that allowing for a time lag between production and consumption raised the NSS figures relative to the NAS series to some extent.

Table 2.2 : Discrepancies between NSS estimates of household consumption expenditure and official estimates of private consumption in India

(Estimates in Rs.10^9 at current prices)

financial year	NSS estimate of hh cons. exp.	Official estimate of private cons. exp.	$\frac{col.(2)-col.(3)}{col.(3)} \times 100$	remarks
(1)	(2)	(3)	(4)	(5)
1954-55	81.3	81.1	0.25	NSS home consumption at retail prices
1955-56	85.6	82.2	4.26	
1956-57	93.0	95.2	(-) 2.31	Income and Expenditure Schedule used
1957-58	99.0	98.4	0.61	- do -
1958-59	109.6	109.5	0.09	- do -
1959-60	113.8	110.2	3.27	
1960-61	121.6	119.5	1.76	
1961-62	128.0	124.8	2.56	
1962-63	134.1	131.3	2.13	
1963-64	142.0	146.3	(-) 2.94	
1964-65	163.0	174.6	(-) 6.53	Integrated Schedule used
1965-66	175.5	184.4	(-) 4.83	- do -
1966-67	193.8	216.5	(-) 10.48	- do -
1967-68	219.3	261.5	(-) 16.14	- do -
1968-69	229.2	261.9	(-) 12.49	- do -
1970-71	265.5	296.8	(-) 10.53	- do -
1972-73	343.5	351.9	(-) 2.39	
1973-74	411.2	430.4	(-) 4.47	
1977-78	579.6*	626.0	(-) 7.41	

* This NSS estimate relates to the period July 1977 - June 1978.

2.4.3b. *Limits of Comparability of NSS and NAS Estimates*

Minhas *et al.* (1986), Minhas (1988) and Minhas and Kansal (1989) have analyzed in great detail the limits of comparability of NSS and NAS estimates. Minhas (1988) pointed out that NSS estimates are subject to both sampling and non-sampling errors, each of which has a bias component and a variance component. Sample size being large and estimation formulae well-chosen, sampling bias may be taken to be negligible, and the sampling errors and non-sampling variance would be small. The NSS data minus its non-sampling bias should, therefore, be comparable with the CSO estimates given that sampling and non-sampling errors in this series are also negligible. This, however, is not found to be true in reality as the analysis by Minhas *et al.* (1986), Minhas (1988) and Minhas and Kansal (1989) would show.

Some of the major factors responsible for the differences in the two series, identified by Minhas and his associates are briefly described below:

A. Differences in Coverage

NSS excludes the houseless population and institutional households (prisons, orphanages, military cantonments, hospitals etc.), but these are included in the CSO estimates. Further, the consumption expenditure of non-profit and charitable institutions is included by the CSO. Again, NAS estimates include government expenditure on consumption of certain items which are provided free or subsidized to individuals. In view of these, the NAS estimates are expected to be higher.

B. Differences in Time Periods

NAS estimates are presented for the financial year April-March, while NSS uses varying time periods for different rounds of enquiry. Hence it becomes difficult to establish any time correspondence between the two. The effects of seasonality in production (like a bumper crop) which are reflected in the NAS estimates may not be captured by the NSS estimates which are being compared. For example, the NAS estimates for the financial year 1983-84 was 22 per cent higher than the NSS 38th round (Jan.-Dec.,1983) estimates. However, much of the consumption for that period captured in the NSS enquiry would have been from the crop of the previous agricultural year (1982-83) — this becomes important since there was a big jump in foodgrains production between the two years. In fact, there was a 14 per cent difference in foodgrains availability between the two years and this was accompanied by a 27 per cent increase in oil seeds production between these years. An adjustment for time period effects in the agricultural sector alone brings down the difference in the estimates from 22 per cent to 12 per cent.

C. Differences in the Methods of Data Collection and Estimation Procedures

The sampling errors of NSS estimates of private consumption are quite small (*vide* Section 2.4.2). However, NSS data might suffer from non-sampling errors like recall lapses — particularly for detailed items within broad groups of items, due to willful suppression or under-reporting of certain expenditures, underestimation of rents since NSS enquiries exclude imputed rentals of owner-occupied housing, under-estimation of items consumed by the affluent strata, possibility of duplication of food expenditures in connection with ceremonials etc. The NAS estimates are based on production data for all consumer goods and services, obtained from various agencies. These data are processed and adjusted by *deducting* exports, intermediate uses and net increase in stocks and *adding* imports — the portion going to private consumption is thus comparable to the NSS estimates. These estimates are, however, vitiated by subjective adjustments, methodological weaknesses, non-availability of certain information like data on changes in stocks, on marketable surplus, intermediate uses, production data from the unorganized sector etc. There are also difficulties in determining the share of the household sector for items like durables and communications.

D. Non-comparability Caused by Unrecorded Data

Since the NAS estimates are from official records they suffer from non-reporting and under-reporting in order to avoid various excise and import duties. Illegal transactions, however, may be well reflected in the NSS consumption data.

E. Sampling and Non-Sampling Errors of the Two Series

There has been considerable amount of research on the s.e.'s of the NSS estimates, and these have been shown to be generally small and fairly stable from round to round except when the sample sizes differ widely. On the other hand , the CSO estimates are collected from diverse survey results (which report no s.e.'s), all of which contribute sampling errors to the NAS estimates making these errors almost intractable. Naturally, these have been conveniently ignored by various researchers using these data for checks upon the NSS estimates. Similarly, non-sampling errors are likely to get cumulated much faster for the NAS estimates which are often derived from a collection of data that are of poor quality, not up to date and often partial in coverage.

F. Differences due to Differences in Price Sets

The implicit prices of the NSS were shown to be consistently higher, at least for foodgrains.

G. Differences due to Unmatched Classification Schemes

For example, the fact that expenditure in hotels and restaurants is classified under consumer services by NAS whereas in NSS it comes under the food group, or while fruit products come under spices and miscellaneous food in NSS whereas they come under the fruit group in NAS, often vitiate meaningful comparisons.

Incorporating some suggestions from Minhas *et al.* (1986) and Minhas (1988) the CSO brought out revised estimates of private consumption for 1980-81 to 1985-86 with 1980-81 as the benchmark year. Minhas and Kansal (1989) compared NSS 38th round data with the revised NAS estimates. Some of the results of Minhas (1988) and Minhas and Kansal (1989) are given below:

In case of foodgrains adjustments were made for differences in implicit prices and time periods and the following was found : NSS estimates were higher by 23 per cent in 1972-73 and by 9 per cent in 1977-78, but these observed differences were reduced to 16 per cent and 3 per cent, respectively, by price adjustments. The effect of the time period adjustment was a reduction by 4 per cent and an increase by 3.4 per cent, respectively, for the two years. The remaining difference was 12 per cent for 1972-73 and 6.8 per cent for 1977-78. Similarly, the NAS estimates of foodgrains consumption in 1982-83 was 77 per cent of the NSS estimate for 1983 — price adjustment narrowed the margin by 12 per cent and time period adjustment by another 7 per cent.

Among the other important food items, NAS estimates were higher for milk and milk products, edible oils and vanaspati, sugar and gur; however, for these items intermediate use was not clearly distinguished by the NAS. In case of fruits and vegetables also CSO estimates were higher; however, this group suffered from some non-comparability due to different classification schemes. The CSO estimates for the meat, fish and egg group was 16 per cent higher and time adjustments increased this further to 31 per cent for 1983, though for the other two years the difference was only marginal.

The NSS probably underestimates consumption of pan, tobacco and liquor; however, the CSO estimates, which are substantially higher than the NSS estimates, are also downward biased.

The CSO estimates of fuel and light are lower (by about 25 per cent for 1983) — the difference is primarily due to very low CSO estimates of firewood consumption.

The CSO estimates of clothing and footwear are higher than those from the NSS by 11 per cent in 1972-73, by 14 per cent in 1977-78 and by 54 per cent in 1982-83. This difference is due to clothing alone since footwear estimates are almost identical. The NSS estimates of this group are characterized by large sampling errors.

The CSO estimates for the medical care group is based on NSS estimates of per capita expenditure data. The two estimates were almost equal in 1972-73. However, the NAS estimates were lower by 24 per cent and by almost one-third, respectively, for 1977-78 and 1983. However, the NAS used the 1972-73 per capita figures for 1977-78 and the 1977-78 figures for 1983 — thus ignoring the increase in per capita consumption of medicines between these years.

The CSO estimates of educational expenditure, which covers both households as well as non-profit institutions, are about four times higher than the NSS estimates for 1983. However, for books and stationery, the NAS estimates were only 30 per cent of the NSS estimates which seems to be an underestimation.

The NAS estimates for consumer durables and transport and communication are also much higher than the NSS estimates. However, the difficulties of comparing these groups have already been mentioned.

On the whole, it was found that the two sets of data were cross-validated to a large extent.

Minhas and Kansal (1989) found that proper documentation of the estimation procedures followed by the CSO was very much required where there are vast differences between old and revised estimates and also for the many commodity groups where directional changes are observed in the differences between the revised and the old estimates for any two years as against the benchmark year.

2.4.3c. *External Checks on Itemwise Consumption*

In most of the other studies which applied external checks on itemwise NSS estimates of household consumption, the NSS estimates were compared with the product flow estimates of the NAS. These studies, mentioned earlier, indicate some systematic pattern of divergence between the two sets of estimates. The following points are worth mentioning :

i) The NSS estimates of average per capita consumption of foodgrains (cereals plus pulses) are found to be appreciably higher than what is implied by the NAS; the NSS estimates appear to be unrealistically high for the richer income groups. However, in the NSS data poorer sections of the population are found to report almost starvation levels of consumption of foodgrains which shows up in the poverty estimates for the country (*vide* Chatterjee and Bhattacharya, 1975; Vaidyanathan, 1986).[4]

ii) For most of the other food items like edible oils, sugar etc. and particularly for meat, fish and eggs and for milk products, NSS yields lower estimates of per capita consumption compared to the NAS estimates (Roy, 1985; Chatterjee, 1982; Bhattacharya *et al.*, 1991).

iii) In case of non-food items, NSS estimates are higher for fuel and light and lower for services and conveyance compared to NAS figures (Roy, 1985; Vaidyanathan, 1986; Bhattacharya *et al.*, 1991).

iv) The NAS estimates of per capita consumption of clothing were lower than the corresponding NSS estimates during the early sixties; but thereafter the latter was always lower (Roy, 1985; Vaidyanathan, 1986; Bhattacharya *et al.*, 1991.

v) For food or non-food taken as groups, the two sets of estimates are fairly close (Chatterjee, 1982).

2.4.4 Concluding Remarks

We may briefly touch upon some other issues that have been raised on the quality of NSS budget data. One is the possibility of systematic changes over time in the magnitudes of non-sampling errors in NSS data owing to identifiable changes in the design of schedules and concepts (Vaidyanathan, 1986). The arguments offered are however, not at all powerful.

Rudra (1972) had expressed the suspicion that luxury and semi-luxury items were being seriously underestimated in the NSS. In fact, the NSS estimates appeared to be quite low when compared to the corresponding supply figures based on production and import statistics. In his opinion, this was the unavoidable consequence of sampling from a population with a highly skew income distribution without stratifying the population by levels of living prior to sample selection leading to an under-representation of the richer sections. This argument also is not convincing, unless the non-response rate is higher for the richer sections. Nevertheless, in recent years, NSS has been trying to over-sample the affluent sections with a view to improving the estimates of characteristics associated with affluence. The main explanation for the downward bias noted by Rudra may be the tendency

[4]Part of the explanation for high NSS estimates for foodgrains, particularly for high income households, may be reporting of meals taken by the employees at the employer's household in rural areas possibly leading to double counting. Ceremonials may also provide a partial explanation; while the host household reports the entire quantum of cereals needed for the feast in its budget, all invited households may not exclude such a meal from their budget when they happen to be selected for interview. Animal feed is possibly another area of confusion leading to wrong inclusion of food offered to livestock mainly used for productive enterprise in the household budget, inflating the figures for household cereals consumption (*vide* Chatterjee and Bhattacharya, 1975).

to under-report consumption of luxury and semi-luxury items by the more affluent respondents.

NSS also possibly under-enumerates the poorest sections of the population since it can not adequately cover the homeless nomads and destitutes without clear addresses (Chatterjee and Bhattacharya, 1975). Comparisons with census-based estimates of population indicate that NSS enquiries have been missing a sizable percentage of the population, particularly in urban areas, probably owing to errors in the listing of households — but the characteristics of the households missed are not very clear.

While NSS budget data at the household level is certainly affected by non-sampling biases due to deliberate misreporting, recall lapses etc., their actual size has not been precisely estimated. In much of the empirical work based on NSS data such biases have been assumed to be uniform in cross-section data across regions and socio-economic classes etc. The biases are also often assumed to be stable over time in many analyses based on time series of NSS data. The results of the present dissertation will not be vitiated by the non-sampling biases present in NSS data, in so far as these biases are more or less constant in.cross-sectional data.

Chapter 3

Effect of Reference Period on Engel Elasticities

3.1 Introduction

This chapter presents the estimates of engel elasticities for some items of the household budget for the rural and urban sectors of India, based on NSS rounds 4, 5, 7, 9, 10, 18 and 28, spanning about two decades from 1952–53 to 1973–74.

The reference period for data collection in the NSS enquiries on consumer expenditure varied over different rounds. A fixed reference period of *one year* was used in the 1st round; the 2nd and 3rd rounds used a moving *week* ('last 7 days') as the reference period; for the 4th and 5th rounds of the NSS enquiry the reference period was *last month* ('last 30 days') for most items, but *last year* ('last 365 days') for some semi-durable and durable items whose consumption can be better recorded for a longer reference period, since expenditure on these are incurred infrequently and can be recalled for a longer period.[1] However, from the 7th round onwards the *last month* reference period was used uniformly for all items of the budget. This continued till the 28th round. Beginning with the 32nd round, both *last month* and *last year* began to be used for items like clothing, footwear, durable goods, medical care and education, while *last month* was used for all items of the budget.

This chapter compares the engel elasticities for clothing and foodgrains across a few NSS rounds some of which used, for data collection, the moving reference period of *last month* for all items while the other rounds collected annual data for some items, but *last month* data for the remaining items.

[1] Actually, for most items, 4th and 5th rounds used *last week* and *last month* in two interpenetrating halves of the entire sample; while the *last year* was used for semi-durables and durables in the entire sample. The data used for engel curve analysis relates to that part of the sample where the *last month* was used for food items etc.

The previously mentioned empirical studies (*vide* Chapter 1, Section 1.3) by Biswas and Bose (1962) or that by NCAER (1986, 1987) had presented only estimates of the constant elasticity from the fitted double logarithmic engel curve. The present study improves upon these results by first choosing the best-fitting algebraic form of the engel curve and then obtaining the engel elasticity from the best-fitting form, which may or may not be the double-log form.

This chapter is organized as follows. The data used in this chapter is briefly described in the next section. Section 3.3 describes in detail the methodology followed in this chapter and also in the next chapter. The results are set out in Section 3.4. Section 3.5 offers some concluding observations.

3.2 Data Analyzed

The data analyzed in this chapter includes all-India level data based on NSS rounds 4, 5, 7, 9, 10, 18 and 28, separately for the rural and urban sectors. Half-samplewise estimates are analyzed for all the rounds except the 28th, for which half-samplewise tabulation is not available.

The data utilized are those used in conventional estimation of engel curves: estimates of average PCE (total over all items) and of average expenditure per capita on each selected item, separately by classes of PCE. Such estimates for the rounds 4, 5, 7, 9, 10 and 28 are obtained from NSS Report Nos. 20, 20, 20, 40, 47 and 240, respectively (*vide* references cited at the end). For the 18th round, on the other hand, the data is based on a special tabulation done at ISI, Calcutta (*vide* G.S. Chatterjee and N. Bhattacharya, 1974).

The item coverage is clothing and foodgrains upto the 10th round ; footwear and durables are added for the 18th and 28th rounds.

A detailed description of NSS household budget data has already been given in Chapter 2. Note again that for rounds 4 and 5 an annual reference period was used for certain items like clothing combined with a moving monthly reference period for the rest of the items of the budget. But for rounds 7, 9, 10, 18 and 28, data on all items of the household budget were collected for a monthly reference period.

3.3 Methodology

For all rounds considered here, except the 18th, the NSS reports give estimates of monthly per capita total consumer expenditure (PCE) of households along with per capita expenditures on individual items or groups of items, separately for different size classes of PCE. Engel relations are estimated by regressing per capita monthly item consumption (y) on monthly per capita total household expenditure (PCE)(x) using the grouped data for 12 or 13 PCE classes as shown below :

class interval of PCE (x)(Rs.)	percentage of population (p_j)	consumption per person per 30 days (Rs.) all items (x_j)	specified item (y_j)
x_0 – x_1	p_1	$\bar{x}_1$	$\bar{y}_1$
x_1 – x_2	p_2	$\bar{x}_2$	$\bar{y}_2$
.	.	.	.
.	.	.	.
.	.	.	.
.	.	.	.
x_{j-1} – x_j	p_j	$\bar{x}_j$	$\bar{y}_j$
.	.	.	.
.	.	.	.
.	.	.	.
x_{k-1} – x_k	p_k	$\bar{x}_k$	$\bar{y}_k$
total	100		

The first step was to plot the averages $\bar{y}_j$ against the averages $\bar{x}_j$ (j=1,2,. . . ,k), with or without transformation of one or both of the variables,. The graphs showed, on visual inspection, which of the following five algebraic forms of engel curves was likely to give a good fit to the data :

$$y = \alpha + \beta \ln x \quad \text{(semi-log or SL)} \qquad (3.3.1)$$

$$\ln y = \alpha + \beta \ln x \quad \text{(double-log or DL)} \qquad (3.3.2)$$

$$\ln y = \alpha + \beta / x \quad \text{(log-inverse or LI)} \qquad (3.3.3)$$

$$\ln y = \alpha + \beta \ln x + \gamma / x \quad \text{(log-log-inverse or LLI)} \qquad (3.3.4)$$

$$\frac{y}{x} = \alpha + \beta \ln x + \gamma / x \quad \text{(budget-share or BS)} \qquad (3.3.5)$$

Four curve forms out of the five mentioned above were estimated in each case and the choice of the best form was guided by a number of objective goodness of fit criteria listed below.

Weighted least squares method was used to estimate the parameters of these engel relations. Thus, to fit the double-log form

$$\Sigma p_j (\ln \bar{y}_j - \alpha - \beta \ \ln \bar{x}_j)^2 \qquad (3.3.6)$$

is minimized with respect to α and β, using p_j's as the class weights. For the 18th round data a similar procedure was followed; however, estimation was based on 10 decile groupwise averages and then the weights (p_j's) were equal for all the classes.

Goodness of fit criteria

For each of the seven NSS rounds mentioned earlier, four engel curve forms chosen from eqns. (3.3.1)–(3.3.5) were compared, separately for each item and sector, on the basis of a number of statistical criteria of goodness of fit. The aim was to choose one or two best-fitting forms in every case.

The criteria used for comparing the goodness of fit of different curve types, apart from R^2, were :

i) $\bar{R}^2$: This was needed because R^2 is not comparable across curve types using unequal number of parameters and here SL and DL use two parameters while LLI and BS use three.

ii) R_y^2 : This is defined as $r^2(y, \hat{y})$. This supplements R^2 which equals r^2 (*regressand, expected value of regressand*). Since different regressands — y, $\ln y$ and $\frac{y}{x}$ — are used in different curve forms, R^2 is not strictly comparable across them, but R_y^2 is.

iii) W : This is defined as

$$W = 1 - \frac{\Sigma p_j(\bar{y}_j - \hat{\bar{y}}_j)}{\Sigma p_j(\bar{y}_j - \bar{y})^2} = \frac{\text{ESS}(y)}{\text{TSS}(y)} \tag{3.3.7}$$

$$\text{where } \bar{y} = \frac{\Sigma p_j \bar{y}_j}{\Sigma p_j}$$

This coincides with R^2 and R_y^2 if y is used as the regressand, but not if $\ln y$ or $\frac{y}{x}$ is used. Note that R_y^2 has the limitation that $r^2(y, \hat{y})$ may be high but y and $\hat{y}$ values may be far from equal. W may be useful from this point of view. In fact, in a few cases, y was markedly different from $\hat{y}$ for the highest PCE class, leading to low or even negative values of W, very different from the value of R^2 or R_y^2.

iv) DW and DW (adjusted) : In fitting the DL form, say, the observational equation may be written as :

$$\sqrt{p_j} \ln \bar{y}_j = \alpha \sqrt{p_j} + \beta \sqrt{p_j} \ln \bar{x}_j + \sqrt{p_j} \epsilon_j \tag{3.3.8}$$

DW was computed from the residuals e_j (estimates of ϵ_j) as :

$$DW = \frac{\sum_{j=2}^{k} (e_j - e_{j-1})^2}{\sum_{j=1}^{k} e_j{}^2} \tag{3.3.9}$$

$$\text{where } e_j = \ln \bar{y}_j - \widehat{\ln \bar{y}_j}$$

DW (adjusted) was computed in the same manner from the values of $\sqrt{p_j} e_j$ — this being theoretically more valid because $\sqrt{p_j} \epsilon_j$ is more nearly homoscedastic than ϵ_j.

By way of illustration, Tables 3.1R and 3.1U present the values of these goodness of fit criteria for different curve forms tried for clothing using NSS 4th round data. Table 3.1R relates to rural India and Table 3.1U to all-India urban.

Table 3.1R : Comparative goodness of fit of different engel curve forms for clothing in rural India, NSS 4th round.

curve type	half-sample	goodness of fit criteria					
		R^2	$\bar{R}^2$	R^2_y	W	DW	DW(adj)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SL	1	0.730	0.704	0.730	0.730	1.10	0.84
	2	0.867	0.854	0.867	0.867	0.68	0.83
	c	0.806	0.785	0.805	0.805	0.89	0.73
DL	1	0.976	0.974	0.960	0.937	2.09	2.08
	2	0.989	0.987	0.984	0.983	3.32	3.48
	c	0.990	0.989	0.987	0.982	2.64	2.73
LLI	1	0.983	0.979	0.979	0.975	2.88	2.96
	2	0.989	0.986	0.984	0.984	3.33	3.47
	c	0.992	0.990	0.990	0.990	3.34	3.24
BS	1	0.552	0.452	0.979	0.976	2.85	2.90
	2	0.715	0.651	0.984	0.984	3.73	3.48
	c	0.727	0.666	0.991	0.990	3.33	3.21

Table 3.1U : Comparative goodness of fit of different engel curve forms for clothing in urban India, NSS 4th round.

curve type	half-sample	goodness of fit criteria					
		R^2	$\bar{R}^2$	R^2_y	W	DW	DW(adj)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SL	1	0.835	0.819	0.835	0.835	0.85	0.95
	2	0.909	0.900	0.909	0.909	0.45	0.54
	c	0.873	0.860	0.873	0.873	0.65	0.75
DL	1	0.991	0.996	0.996	0.996	1.53	2.05
	2	0.988	0.987	0.986	0.978	1.57	2.10
	c	0.995	0.994	0.998	0.996	1.20	1.73
LLI	1	0.992	0.990	0.994	0.992	2.04	2.20
	2	0.992	0.990	0.993	0.992	2.04	2.25
	c	0.997	0.996	0.998	0.998	1.74	1.95
BS	1	0.197	0.019	0.994	0.992	2.09	2.23
	2	0.303	0.148	0.992	0.992	2.04	2.25
	c	0.444	0.321	0.998	0.998	1.80	2.02

In comparing different curve forms on the basis of the above criteria W is given the foremost importance. This is supplemented by $\bar{R}^2$, considering that W cannot be adjusted for the number of degrees of freedom. The two DW values come next. Broadly speaking, DW values well below 2 or above 3 are treated as undesirable.

For example, for clothing from the 4th round, rural sector (*vide* Table 3.1R) one would choose the DL, LLI and BS forms on the basis of W, but reject the BS form when $\bar{R}^2$ is considered and again reject the LLI form when the DW values are considered; and so the DL is finally chosen as the best fitting form, followed by the LLI form. Similarly, for the urban sector (*vide* Table 3.1U), one would again choose the DL, LLI and the BS forms on the basis of W, but reject the BS form on the basis of $\bar{R}^2$ and after considering the two DW values the LLI comes out as the best fitting form, followed by the DL.

Elasticities presented

For the double-log form the engel elasticity η_x is constant and is equal to β; but for the variable elasticity forms, the engel elasticity varies with x. In such cases, one generally presents the value of η_x at $x = \bar{x}$, though other representative values like the median of x can be used. In this paper we use in addition to $\eta_{\bar{x}}$, the average elasticity $\bar{\eta}$ of a variable elasticity engel curve used by Bhattacharya (1972) (see also Coondoo, 1975b and Jain, 1972) defined as a weighted average of the elasticities at all points of the curve :

$$\bar{\eta} = \frac{\int_0^{\infty} g(x)\,\mathrm{E}(y\,|\,x)\,\eta_x\,dx}{\int_0^{\infty} g(x)\,\mathrm{E}(y\,|\,x)dx} = \frac{\int_0^{\infty} g(x)\,\mathrm{E}(y\,|\,x)\eta_x\,dx}{\mathrm{E}(y)} \tag{3.3.10}$$

where $g(x)$ is the frequency function of the marginal distribution of persons by PCE (x) and E $(y \mid x)$, the conditional expectation of y given x. This is, in fact, an application of the general idea of Stone (1954) for deriving the market elasticity from micro elasticities of all individuals. For particular curve forms $\bar{\eta}$ may coincide with η_x at a particular value of x, say, at $x = \bar{x}$.

It should be mentioned here that between the two overall measures of engel elasticity, $\eta_{\bar{x}}$ and $\bar{\eta}$, of a variable elasticity engel curve, the latter is more comprehensive in nature since its computation takes into account not only the variation in elasticity across PCE levels but also the distribution of item expenditure across the population of consumers, whereas $\eta_{\bar{x}}$ does not incorporate the distributional features of item expenditure.

Here the elasticities from the chosen variable elasticity forms are presented at $x = \bar{x}$ together with their average elasticities ($\bar{\eta}$).

The expressions for these elasticities are as follows:

curve form	$\eta_{\bar{x}}$	$\bar{\eta}$
SL	$\beta/[\alpha+\beta\ln\bar{x}]$	$\beta/[\alpha+\beta\,\mathrm{E}\,(\ln x)]$
LI	$\beta/\bar{x}$	$\beta\,\mathrm{E}\,(y/x)/\,\mathrm{E}\,(y)$
LLI	$\beta-[\gamma/\bar{x}]$	$\beta-[\gamma\,\mathrm{E}\,(y/x)/\,\mathrm{E}\,(y)]$
BS	$1+[\beta\bar{x}-\gamma]/\,\mathrm{E}\,(y\,\vert\,\bar{x})$	$1+[\beta\,\mathrm{E}\,(x)-\gamma]/\,\mathrm{E}\,(y)$

In the computations, $\mathrm{E}\,(x)$ was taken as $\bar{x}$ and $\mathrm{E}\,(y)$ as $\bar{y}=\sum p_j\bar{y}_j$; the other expectations were estimated as weighted averages of PCE-classwise values of $\ln\bar{x}_j$, $\hat{\bar{y}}_j$, or $\hat{\bar{y}}_j/\bar{x}_j$, with the p_j's as weights.

3.4 Results

This section presents the estimates of engel elasticities for foodgrains and clothing from NSS rounds 4, 5, 7, 9, 10, 18 and 28.

The estimates of engel elasticities for foodgrains and clothing are set out in Tables 3.2 and 3.3, respectively. Note that in most cases, since variable elasticity engel curve forms are chosen, two alternative elasticities are shown — the elasticity at average value of PCE (denoted $\eta_{\bar{x}}$) and the average elasticity of the entire engel curve (denoted $\bar{\eta}$). Also, for all rounds except the 28th, the estimates are presented for the two half-samples of the NSS sample, as also for the combined sample. The divergence between the two half-sample estimates indicates the margin of uncertainty associated with the combined sample estimates.

The estimates are presented for the two curve forms which fit the combined sample data best for each round; however, in almost all cases, the forms which fit the combined sample data best are also the best-fitting forms for the two half-samples.

The most striking result is that for both rural and urban India the engel elasticity for clothing rose markedly from about 0.9–1.0 in the 4th and 5th rounds to about 1.4–1.5 in rounds 7, 9 and 10 (*vide* Table 3.3). This rise is clearly significant. This was almost certainly due to a change in the reference period used for data collection. In rounds 4 and 5, as stated earlier, last week or last month was used for most items including food, but last year was used for clothing, footwear and durables.[2] From the 7th round onward, last month began to be used for all items of the budget including clothing, footwear and durables.

[2]The data analyzed here relates to that part of the sample where the last month, and not the last week, was employed for items like food.

Table 3.2 : Engel elasticities *for foodgrains* estimated from household budget data collected in different NSS rounds, separately for two best-fitting engel curve types : all India, rural and urban.

NSS	curve type 1							curve type 2						
	curve	$\eta_{\bar{x}}$			$\bar{\eta}$			curve	$\eta_{\bar{x}}$			$\bar{\eta}$		
round*	type	h.s.1	h.s.2	comb.	h.s.1	h.s.2	comb.	type	h.s.1	h.s.2	comb.	h.s.1	h.s.2	comb.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
all India, rural														
4	LLI	0.61	0.61	0.61	0.65	0.65	0.65	SL	0.57	0.57	0.58	0.64	0.66	0.65
5	LLI	0.44	.50	0.48	0.52	0.54	0.54	LI	0.45	0.42	0.44	0.53	0.50	0.51
7	LI	0.41	0.42	0.42	0.49	0.48	0.50	SL	0.45	0.45	0.45	0.49	0.48	0.49
9	LLI	0.53	0.44	0.49	0.58	0.51	0.55	LI	0.48	0.42	0.45	0.55	0.50	0.53
10	LLI	0.59	0.56	0.57	0.62	0.59	0.61	SL	0.58	0.55	0.56	0.66	0.62	0.63
18	LLI	0.46	0.52	0.49	0.51	0.55	0.53	BS	0.49	0.52	0.51	0.49	0.52	0.51
28	LLI	-	-	0.51	-	-	0.55	SL	-	-	0.51	-	-	0.54
all India, urban														
4	LI	0.23	0.21	0.22	0.31	0.26	0.30	SL	0.31	0.24	0.28	0.33	0.26	0.30
5	LLI	0.26	0.33	0.29	0.34	0.38	0.36	SL	0.29	0.35	0.32	0.32	0.38	0.35
7	LLI	0.24	0.20	0.22	0.33	0.28	0.31	LI	0.25	0.21	0.23	0.33	0.28	0.31
9	LLI	0.34	0.23	0.29	0.37	0.31	0.34	SL	0.35	0.27	0.31	0.38	0.29	0.33
10	LLI	0.27	0.26	0.26	0.27	0.32	0.32	SL	0.29	0.28	0.28	0.31	0.30	0.30
18	LLI	0.15	0.21	0.18	0.25	0.32	0.28	LI	0.17	0.24	0.20	0.24	0.31	0.28
28	LLI	-	-	0.23	-	-	0.32	LI	-	-	0.28	-	-	0.33

*See Section 1 on change in reference period for data collection introduced in the 7th round.

Table 3.3 : Engel elasticities *for clothing* estimated from household budget data collected in different NSS rounds, separately for two best-fitting engel curve types : all India, rural and urban.

	curve type 1							curve type 2						
NSS	curve	$\eta_{\bar{x}}$			$\bar{\eta}$			curve	$\eta_{\bar{x}}$			$\bar{\eta}$		
round*	type	h.s.1	h.s.2	comb.	h.s.1	h.s.2	comb.	type	h.s.1	h.s.2	comb.	h.s.1	h.s.2	comb.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
all India, rural														
4	DL	0.90	0.86	0.88	0.90	0.86	0.88	–	–	–	–	–	–	–
5	LLI	0.90	0.82	0.87	0.90	0.83	0.87	BS	0.91	0.85	0.87	0.91	0.85	0.88
7	LLI	1.60	1.49	1.54	1.42	1.46	1.43	–	–	–	–	–	–	–
9	LLI	1.64	1.40	1.50	1.49	1.40	1.45	–	–	–	–	–	–	–
10	LLI	1.72	1.43	1.57	1.57	1.39	1.46	BS	1.59	1.38	1.48	1.59	1.38	1.48
18	LLI	1.92	1.93	1.92	1.87	1.83	1.84	BS	1.79	1.78	1.78	1.79	1.78	1.78
28	LLI	–	–	2.14	–	–	2.20	BS	–	–	2.06	–	–	2.06
all India, urban														
4	LLI	1.01	0.98	0.99	1.01	0.98	0.99	DL	1.03	1.02	1.02	1.03	1.02	1.02
5	LLI	0.94	0.99	0.94	0.94	0.99	0.94	DL	0.96	1.04	0.98	0.96	1.04	0.98
7	LLI	1.56	1.30	1.42	1.35	1.18	1.27	BS	1.46	1.20	1.35	1.45	1.19	1.35
9	LLI	1.67	1.53	1.59	1.62	1.52	1.56	DL	1.73	1.56	1.63	1.73	1.56	1.63
10	LLI	1.55	1.26	1.40	1.30	1.19	1.26	BS	1.40	1.20	1.31	1.40	1.20	1.31
18	LLI	1.58	1.63	1.64	2.04	1.90	2.00	BS	1.42	1.56	1.45	1.41	1.56	1.48
28	LLI	–	–	2.10	–	–	2.03	BS	–	–	1.90	–	–	1.89

Table 3.4 : Engel elasticities *for footwear* and *durable goods* for NSS rounds 18 and 28, separately for two best-fitting engel curve types : all India, rural and urban.

	curve type 1							curve type 2						
NSS	curve	$\eta_{\bar{x}}$			$\bar{\eta}$			curve	$\eta_{\bar{x}}$			$\bar{\eta}$		
round	type	h.s.1	h.s.2	comb.	h.s.1	h.s.2	comb.	type	h.s.1	h.s.2	comb.	h.s.1	h.s.2	comb.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
footwear : all-India, rural														
18	LLI	2.58	2.73	2.70	2.21	2.49	2.48	BS	2.18	2.22	2.22	2.19	2.22	2.22
28	BS	–	–	2.34	–	–	2.34	–	–	–	–	–	–	–
footwear : all-India, urban														
18	SL	1.34	1.22	1.25	1.95	1.63	1.75	–	–	–	–	–	–	–
28	BS	–	–	2.11	–	–	2.10	–	–	–	–	–	–	–
durable goods : all-India, rural														
18	LLI	3.69	3.08	3.39	4.32	3.03	3.69	DL	3.60	3.09	3.32	3.60	3.09	3.32
28	BS	–	–	2.86	–	–	3.02	–	–	–	–	–	–	–
durable goods : all-India, urban														
18	DL	2.73	2.20	2.39	2.73	2.20	2.39	–	–	–	–	–	–	–
28	DL	–	–	3.18	–	–	3.18	BS	–	–	2.55	–	–	2.61

Such a shift in the engel elasticities for clothing was noticed by Bhattacharya (1967, 1978a) from the elasticities reported by Biswas and Bose (1962). Note that while Biswas and Bose used the double-logarithmic engel curves in all cases, the present study uses those engel curve forms which are found to fit the data best.

No such shift over time is clearly discernible in the engel elasticities for foodgrains presented in Table 3.2.

For the sake of interest and to facilitate comparison with results based on NSS 38th round presented in Section 4.4 of Chapter 4, estimated elasticities for footwear and durable goods for NSS rounds 18 and 28 are presented here in Table 3.4. Judging by the reference periods used, these estimates are comparable to NSS 38th round estimates based on 'last month' data for all items.

3.5 Concluding Observations

The finding that engel elasticity for clothing rose markedly when the reference period for data collected changed in NSS round 7 shows *the effect of reference period on* engel elasticities estimated from household budget data for an economy like the Indian economy, with pronounced seasonality in household consumption. This will be corroborated by findings presented in Chapter 4 based on NSS 38th round where last month as well as last year were used as reference periods for item groups like clothing. All these stress the need of systematic researches into this problem.

Another finding, not related to the main question addressed in this paper, is the rising trend in engel elasticity for clothing over time, even when the reference period did not change, in both the sectors. This merits in-depth study. Presumably, this engel elasticity could be related to time trends in the price of clothing relative to the general price level or to time trends in relative prices within the clothing group (*vide* Coondoo, 1969, for a study of this nature on the engel elasticity for cereals in India).

Chapter 4

Effect of Reference Period on Engel Elasticities : Further Evidence from NSS 38th Round Data*

4.1 Introduction

This chapter presents the estimates of engel elasticities of consumption of certain groups of items, based on household budget data collected in the NSS 38th round (Jan.–Dec. 1983) enquiry, focussing on the effect of the length of the reference period on these elasticities.

The NSS generally employs a moving reference period of 'last 30 days' preceding the date of interview (also known as the 'last month' reference period) for purposes of data collection. The interviews are staggered evenly over the survey period, usually one year. Different households thus furnish information on consumption expenditure for different periods of 30 days. This naturally introduces seasonality and other short-run factors into the data collected from any particular household. While the average consumption over sample households gives a fair approximation to annual levels of consumption, seasonal and other short-run fluctuations get superimposed on the true variation across households exaggerating the inequality in the size distribution of population by PCE (per capita total consumer expenditure), denoted x, the widely used measure of level of living. Further, engel curves (strictly, expenditure-consumption curves) may get distorted, especially for items like clothing which are considerably affected by seasonality and other transitory

*This chapter is based on Ghose and Bhattacharya (1995).

factors. For example, since foodgrains consumption is much more stable over the different months than say, consumption of clothing, then if households are ranked in ascending order of PCE, households spending a higher proportion of (per capita) total consumption expenditure (x) on foodgrains would tend to be those with lower values of x, because they have provided the information for the periods in which they spent relatively little on items other than foodgrains. The reverse will happen for seasonal commodities like clothing ; the households having higher values of x would show a greater proportion of their total consumption expenditure spent on clothing, possibly because they have given the information for some festive seasons. Thus, such data would exaggerate the rise in the proportion of total expenditure spent on clothing with increase in PCE (x), simply because of the seasonal nature of expenditure on clothing. Evidence has already been cited to show that the use of an annual reference period for collecting data on clothing leads to elasticities which are closer to 1 compared to elasticities based on a month reference period (*vide* Chapter 1, Sec. 1.3.2).

In the last chapter engel elasticities of clothing consumption have been presented for some earlier rounds of the NSS which used different reference periods for data collection (namely, 'last month' and 'last year'). The results show that there are marked differences in elasticities between the rounds using last year as reference period and those using last month as reference period.

In the 38th round of the NSS consumer expenditure enquiry both 'last month' (30 days) and 'last year' (365 days) reference periods were used simultaneously for all sample households for collection of data on certain items/item groups, viz., clothing, footwear, durable goods, medical care and education, while only 'last month' was used for all other items of the household budget. However, for all items, only the data based on 'last month' are presented in the NSS reports. This chapter analyses data for clothing, footwear etc. and estimates the engel elasticities of these items using the data collected for both the reference periods. From the results of Chapter 3 one can notice a jump in clothing elasticity between rounds 4 and 5, on the one hand, and rounds 7, 9, and 10, on the other, elasticity being much higher from round 7 onwards when the 'last year' reference period for some seasonal and/or semi-durable and durable items was abandoned in favour of the 'last month' reference period (*vide* Section 3.4, Chapter 3).

The results of this chapter provide further evidence on how, for the same round, engel elasticities of some items change noticeably if NSS consumption expenditure data for items like clothing, collected for the 'last month' reference period, are replaced by 'last year' data.

The remainder of this chapter is organized as follows. Section 4.2 briefly describes the data used. (For further details see Chapter 2.) Section 4.3 outlines the methodology followed. Section 4.4 presents the empirical findings and Section 4.5 offers some concluding observations. Some results relating to the shift in the size distribution of population by PCE with change in the reference period are presented in Appendix B.

4.2 Data Analyzed

This chapter is mainly based on a retabulation of NSS 38th round (Jan.–Dec. 1983) ungrouped (household level) budget data using the computer tapes supplied to ISI, Calcutta, by the NSSO, Govt. of India.

In the 38th round enquiry both 'last month' and 'last year' data were recorded simultaneously for some items of consumption, mainly, clothing, footwear, durables, medical care and education; for all other items of the budget, 'last month' was used as the reference period.

The main findings of the 38th round enquiry were released through NSS Report No. 332 (National Sample Survey Organization, Govt. of India, 1986). However, all results in this report relate only to the data collected for the last month reference period and the data relating to the annual reference period for the items mentioned above have not been tabulated.

For the present study, NSS data for 13 states, namely, Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal, were analyzed together with all-India data, separately for the rural and urban sectors. For all-India data, besides the combined sample, the two half-samples were also separately analyzed.

Six item groups which have been considered here are foodgrains, clothing, footwear, durable goods, medical care and education.

Note that as stated in Chapter 2, the retabulation of the 38th round budget data done for the present study gave estimates slightly different from those appearing in NSS Report No.332 (see Section 2.2.7, Chapter 2). However, these discrepancies are generally small and should not vitiate the main findings of this chapter.

4.3 Methodology

PCE (per capita household consumer expenditure on all items per 30 days), used as a simple measure of living standards, was calculated in two ways from the 38th round ungrouped data: (i) utilizing 'last month' data for all items of the household budget and (ii) utilizing data for 'last year' for the item-groups of interest, namely, clothing, footwear, durables, medical care and education and 'last month' data for all other item-groups. The former is called '*conventional* PCE' and the latter is termed '*adjusted* PCE'.

The 38th round ungrouped household level data were grouped into 13 PCE classes using first *conventional* PCE and then *adjusted* PCE. This was done separately for the 13 states, the all-India combined sample together with its two half-samples, and also by sectors — rural and urban.

In each case, tables were generated showing the following for the 13 size classes of PCE : percentage of population (p_j), average PCE ($\bar{x}_j$), and average per capita expenditure on the item under study ($\bar{y}_j$), $j = 1, 2, \ldots, 13$.

The rest of the methodology followed was the same as in Chapter 3 (*vide* Section 3.3). Five different forms of engel functions, namely, SL, DL, LI, LLI and BS (eqns. (3.3.1) through (3.3.5)) were fitted to the data. These forms were compared on the basis of statistical criteria like R^2, $\bar{R}^2$, $R_y^2 = r^2(y, \hat{y})$, W and DW statistics. Two best fitting forms were again considered for each item, sector and state/ all-India combination. In most cases, the best fitting form was the same for the two half-samples of any given sector and item. These results, for all-India, rural and urban data, are presented in Appendix A.

The method of estimation was exactly the same as before (*vide* Section 3.3, Chapter 3). WLS method of estimation was used, the class weights being the p_j's. The elasticity at average PCE ($\bar{x}$), denoted $\eta_{\bar{x}}$, and the average elasticity for the entire engel curve, $\bar{\eta}$, were calculated for both conventional PCE and adjusted PCE for all items, states and sectors, as well as for both the sectors of the all-India combined sample and its two half-samples. These elasticities were then compared with focus on the difference between the two reference periods.

4.4 Findings

This section presents the estimates of engel elasticities of consumption of selected items of the household budget, focussing on the effect of switching over from 'last month' to 'last year' reference period for items like clothing. These results are all based on the re-tabulation of NSS 38th round data undertaken at ISI, Calcutta, for the purpose of the present study.

For the sake of interest, we first present, in Tables 4.1R and 4.1U, the size distribution of PCE and the average expenditures on different items, based on the present retabulation, separately for conventional PCE and adjusted PCE for all-India, separately for rural and urban sectors. Some important results relating to the shift in the size distribution of population by PCE are reported in Appendix B. Some measures of inequality of the size distributions like the Lorenz curve and the Lorenz ratio are presented in this appendix.

Table 4.1R : Size distribution of PCE and average expenditures on different items by size classes of PCE, separately for *conventional* and *adjusted* PCE, based on NSS 38th round (Jan. - Dec. 1983), all-India, rural.

interval of PCE (Rs.)	conventional PCE								adjusted PCE							
	percentage of population	average expenditure per person per 30 days (Rs.)							percentage of population	average expenditure per person per 30 days (Rs.)						
		food-grains	cloth-ing	foot-wear	dur-ables	medical care	edu-cation	total		food-grains	cloth-ing	foot-wear	dur-ables	medical care	edu-cation	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
0–30	1.01	12.21	0.30	0.04	0.03	0.30	0.05	24.32	0.74	11.53	1.98	0.09	0.09	0.50	0.08	24.52
30–40	2.57	18.98	0.44	0.06	0.05	0.54	0.06	35.77	1.96	17.58	2.54	0.15	0.17	0.56	0.10	35.66
40–50	5.18	23.00	0.73	0.11	0.07	0.85	0.09	45.42	4.44	21.91	3.34	0.22	0.26	0.86	0.14	45.58
50–60	8.14	26.57	1.18	0.18	0.12	1.26	0.17	55.27	7.41	25.63	4.10	0.30	0.40	1.11	0.19	55.37
60–70	9.81	29.75	1.85	0.24	0.24	1.59	0.29	65.16	9.95	28.43	4.73	0.39	0.55	1.40	0.28	65.10
70–85	15.36	33.24	2.71	0.36	0.30	2.34	0.35	77.33	16.32	32.52	5.52	0.49	0.74	1.71	0.40	77.48
85–100	13.64	36.96	4.30	0.56	0.52	3.15	0.53	92.24	14.88	36.33	6.59	0.67	1.07	2.14	0.56	92.37
100–125	16.83	39.49	6.58	0.94	0.94	4.79	0.76	111.45	18.21	39.56	7.99	0.90	1.66	2.72	0.82	111.56
125–150	9.83	41.85	10.68	1.39	1.64	6.62	1.35	136.48	10.67	42.62	10.11	1.25	2.73	3.67	1.19	136.41
150–200	9.63	44.97	17.14	2.30	3.22	9.66	1.81	170.73	9.38	45.96	13.13	1.71	4.54	4.81	1.68	170.68
200–250	3.84	48.00	30.20	3.40	6.29	15.06	2.70	221.81	3.31	50.62	17.30	2.12	8.49	7.11	2.28	220.78
250–300	1.73	49.06	44.71	5.25	9.81	17.73	3.62	272.03	1.30	53.75	21.03	2.63	11.84	9.06	3.18	271.44
300 –	2.43	60.97	79.21	8.71	49.48	33.35	7.09	462.03	1.41	71.63	31.28	3.71	21.72	11.40	4.08	435.00
all classes	100.00	36.29	9.00	1.13	2.40	5.19	0.95	111.93	100.00	36.30	7.92	0.87	2.14	2.72	0.81	107.75

Table 4.1U : Size distribution of PCE and average expenditures on different items by size classes of PCE, separately for *conventional* and *adjusted* PCE, based on NSS 38th round (Jan. - Dec. 1983), all-India, urban.

interval of PCE (Rs.)	conventional PCE: percentage of population	conventional PCE: average expenditure per person per 30 days (Rs.): food-grains	cloth-ing	foot-wear	dur-ables	medical care	edu-cation	total	adjusted PCE: percentage of population	adjusted PCE: average expenditure per person per 30 days (Rs.): food-grains	cloth-ing	foot-wear	dur-ables	medical care	edu-cation	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
0–30	0.40	9.21	0.17	0.16	0.04	0.49	0.44	20.54	0.31	8.98	1.97	0.31	0.25	0.41	0.23	20.66
30–40	0.57	15.06	0.09	0.18	0.01	0.76	0.17	35.95	0.36	13.53	2.97	0.40	0.23	0.99	0.38	35.91
40–50	1.47	19.10	0.43	0.08	0.09	0.88	0.27	45.74	1.40	17.41	3.38	0.34	0.42	1.00	0.43	45.67
50–60	3.13	21.07	0.58	0.25	0.12	1.18	0.37	55.38	2.25	20.65	3.77	0.37	0.26	1.21	0.40	55.60
60–70	5.02	24.19	0.91	0.17	0.17	1.55	0.51	65.28	4.45	23.18	4.35	0.42	0.36	1.33	0.52	65.57
70–85	9.52	27.19	1.32	0.31	0.17	1.86	0.64	77.44	9.33	26.83	5.29	0.53	0.49	1.50	0.77	77.92
85–100	10.62	29.34	2.43	0.54	0.27	2.64	0.94	92.59	10.27	28.50	6.35	0.73	0.70	1.86	1.05	92.28
100–125	17.35	31.08	3.68	0.80	0.56	3.27	1.48	111.91	17.46	30.90	8.22	1.04	1.08	2.42	1.68	112.38
125–150	12.90	33.46	5.61	1.24	0.89	4.80	2.26	137.08	13.89	33.17	10.38	1.36	1.72	2.94	2.50	137.14
150–200	16.07	34.84	10.19	1.77	1.82	6.09	3.51	172.12	17.57	34.56	13.42	1.95	3.16	3.85	3.67	172.34
200–250	8.53	36.15	16.72	2.95	2.93	8.63	5.63	223.02	9.16	36.93	17.49	2.55	5.71	5.22	5.50	222.77
250–300	5.25	36.90	23.46	4.18	5.65	10.79	7.12	272.81	5.16	37.31	21.90	3.25	8.01	6.01	6.66	272.45
300 –	9.17	39.82	59.29	8.61	29.00	22.17	13.50	462.76	8.39	39.68	32.62	4.74	18.84	10.15	11.41	431.20
all classes	100.00	31.96	11.55	1.95	3.77	6.09	3.41	163.72	100.00	31.96	12.19	1.67	3.65	3.58	3.31	161.34

Table 4.2 shows the statewise averages of conventional PCE and adjusted PCE (Rs. per 30 days) for the 13 selected states, by sectors, together with the sample size, i.e., the number of sample households in each case. It can be seen that the average PCE for the states as well as for India as a whole, is usually slightly smaller for adjusted PCE, except for a few cases (Gujarat, rural and urban and Madhya Pradesh, urban). The two sets of averages are, however, broadly equal, the overall difference being 4 per cent for the rural sector and less than 2 per cent for the urban.

Tables 4.3R and 4.3U show the all-India elasticities separately for the rural and urban sectors, respectively, and also for the two half-samples and the combined sample. Estimates based on only one best-fitting Engel curve form are presented in each case.

As Tables 4.3R and 4.3U reveal, both $\eta_{\bar{x}}$ and $\bar{\eta}$ change dramatically for clothing with a switch in the reference period ; in both the sectors the elasticity is around 2.0–2.2 when last month data is used for all items of the budget but it drops to about 1.0–1.1 when annual data for clothing and other items, listed in the footnote of Table 4.3R, is used.

For footwear, the elasticity changes from 1.9–2.1 to about 1.4 for rural India and from 1.7–1.9 to 1.2–1.3 for urban India.

For durable goods, the elasticity is around 2.75 for rural India and 2.6–3.2 for urban India when data relate to the last month, but drops to about 2.1–2.2 for both the sectors when annual data are used for the five items including clothing.

For medical care, based on last month data, the elasticities are 1.6–1.7 for rural India and 1.3–1.4 for urban India; these drop to about 1.25 and 1.1, respectively, when annual information is used for items like clothing.

For education, the drop in elasticity is much smaller. For rural India, the elasticity decreases from about 1.8–1.9 to 1.65–1.75 when annual data are used for the listed items; the corresponding decline for urban India is from 1.5–1.8 to 1.5–1.6.

A small shift in elasticity is seen for foodgrains also but this shift is in the *opposite direction*, from about 0.4 to 0.5 for the rural sector.[1] However, for urban India, no such shift is discernible.

Similar results were obtained for the 13 major states considered here, namely, Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. The main results of this analysis are presented in Appendix C.

[1]It is possible that, on the whole, the change in reference period would shift most of the engel elasticities towards unity, which is the weighted average of engel elasticities of all items of the budget.

Table 4.2 : Statewise averages of *conventional* and *adjusted* PCE, for 13 selected states, rural and urban.

state	rural			urban		
		average PCE (Rs.)			average PCE (Rs.)	
	sample size (no. of hhs.)	conventional PCE	adjusted PCE	sample size (no. of hhs.)	conventional PCE	adjusted PCE
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	5492	114.60	105.79	2625	156.27	145.55
Bihar	7923	93.79	92.02	2126	138.74	135.73
Gujarat	2489	121.13	122.58	1732	162.90	167.00
Karnataka	3331	117.70	113.84	2271	166.18	164.44
Kerala	3057	140.28	134.60	1328	179.56	169.97
Madhya Pradesh	5728	100.80	97.60	2455	143.71	145.64
Maharashtra	5578	110.17	106.46	5150	184.72	184.33
Orissa	3086	97.32	95.79	901	148.63	146.95
Punjab	2152	169.93	157.09	1641	184.69	182.62
Rajasthan	3551	124.43	114.92	1611	163.69	154.46
Tamil Nadu	4391	118.18	112.80	3678	158.74	156.06
Uttar Pradesh	10554	103.12	98.03	4310	136.01	134.73
West Bengal	5012	105.71	103.64	3361	169.22	168.25
all-India	76797	111.93	107.75	40010	163.72	161.34

Table 4.3R : Estimates of engel elasticities for selected items of consumption, separately for the two reference periods, by engel curve type and by half-samples, all-India, rural.

no. of sample households : 76797

item	half-sample	reference period : last 30 days			reference period : last 365 days*		
		curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
foodgrains	h.s.1	LLI	0.40	0.45	LLI	0.49	0.52
	h.s.2	LLI	0.41	0.45	LLI	0.49	0.52
	comb.	LLI	0.40	0.45	LLI	0.49	0.52
clothing	h.s.1	LLI	2.16	2.09	LLI	1.02	1.02
	h.s.2	LLI	2.18	2.13	LLI	1.06	1.06
	comb.	LLI	2.17	2.11	LLI	1.04	1.04
footwear	h.s.1	LLI	2.00	1.96	LLI	1.38	1.37
	h.s.2	LLI	2.14	2.01	LLI	1.43	1.37
	comb.	LLI	2.07	1.98	LLI	1.41	1.38
durables	h.s.1	DL	2.73	2.73	DL	2.07	2.07
	h.s.2	DL	2.75	2.75	DL	2.16	2.16
	comb.	DL	2.75	2.75	DL	2.11	2.11
medical care	h.s.1	LLI	1.70	1.66	LLI	1.25	1.24
	h.s.2	BS	1.61	1.60	BS	1.27	1.26
	comb.	LLI	1.69	1.65	LLI	1.27	1.27
education	h.s.1	LLI	1.87	1.79	LLI	1.67	1.67
	h.s.2	LLI	1.98	1.91	LLI	1.74	1.71
	comb.	LLI	1.92	1.86	LLI	1.71	1.67

*Actually the reference period was last 30 days for most items of the budget but last 365 days for clothing, footwear, durables, medical care and education.

Table 4.3U : Estimates of engel elasticities for selected items of consumption, separately for the two reference periods, by engel curve type and by half-samples, all-India, urban.

no. of sample households : 40010

item	half-sample	reference period : last 30 days			reference period : last 365 days*		
		curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
foodgrains	h.s.1	LLI	0.23	0.28	LLI	0.26	0.30
	h.s.2	LLI	0.21	0.28	LLI	0.23	0.30
	comb.	LLI	0.22	0.28	LLI	0.25	0.30
clothing	h.s.1	LLI	2.22	2.17	LLI	1.06	1.06
	h.s.2	LLI	2.06	1.98	LLI	1.10	1.10
	comb.	LLI	2.13	2.07	LLI	1.08	1.08
footwear	h.s.1	LLI	1.82	1.84	LLI	1.27	1.26
	h.s.2	LLI	1.92	1.92	LLI	1.30	1.30
	comb.	BS	1.71	1.71	BS	1.24	1.24
durables	h.s.1	LLI	2.82	3.33	LLI	2.15	2.22
	h.s.2	DL	2.63	2.63	DL	2.10	2.10
	comb.	DL	2.57	2.57	DL	2.08	2.08
medical care	h.s.1	LLI	1.39	1.40	LLI	1.12	1.12
	h.s.2	LLI	1.32	1.30	LLI	1.06	1.06
	comb.	BS	1.33	1.33	BS	1.10	1.10
education	h.s.1	BS	1.54	1.53	BS	1.49	1.48
	h.s.2	LLI	1.78	1.79	LLI	1.63	1.63
	comb.	BS	1.61	1.60	BS	1.50	1.49

*See note below Table 4.3R.

Table 4.4 gives a summary of these results based on elasticities at average PCE ($\eta_{\bar{x}}$) and also those based on average elasticities ($\bar{\eta}$).[2]

The averages of the statewise elasticities for each item group are set out in cols.(4) and (5) of Table 4.4. The shift in elasticities with a change in the reference period is clearly discernible from these two columns, as in the case of the all-India results. For clothing, here too, the elasticities $\eta_{\bar{x}}$, drop from around 2.1 and 2.2 to around 1.0–1.1, for the two sectors, with a switch from last month to last year reference period. In case of $\bar{\eta}$ the clothing elasticities drop from around 2 to around 1.

Col.(7) shows that the drop in elasticities was the most dramatic for clothing— the average (simple mean) difference between the two sets of statewise elasticities being nearly 1.1 in both the sectors for $\eta_{\bar{x}}$; the average difference in $\bar{\eta}$ is 1.02 for the rural sector and 0.93 for the urban. This is followed by durables for which the average difference in $\eta_{\bar{x}}$ is 0.84 for the rural sector and 0.63 for the urban sector — the same difference being 0.91 and 0.59, respectively, in case of $\bar{\eta}$. The average differences are numerically smaller, but still quite sizable, for footwear and medical care. The differences between the elasticities based on last month data and last year data are the least pronounced for foodgrains and education.

Col.(6) presents counts needed for an application of the sign test to the 13 statewise differences. Note that for foodgrains and clothing, in either sector, all the statewise differences have the same sign and the same is true of medical care in the rural sector. The statistical significance of such shifts in the elasticities is beyond all doubt. A similar verdict can be given in all cases where the count in col.(6) is 11 or 12. However, for education, the sign test is rather inconclusive; based on $\eta_{\bar{x}}$ the shift is *not* significant for the urban sector and significant at the 5% level for the rural sector only if a *one-sided* test is used. Based on $\bar{\eta}$ the shift is not significant for either sector.

Note, from cols.(8) and (9), that in case of clothing the minimum differences, based on $\eta_{\bar{x}}$, between the two sets of statewise elasticities, for the rural and urban sectors, are as high as 0.62 and 0.76, respectively, the maximum differences being 1.44 and 1.34, respectively. The minimum differences based on $\bar{\eta}$ are also as high as 0.61 and 0.59, respectively, the maximum differences being 1.41 and 1.34, respectively.

[2]Each of these elasticities are from the curve form which best fits both last month and last year data for that particular item and state-sector combination — this is very often the LLI form. The cases where a common form is not available are not considered here, so the number of states covered (see col.3) is not always 13 in Table 4.4.

Table 4.4 : Summary of statewise differences in engel elasticities for 13 major states based on (i) *last month* data and on (ii) *last year* data, whenever available*, rural and urban.

sector	item	no. of states covered	average of statewise elasticities		summary of statewise differences*			
			last month data	last year data	no. of +ve differences	average difference	range of difference	
							minimum	maximum
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(a) based on $\eta_{\bar{x}}$								
rural	foodgrains	13	0.48	0.56	0	-0.09	-0.13	-0.01
	clothing	13	2.13	1.05	13	1.09	0.62	1.44
	footwear	11	2.00	1.37	11	0.63	0.28	0.85
	durables	12	2.94	2.11	12	0.84	0.36	1.01
	medical care	13	1.71	1.29	13	0.42	0.21	0.61
	education	11	1.70	1.51	10	0.19	-0.04	0.70
urban	foodgrains	13	0.27	0.32	0	-0.05	-0.11	-0.02
	clothing	13	2.20	1.10	13	1.10	0.76	1.34
	footwear	13	1.92	1.40	12	0.52	-0.09	0.86
	durables	13	2.73	2.10	12	0.63	-0.06	1.29
	medical care	13	1.37	1.10	11	0.27	-0.30	0.76
	education	13	1.82	1.68	9	0.14	-0.36	0.71
(a) based on $\bar{\eta}$								
rural	foodgrains	13	0.51	0.58	0	-0.08	-0.16	-0.01
	clothing	13	2.07	1.05	13	1.02	0.61	1.41
	footwear	11	1.91	1.34	11	0.57	0.39	0.79
	durables	12	2.97	2.06	12	0.91	0.41	1.82
	medical care	13	1.68	1.28	13	0.39	0.21	0.58
	education	11	1.69	1.51	9	0.18	-0.04	0.73
urban	foodgrains	13	0.32	0.36	0	-0.04	-0.11	-0.01
	clothing	13	2.02	1.09	13	0.93	0.59	1.34
	footwear	13	1.74	1.37	12	0.37	-0.10	0.86
	durables	13	2.68	2.09	12	0.59	-0.06	1.18
	medical care	13	1.36	1.11	11	0.25	-0.34	0.55
	education	13	1.72	1.62	9	0.10	-0.35	0.71

*See note below Table 4.3R

On the whole, Table 4.4 shows that the statewise results are corroborative of the all-India picture. In both the sectors, for foodgrains, the elasticity rises significantly but by a *small* amount and for all other items considered here, the elasticity falls significantly by *large* amounts, when one utilizes last year data in place of last month data for items like clothing. However, for education, in either sector, the decline is *small* and this decline is significant, by the sign test applied to col.(6) of Table 4.4, only for the rural sector when based on $\eta_{\bar{x}}$ and not significant for either sector when based on $\bar{\eta}$.

Since the average of PCE ($\bar{x}$) was slightly smaller for adjusted PCE than for conventional PCE the values of $\bar{\eta}$ based on last month data and on last year data presented in Tables 4.3R, 4.3U and 4.4 may not be strictly comparable. However, the estimate of $\eta_{\bar{x}}$ obtained from last year data was found to change very little when recalculated at the average PCE for last month data. Also the differences in average PCE are too small to explain the differences in $\bar{\eta}$ found for most of the items.

4.5 Conclusions

The previous section reveals that for items like clothing, where seasonality is pronounced, the estimates of engel elasticities depend critically on the reference period used for collecting household budget data. This problem has not received much attention in international literature.

In principle, one should use annual data as far as possible in engel curve analysis, and one should use appropriate methods of engel curve analysis when annual data are not available or when such data are liable to suffer from problems like recall lapse etc.

In the absence of reliable annual data one may utilize 'last month' or 'last week' data, treating the problem of seasonality as an errors-in-variables (EIV) problem, where the presence of errors in both item consumption and total consumption expenditure based on last month or last week data may lead to biased estimates of the parameters of the engel curve.

Chapter 5

IV Estimation of Engel Elasticities*

5.1 Introduction

The main motivation of the present dissertation is to estimate the engel elasticities of clothing and some other items of consumption, after eliminating the possible effects of seasonality and other short-run fluctuations, from Indian National Sample Survey (NSS) household budget data relating to the 'last month' reference period.

As already explained in the previous chapters, for its enquiries on household consumer expenditure, the NSS Organization generally employs a moving reference period of 'last 30 days' preceding the date of interview ('last month') and staggers the interviews evenly over the survey period, usually one year. Different households thus furnish information for different periods of 30 days and this introduces seasonality and other short-run factors into the data for any particular household. While the average consumption over sample households gives a fair approximation to annual levels of consumption, seasonal and other short-run fluctuations get superimposed on the true variation across households possibly distorting the engel curves, particularly for items like clothing which are considerably affected by seasonality and other transitory factors.

While scientific information is by no means plentiful, household consumption is known to be strongly seasonal in India, mainly due to the influence of agriculture and the cropping seasons on household incomes and prices.[1] Many rural households pass through lean periods with great difficulty and find much-needed relief in harvesting

*The results of this chapter are presented in Ghose and Bhattacharya (1997).

[1]Although not strictly relevant here, one may note that many official CPI numbers in India use varying weightages of items of the "fruits and vegetables" group for different seasons of the year (Labour Bureau, Govt.of India, 1972).

and post-harvest months. They tend to spend more on food, clothing, footwear etc in post-harvest months which often overlap with months when many of the festivals and wedding ceremonies are held. Even medical treatment may be postponed till the household has some cash income. Expenditure on education shows seasonal variation because school fees tend to be paid and books purchased in the early months of the academic year.

Unfortunately in India, as in many other LDCs, household budget data have to be collected by the interview method, because, quite often, households do not keep accounts or diaries, and receipts from shops/vendors are generally not available. The questionnaires are therefore filled up on the basis of responses of households based on their capacity for recalling past events. Faced with such a situation, the Indian NSS employs a moving reference period of last 30 days preceding the date of interview for collecting household consumption data. For any particular sample household the data relate to a randomly chosen period of 30 consecutive days ending on one of the 365 days of the survey year. Therefore, approximately speaking, if the unobserved annual total of consumption expenditure $\div$ (365/30) represents the true value of consumption, the reported value relating to the past 30 days can be taken as equal to the true value $\pm$ an error of observation whose expected value is nearly zero. [2]

In recent rounds like the 38th the NSS also collected additional data on consumption expenditure for 'the last 365 days' ('last year') preceding the date of interview for five item-groups : clothing, footwear, durables, medical care and education. Analysis of such data in the previous chapter showed that weighted least squares (WLS) estimates of engel elasticities for some of these items decline dramatically when available 'last year' data for these items are used in place of corresponding 'last month' data. When item consumption relates to 'last month' the determining variable is total consumer expenditure during the same month; but when item consumption relates to 'last year' (reduced to a monthly basis) the determining variable is total consumer expenditure during the last month on food and other items excluding the five items considered above plus 30/365 times total consumer expenditure on the five items. Actually, in the first case, the regression is of per capita item consumption on per capita total household consumption expenditure,

[2] As mentioned by Deaton (1997, pp. 25-27), many countries use last week or last month as reference period for food and some other groups of items but longer reference periods like last year (last 365 days) for more expensive and rarely purchased items like durables. Problems of seasonality are not fully eliminated by this. This was done in the recent rounds of the Indian NSS, which employed both last month and last year reference periods for several item groups. Note that the statement made in the last sentence of the foregoing paragraph remains approximately correct if one combines data for different reference periods to estimate the annual total of consumption expenditure for any individual household.

i.e., PCE ('last month') and in the second case, the regressor is PCE ('last year'). The true engel elasticity may be defined as the elasticity which would be obtained from the relation between 'permanent' components of item consumption and total income/consumption per capita. The elasticity derived from last year data would only be an approximation to this, if errors in observation are not too large.

As reported in the previous chapter (see also Ghose and Bhattacharya, 1995) using estimates based on a retabulation of all-India NSS 38th round (Jan.–Dec. 1983) household budget data the expenditure elasticity of clothing, for both rural and urban India, is found to be around 2.1 when 'last month' data is used for all items of the budget, but it drops to about 1.0-1.1 when annual data for clothing and other four items is used. Similarly, for footwear, the elasticity changes from 1.9-2.1 to about 1.4 for rural India and from 1.7-1.9 to 1.2-1.3 for urban India. The elasticity for durables drops from 2.75 for rural India and 2.6-3.3 for urban India to 2.1-2.2 for both rural and urban India when annual data is used. Similar changes are noticed for expenditure elasticities for medical care and education. Separate analyses for 13 major states of India yielded results which corroborated the main findings of the all-India analysis. These results highlight the need for special methods of estimating engel elasticities from budget data relating to short reference periods like 'last month' or 'last week'. The standard techniques of dealing with the EIV problem offer no easy solutions in this case, especially because the two errors in variables are correlated. Instrumental Variable (IV) estimation suggested by Liviatan (1961) is a possibility. The present chapter explores the possibility of IV estimation by using different combinations of item expenditures, excluding those items for which seasonality is pronounced, as instruments.

Section 5.2 describes briefly the data analyzed and the methodology adopted for this study. Sections 5.3, 5.4 and 5.5 present the important findings of the study. Section 5.3 compares the estimates of engel elasticities based on different IV estimators with WLS estimates based on last month and last year data. Section 5.4 makes a comparative study of these estimates in respect of the divergence between half-sample estimates of the elasticities. Section 5.5 examines the correlation between the chosen IVs and some estimates of the errors in the variables. Section 5.6 concludes the chapter with some observations.

5.2 Material Analyzed and Methodology

The present chapter is based on NSS 38th round (Jan.–Dec. 1983) ungrouped (household level) budget data available on the computer tapes provided to ISI, Calcutta, by the NSSO, Govt. of India.

NSS data for 13 states, namely, Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan,Tamil Nadu, Uttar Pradesh and West Bengal, are analyzed here separately for the rural and urban sectors. All-India results presented in Table 5.4 are in fact overall results for these 13 states combined, that is to say, the remaining states and union territories are excluded. The sample size for each state-sector combination is given in col.(2) of Tables 5.1R and 5.1U of the next section.

For this study the following three-parameter Working-Leser budget share form of engel equation (BS) was estimated by the IV method :

$$y/x = \alpha + \beta \ln x + \gamma/x \tag{5.2.1}$$

Here x is per capita total consumer expenditure on all items and y is per capita expenditure on the selected item, for a sample household, both based on last month data. This was found to be one of the best-fitting.forms for Indian NSS 38th round budget data (*vide* Chapter 4).[3]

To fit the Working-Leser function by IV method, (5.2.1) above was recast as

$$y = \gamma + \alpha x + \beta x \ln x \tag{5.2.2}$$

to avoid the regressand y/x. If one uses $\frac{y}{x} = \frac{Y+u}{X+v}$, there is a mix-up of the errors in variables v and u in x and y, respectively, and the model moves far from the simple linear EIV model analyzed in econometric literature. Since our focus is on the *bias* of the estimates, we ignore the problems of heteroscedasticity that may be created due to this reformulation of the Working-Leser function.

Note also that when we state that we used a pair of IVs $Z = (Z_1, Z_2)$, we really used Z_1 and $Z_2 \ln Z_2$ as the instruments for the estimation.

The IV estimation was done using the 2SLS estimation procedure with SHAZAM (see Judge, Griffiths et al., 1988, Chs. 14-15). The 2SLS estimator is given by

$$\hat{\beta}_{2SLS} = [X'Z(Z'Z)^{-1}Z'X]^{-1}X'Z(Z'Z)^{-1}Z'y \tag{5.2.3}$$

$$\text{and Var } (\hat{\beta}_{2SLS}) = \sigma^2[X'Z(Z'Z)^{-1}Z'X]^{-1} \tag{5.2.4}$$

$$\text{with } \hat{\sigma}^2 = \hat{u}'\hat{u}/(n-k) = (y - X\hat{\beta}_{2SLS})'(y - X\hat{\beta}_{2SLS})/(n-k) \tag{5.2.5}$$

The 2SLS estimator as defined in (5.2.3) is the same as the IV estimator of (1.4.11) (*vide* Chapter 1, Section 1.4) if the number of instruments is equal to the number of explanatory variables, as is the case in this study.

Since the sampling design adopted by the NSSO is a complex one, direct estimation of standard errors is difficult. However, the fact that the sample was divided into two independent replicates (interpenetrating sub-samples) having the

[3]The LLI form $\ln y = \alpha + \beta \ln x + \frac{\gamma}{x}$, which was also a best-fitting form, was avoided in view of the occurrence of zero item expenditures for a few households in the sample.

same basic design makes the estimation of standard errors fairly easy (Cochran, 1977).

If the combined sample consists of two independent replicates or interpenetrating subsamples and the estimates of any parameter Θ obtained from the two replicates are given by $\hat{\Theta}_1$ and $\hat{\Theta}_2$, then the combined sample estimate of Θ is given by

$$\hat{\Theta} = \frac{(\hat{\Theta}_1 + \hat{\Theta}_2)}{2},$$

and the variance of $\hat{\Theta}$ can be estimated as

$$\hat{V}(\hat{\Theta}) = \frac{(\hat{\Theta}_1 - \hat{\Theta}_2)^2}{4},$$

The estimated standard error of $\hat{\Theta}$ is :

$$S_{\hat{\Theta}} = \frac{|\hat{\Theta}_1 - \hat{\Theta}_2|}{2}.$$

Five variables have been tried as IVs from those item groups or subgroups of the household budget whose consumption is believed to be relatively less affected by seasonal and short-run factors, which is why only last month data were collected for them. These are :

c : per capita expenditure on cereals;

c+o : per capita total expenditure on all items excluding expenditure on the five seasonal items, namely, clothing, footwear, durable goods, medical care and education; so c+o includes expenditure on food, pan, tobacco, intoxicants, fuel and light, housing and certain groups of miscellaneous items;[4]

o : per capita total expenditure on all items minus expenditure on cereals and on five seasonal items mentioned above;

f : per capita expenditure on food;

c+o-f : per capita expenditure on non-food items excluding the five seasonal items.

Various pairs of these five basic instruments have been used to estimate the model.

[4]This IV was suggested by Professor Angus Deaton in a personal communication to the authors.

5.3 Results I : Comparisons of Different Estimates of Engel Elasticity

The results are presented in this and the next two sections.

This section presents some of the statewise engel elasticities based on different IV estimators and also the all-India rural and urban elasticities, for the five items considered. These elasticities are then compared on the basis of closeness of the different estimates to the conventional WLS estimates based on last month and last year data. We also examine the distances between the various pairs of estimates.

Cols. (5)-(13) of Tables 5.1R and 5.1U present the different IV estimates of engel elasticities for clothing for the rural and urban sectors of the 13 states. They also show the conventional estimates of elasticities from last month and last year data (*vide* cols. (3)-(4)) obtained by the usual WLS method. Similar results have been obtained for each of the other four seasonal items considered, namely, footwear, durable goods, medical care and education, but these have been presented in Appendix D.

Tables 5.2R and 5.2U give the results of comparison of the statewise elasticities from the IV method with the corresponding conventional WLS estimates based on last year data. For the sake of interest, WLS estimates based on last month data are also compared with similar estimates based on last year data. The upper half of each table shows the algebraic sum $\sum(Z_i-Z)$ of differences between the last year estimates (Z) and each selected IV estimate (Z_i), the sum extending over the 13 states separately for each item and for rural and urban sectors. The lower half of the table presents the corresponding sum of absolute differences $\sum|Z_i-Z|$. The different estimates have then been ranked (the ranks are shown in brackets) according to their closeness to last year estimates, separately for each item and sector.

Finally, col.(7) of either table gives the sum of these ranks over the five items considered for each of the estimators — it therefore indicates which of the IV estimates may be the best for estimating elasticities for all of the five seasonal items taken together.

Col.(7) of Table 5.2R shows that for the rural sector food expenditure gives the best pair of instruments (f, f) when judged by $\sum(Z_i - Z)$, and this is followed by the pair $(c+o, c+o)$. Judging by $\sum \mid Z_i - Z \mid$, $(c+o, c+o)$ is the best pair followed by (f, f) for the rural sector. Table 5.2U, col.(7), shows that $(c+o, c+o)$ and (f, f), in that order, are the best instruments for the urban sector also in terms of $\sum \mid Z_i - Z \mid$. By the criterion $\sum(Z_i - Z)$, however, for the urban sector, $(f, c+o-f)$ is the best followed by $(c+o-f, f)$. These rankings give the overall picture considering the five items together and judging by closeness to last year based estimates.

Table 5.1R : Estimates of engel elasticities for clothing, for 13 major states, obtained by different methods, rural sector.

states	no. of sample hhs.	WLS estimates		IV estimates based on last month data								
		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	5419	2.08	1.22	1.45	1.50	1.40	1.47	1.48	1.45	1.42	1.35	1.38
Bihar	7879	2.09	0.93	1.65	1.92	1.36	1.22	1.11	1.63	1.42	1.21	1.31
Gujarat	2477	2.35	1.25	1.75	1.78	0.93	1.55	1.58	1.74	1.55	1.74	1.64
Karnataka	3263	2.06	1.09	1.26	1.37	1.06	0.79	4.03	1.25	1.13	1.55	1.03
Kerala	3009	1.98	1.28	1.73	1.70	1.87	1.90	1.94	1.73	1.81	1.78	1.81
Madhya Pradesh	5719	1.98	0.90	1.75	2.02	1.01	0.98	1.94	1.75	1.28	1.43	1.01
Maharashtra	5517	1.91	0.89	1.21	1.32	0.92	0.84	0.72	1.22	1.00	2.01	6.82
Orissa	3052	1.86	0.94	1.13	1.38	0.67	1.05	1.06	1.09	0.91	1.09	1.06
Punjab	2095	2.03	1.01	1.16	1.04	1.56	1.49	1.39	1.14	1.53	1.39	1.51
Rajasthan	3530	1.76	0.84	1.26	1.31	0.88	0.55	0.18	1.27	1.06	0.63	0.91
Tamil Nadu	4540	1.86	1.24	2.17	2.41	1.70	2.34	2.43	2.38	0.39	5.28	4.24
Uttar Pradesh	10517	1.94	0.94	1.33	1.46	0.93	0.39	1.51	1.32	1.12	1.63	0.73
West Bengal	4996	1.96	1.13	1.38	1.41	1.41	1.38	1.40	1.50	1.20	1.13	1.09

Table 5.1U : Estimates of engel elasticities for clothing, for 13 major states, obtained by different methods, urban sector.

states	no. of sample hhs.	WLS estimates		IV estimates based on last month data								
		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	2494	1.93	1.34	0.89	0.84	0.92	0.66	0.10	1.01	0.63	-	0.26
Bihar	1992	1.96	1.09	1.15	1.13	0.50	1.21	1.24	1.11	1.07	0.87	1.04
Gujarat	1663	2.33	1.13	1.66	1.60	2.59	1.15	0.82	1.70	1.70	1.13	1.41
Karnataka	2097	1.98	1.12	2.45	2.16	3.24	0.59	5.01	2.53	2.89	2.21	2.43
Kerala	1225	2.05	1.27	1.64	1.69	1.66	1.51	1.51	1.62	1.66	1.61	1.61
Madhya Pradesh	2376	1.94	1.03	1.60	1.69	0.68	1.78	1.95	1.66	1.07	1.40	1.98
Maharashtra	4797	1.70	0.89	1.11	1.08	1.37	1.19	1.30	1.14	1.16	1.21	1.22
Orissa	824	1.99	1.09	1.36	1.30	1.56	1.32	1.29	1.36	1.54	1.64	1.32
Punjab	1557	1.88	0.95	1.24	1.23	1.34	1.04	1.08	1.34	1.00	1.35	0.86
Rajasthan	1579	1.74	0.96	1.13	1.19	0.45	1.12	1.12	1.15	0.71	1.11	1.17
Tamil Nadu	3499	1.98	1.20	0.79	0.48	1.52	1.75	1.68	0.87	1.12	1.08	1.11
Uttar Pradesh	4180	1.91	1.08	1.32	1.35	0.93	1.23	1.30	1.33	1.11	1.23	1.21
West Bengal	3138	1.87	1.06	1.19	1.22	1.04	1.16	1.20	1.18	1.06	1.19	1.17

Table 5.2R : Algebraic and absolute sums over 13 states of differences between IV estimates of elasticities (Z_i) and conventional WLS estimates from last year data(Z), rural sector.*

type of estimate		items										row sum
		clothing		footwear		durables		medical care		education		of ranks
(1)		(2)		(3)		(4)		(5)		(6)		(7)
						$\sum(Z_i - Z)$						
WLS :	last month	12.20	(10)	6.71	(8)	10.13	(10)	4.56	(8)	4.15	(6)	42
	last year	0.00		0.00		0.00		0.00		0.00		
IVs :	c+o,c+o	5.57	(4)	2.22	(5)	-1.35	(2)	-1.36	(4)	-0.63	(2)	17
	o,o	6.96	(6)	4.35	(7)	-1.63	(3)	0.11	(1)	0.95	(3)	20
	c,c	2.04	(1)	-2.38	(6)	-9.55	(8)	-6.83	(9)	-5.43	(8)	32
	c,o	2.28	(3)	-7.23	(10)	-3.79	(5)	-8.92	(10)	-10.38	(10)	38
	o,c	7.11	(7)	0.16	(1)	2.00	(4)	1.16	(2)	2.53	(5)	19
	f,f	5.81	(5)	2.06	(4)	-1.16	(1)	-1.32	(3)	-0.06	(1)	14
	c+o-f,c+o-f	2.16	(2)	-0.41	(2)	-5.99	(7)	-4.43	(7)	-4.93	(7)	25
	f,c+o-f	8.56	(8)	-1.30	(3)	5.62	(6)	-2.56	(5)	1.32	(4)	26
	c+o-f,f	10.88	(9)	6.73	(9)	9.76	(9)	-3.83	(6)	-7.62	(9)	42
						$\sum\|Z_i - Z\|$						
WLS :	last month	12.20	(10)	6.71	(6)	10.13	(4)	4.56	(5)	4.23	(1)	26
	last year	0.00		0.00		0.00		0.00		0.00		
IVs :	c+o,c+o	5.57	(4)	4.10	(2)	8.95	(1)	1.86	(1)	6.65	(3)	11
	o,o	6.96	(6)	6.33	(5)	8.97	(2)	2.11	(3)	6.67	(4)	20
	c,c	3.30	(1)	6.28	(4)	11.15	(5)	7.03	(6)	8.99	(6)	22
	c,o	4.66	(3)	10.41	(9)	20.13	(7)	8.92	(7)	15.66	(9)	35
	o,c	8.77	(7)	8.90	(8)	26.46	(9)	12.20	(8)	17.25	(10)	42
	f,f	5.81	(5)	3.70	(1)	8.98	(3)	1.88	(2)	6.12	(2)	13
	c+o-f,c+o-f	3.92	(2)	5.45	(3)	11.23	(6)	4.45	(4)	8.75	(5)	20
	f,c+o-f	8.98	(8)	7.20	(7)	24.04	(8)	13.14	(9)	15.62	(8)	40
	c+o-f,f	11.50	(9)	17.33	(10)	31.64	(10)	14.97	(10)	15.50	(7)	46

*Figures within parentheses are ranks of the estimates presented in a particular column of a sub-table, based on the algebraic/absolute sum of differences.

Table 5.2U : Algebraic and absolute sums over 13 states of differences between IV estimates of elasticities (Z_i)and conventional WLS estimates from last year data(Z), urban sector*.

type of estimate		items										row sum
		clothing		footwear		durables		medical care		education		of ranks
(1)		(2)		(3)		(4)		(5)		(6)		(7)
						$\sum(Z_i - Z)$						
WLS :	last month	11.05	(10)	4.72	(6)	7.29	(10)	2.96	(4)	1.40	(3)	33
	last year	0.00		0.00		0.00		0.00		0.00		
IVs :	c+o,c+o	3.32	(6)	-2.75	(3)	-5.80	(7)	-4.62	(7)	-0.97	(2)	25
	o,o	2.75	(5)	-3.03	(4)	-6.40	(8)	-3.94	(6)	-0.24	(1)	24
	c,c	3.59	(7)	-10.84	(10)	-4.78	(3)	-7.38	(10)	-8.67	(10)	40
	c,o	1.50	(1)	-6.24	(9)	-3.07	(2)	-3.48	(5)	-4.70	(6)	23
	o,c	5.39	(9)	-1.56	(2)	-5.16	(6)	1.47	(2)	-6.97	(8)	27
	f,f	3.79	(8)	-0.77	(1)	-5.03	(5)	-4.95	(8)	-1.67	(4)	26
	c+o-f,c+o-f	2.51	(3)	-6.22	(8)	-8.81	(9)	-5.99	(9)	-7.81	(9)	38
	f,c+o-f	1.82	(2)	-5.12	(7)	-1.54	(1)	0.21	(1)	-5.53	(7)	18
	c+o-f,f	2.58	(4)	3.18	(5)	-4.92	(4)	-2.65	(3)	-3.64	(5)	21
						$\sum\lvert Z_i - Z\rvert$						
WLS :	last month	11.05	(10)	5.82	(1)	7.41	(1)	3.66	(1)	2.70	(1)	14
	last year	0.00		0.00		0.00		0.00		0.00		
IVs :	c+o,c+o	5.04	(3)	6.31	(2)	8.46	(4)	6.06	(5)	5.87	(2)	16
	o,o	5.19	(6)	6.83	(4)	8.00	(2)	5.68	(3)	7.34	(6)	21
	c,c	7.67	(8)	14.84	(10)	19.40	(10)	8.96	(9)	12.13	(10)	47
	c,o	3.93	(1)	7.66	(6)	11.73	(7)	5.92	(4)	8.54	(8)	26
	o,c	8.49	(9)	10.90	(9)	14.62	(8)	9.31	(10)	8.09	(7)	43
	f,f	5.11	(4)	6.69	(3)	8.25	(3)	6.13	(6)	6.69	(4)	20
	c+o-f,c+o-f	4.63	(2)	9.04	(8)	14.95	(9)	7.27	(7)	9.59	(9)	35
	f,c+o-f	5.18	(5)	8.60	(7)	10.78	(5)	7.51	(8)	7.19	(5)	30
	c+o-f,f	5.20	(7)	7.04	(5)	11.38	(6)	4.57	(2)	5.88	(3)	23

*See note below Table 5.2R.

Table 5.3 : Pairwise comparisons of statewise elasticities for *clothing*, obtained by different methods, rural sector.

		WLS estimate		type of IV estimate (based on last month data)								
type of estimate		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						$\sum(Z_i - Z_j)$						
WLS :	last month	0.00										
	last year	-12.20	0.00									
IV :	c+o,c+o	-6.63	5.57	0.00								
	o,o	-5.24	6.96	1.39	0.00							
	c,c	-10.16	2.04	-3.53	-4.92	0.00						
	c,o	-9.92	2.28	-3.29	-4.68	0.24	0.00					
	o,c	-5.09	7.11	1.54	0.15	5.07	4.83	0.00				
	f,f	-6.39	5.81	0.24	-1.15	3.77	3.53	-1.30	0.00			
	c+o-f,c+o-f	-10.04	2.16	-3.41	-4.80	0.12	-0.12	-4.95	-3.65	0.00		
	f,c+o-f	-3.64	8.56	2.99	1.60	6.52	6.28	1.43	2.75	6.40	0.00	
	c+o-f,f	-1.32	10.88	5.31	3.92	8.84	8.60	3.77	5.07	8.72	2.32	0.00
						$\sum \mid Z_i - Z_j \mid$						
WLS :	last month	0.00										
	last year	12.20	0.00									
IV :	c+o,c+o	7.25	5.57	0.00								
	o,o	6.42	6.96	1.69	0.00							
	c,c	10.16	3.30	4.67	6.30	0.00						
	c,o	10.88	4.66	4.65	5.96	3.24	0.00					
	o,c	10.17	8.77	6.24	6.49	7.73	6.21	0.00				
	f,f	7.43	5.81	0.46	1.59	4.89	4.59	6.10	0.00			
	c+o-f,c+o-f	10.04	3.92	4.31	6.00	3.34	4.70	8.17	4.59	0.00		
	f,c+o-f	10.68	8.98	6.57	7.08	8.50	7.46	8.55	6.45	8.30	0.00	
	c+o-f,f	15.90	11.50	10.91	11.90	10.30	9.54	14.27	10.75	11.10	8.42	0.00

Table 5.4 : Weighted mean* of 12** statewise elasticities obtained by different methods, rural and urban.

		WLS estimates		IV estimates based on last month data								
sector	item	last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
rural	clothing	2.00	1.01	1.43	1.54	1.12	1.01	1.47	1.43	1.26	1.45	1.77
	footwear	1.78	1.22	1.30	1.47	0.82	0.23	1.16	1.29	1.01	1.11	1.85
	durables	2.77	2.05	1.76	1.74	1.49	1.14	2.27	1.79	1.48	3.04	2.50
	medical care	1.62	1.27	1.14	1.27	0.66	0.37	1.77	1.14	0.86	1.65	0.96
	education	1.73	1.39	1.31	1.47	0.80	-0.05	1.64	1.36	0.86	1.86	0.32
urban	clothing	1.91	1.06	1.36	1.34	1.36	1.13	1.46	1.39	1.26	1.19	1.29
	footwear	1.74	1.25	1.24	1.26	0.65	1.06	1.33	1.38	1.06	1.07	1.22
	durables	2.67	1.99	1.53	1.48	1.83	1.84	1.48	1.59	1.43	1.77	1.54
	medical care	1.34	1.11	0.81	0.86	0.56	0.85	1.23	0.77	0.75	1.14	0.92
	education	1.62	1.60	1.26	1.27	0.88	1.36	0.93	1.19	0.89	1.06	1.16

*Statewise 1981 census populations were used to construct weights as *population* × *average per capita item expenditure.*

**Tamil Nadu was excluded for reasons explained in the text.

If one looks at individual items, instruments based on $c+o$ or f do not appear to be the best for many item-sector combinations, especially for the urban sector, and also for clothing in either sector if one takes the 'last year' estimate as the criterion.

Interestingly, the conventional WLS estimate based on last month data appears to be closer to last year based estimates than any IV estimate judging by sums $\sum \mid Z_i - Z \mid$ for several items, especially in the urban sector. But the sums $\sum(Z_i - Z)$ give a very different picture — last month estimates tend to be relatively far from last year based estimates on this criterion. Note that the sums $\sum(Z_i - Z)$ would be better indicators of systematic biases, if any, of different estimates, compared to the last year estimate.

Table 5.3 presents, as an example, a summary picture of the distances between different pairs of statewise estimates for clothing for the rural sector. The upper half of the table shows the algebraic sum of differences between each pair of estimates $\sum(Z_i - Z_j)$, the sum being over the 13 states. The lower half of the table shows the corresponding sum of absolute differences $\sum \mid Z_i - Z_j \mid$. Table 5.3 and analogous tables (shown in Appendix D) for other item-sector combinations generally show that IV estimates $(c+o, c+o)$ are close to IV estimates (f, f) and (o, o), which is quite understandable.

Table 5.4 presents the all-India rural and urban elasticities for the five items under consideration calculated as a weighted average of 12 statewise elasticities using the 1981 census population of each state (sector) to construct its weight as *population* × *average expenditure*. Here Tamil Nadu has been excluded from the 13 states originally considered since it appears that the correlation between IVs and the seasonal disturbances are exceptionally high for Tamil Nadu (see Section 5.5) due to the existence of a few outliers in the data which were detected at the last stage when no remedial steps could be taken.

The estimates presented in Table 5.4 should be much less affected by sampling errors than the statewise estimates, and should therefore reveal relative biases, if any, of the different estimates of elasticities. Taking the last year estimates in col.(4) as the criterion, one finds that IV estimates $(c+o, c+o)$ or (f, f) — these are quite close, especially for the rural sector — are, on the average, roughly equal to the last year estimates for several of the ten item-sector combinations. But there are fairly large discrepancies for other combinations like clothing for rural sector and all but footwear for urban sector. The instruments (c, o) and $(f, c+o-f)$ seem to be better for some items in the urban sector.

5.4 Results II : Divergence between Half-Sample Estimates

This section presents the results, mainly, of the examination of divergences between half-sample estimates of engel elasticities for the different choices of instruments.

For each statewise engel elasticity estimated by IV method, the standard error of the combined sample estimate was estimated from the divergence between the two half-sample estimates of the same elasticity. Tables 5.5R and 5.5U first present (see sub-table (a)) the median of these statewise standard errors separately for each IV estimate, and also for each item and sector.

Next, in sub-tables (b) in both the tables, we present the median rank of each IV estimate by the magnitude of standard error. Note that this is not the rank of the medians shown in sub-table(a). The different estimates were ranked by size of standard error, separately for each state, and then the median of statewise ranks obtained by each IV estimate was found and presented in sub-table (b).

Finally, sub-tables (c) in Tables 5.5R and 5.5U show the standard deviations of the statewise engel elasticities estimated by different IV techniques. For reasons stated earlier, the estimates for Tamil Nadu were excluded from such calculations. Sub-table (c) does not relate to sampling errors, strictly speaking. But since the true values of the statewise elasticities are unlikely to be really different, the standard deviation of statewise elasticities should reflect the sampling variability of the statewise estimates.

For the rural sector, judging by median ranks in sub-table (b) of Table 5.5R, IVs $(c+o, c+o)$ and (f, f) seem to give the most stable estimates followed by (o, o).

The medians of standard errors in sub-table (a) show that (f, f) may have a slight edge over $(c+o, c+o)$ in point of sampling error.

The picture is somewhat different for the urban sector — see sub-tables (a) and (b) of Table 5.5U. Four choices of instruments — $(c+o, c+o), (f, f), (o, o)$ and $(c+o-f, c+o-f)$ appear to give the best estimates (with the smallest half-sample divergence); the choice (o, c) may also be good in a few cases.

The standard deviations in the sub-tables (c) broadly corroborate the above. The instruments $(c+o-f, c+o-f)$ also seem to be good for the rural sector for some items. But for the urban sector, the same instruments $(c+o-f, c+o-f)$ seem to be relatively poor when compared to $(c+o, c+o), (f, f)$ and (o, o). The choice (c, o) seems to be good for several items.

Table 5.5R : Comparisons of sampling variability of statewise elasticities obtained by different methods of IV estimation, rural sector.

item	instrumental variables used								
	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(a) median of statewise standard errors based on divergence between half-sample estimates									
clothing	0.095	0.190	0.140	0.225	0.520	0.075	0.150	0.350	0.315
footwear	0.110	0.100	0.235	0.225	0.420	0.110	0.175	0.215	0.370
durables	0.400	0.330	0.395	0.550	0.685	0.320	0.555	0.935	0.885
medical care	0.075	0.120	0.255	0.250	0.680	0.065	0.090	0.540	0.230
education	0.310	0.335	0.185	0.345	0.940	0.235	0.305	0.775	0.535
(b) median rank of each IV estimate by size of standard error									
clothing	3	6	4	6	8	4	4	7	6
footwear	3.5	3	5	6	8	3.5	6	7	6
durables	3	3	5	7	7	2	5	7	6
medical care	3	4	6	7	7	3	3	8	6
education	4	4.5	3	5	7	4	4	9	7
(c) standard deviation of elasticities for different states excluding Tamil Nadu									
clothing	0.23	0.27	0.33	0.43	0.89	0.23	0.25	0.35	1.58
footwear	0.45	0.59	0.59	0.98	0.97	0.45	0.39	0.69	3.08
durables	0.62	0.49	1.13	1.34	1.95	0.63	0.98	2.45	4.72
medical care	0.26	0.31	0.51	0.73	1.53	0.26	0.30	1.59	1.96
education	0.74	0.76	1.05	1.81	1.78	0.72	0.91	1.66	1.73

Table 5.5U : Comparisons of sampling variability of statewise elasticities obtained by different methods of IV estimation, urban sector.

item	instrumental variables used								
	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(a) median of statewise standard errors based on divergence between half-sample estimates									
clothing	0.150	0.170	0.435	0.245	0.155	0.150	0.295	0.195	0.250
footwear	0.195	0.190	0.555	0.240	0.141	0.200	0.170	0.180	0.210
durables	0.410	0.365	0.830	0.515	0.435	0.430	0.460	0.695	0.580
medical care	0.205	0.220	0.355	0.310	0.310	0.215	0.210	0.430	0.375
education	0.175	0.150	0.700	0.415	0.270	0.200	0.190	0.305	0.460
(b) median rank of each IV estimate by size of standard error									
clothing	4	4	8	6	6	5	6	2	6
footwear	6	5	7	5	3	5	4	4	5
durables	3	3	8	5	5	5	5	7	6
medical care	4	5	7.5	6	7	4	3	5	4
education	4	3	7	6	7	3.5	3	5	6
(c) standard deviation of elasticities for different states excluding Tamil Nadu									
clothing	0.39	0.34	0.80	0.31	1.14	0.40	0.58	0.50	0.52
footwear	0.39	0.35	1.10	0.45	1.17	0.43	0.60	0.67	0.53
durables	0.70	0.62	2.03	1.26	1.64	0.71	1.21	1.19	1.07
medical care	0.42	0.41	0.69	0.37	1.31	0.44	0.50	1.05	0.37
education	0.19	0.29	1.17	0.76	0.67	0.29	0.53	0.26	0.39

5.5 Results III : Correlations between the IVs and the Errors in Variables

One may try to examine the correlation between the chosen instrumental variables and the seasonal/short-run disturbances in the regressors and the regressands utilizing the differences between the per capita total/item expenditure for the last month and the corresponding expenditure for the last year. If one assumes that the last year expenditures represent the 'true' values, then these differences can be taken as estimates of errors in variables. As already mentioned, in the consumer expenditure enquiry of the 38th round of the NSS, last year data was collected simultaneously with last month data for the five item groups: clothing, footwear, durables, medical care and education. Note that for the regressor $x \ln x$, the errors in variables were estimated as $x \ln x$ (last month) *minus* $x \ln x$ (last year, reduced to a 30 days basis).

Tables 5.6R and 5.6U present, in sub-tables (a), the values of the correlation coefficients between each instrument used and the estimated EIV in each regressor or regressand, averaged over twelve states, for the rural and urban sectors separately. The number of -ve signs occurring among the statewise correlations is also presented in subtables (b) of these tables. For the sake of interest, the instrument $f - c$ was included in these tables even though $f - c$ or $(f - c)\ln(f - c)$ was not used as instrument in this study.

Many of the instruments show small values of the (average) correlation coefficient — about 0.1 or 0.2 — with errors in x or $x \ln x$, but even these appear to be statistically significant by the two-sided sign test. In fact, the tendency would be significant at the 5% level if the number of negative signs in sub-table (b) is ≤ 2. The average value of the correlation is often smaller, about 0.1 or less, for the urban sector, and larger, about 0.15–0.20, for the rural sector.

As regards correlations between the instruments and the errors in the five itemwise expenditures, the correlations are somewhat higher (0.1–0.15) for expenditure on clothing or footwear and lower for the three remaining items. Actually, for durables and education, the average values of the correlations are nearly zero.

Interestingly, the correlations are nearly the same for any instrument Z and the corresponding instrument $Z \ln Z$.

Judging by these correlations, the best instruments would appear to be those based on $(c + o - f)$, followed by those based on c. But these did not perform as well as the IVs based on $c + o, o$ or f in the different comparative studies reported above.

Table 5.6R : Summary of 12 statewise correlation coefficients between estimates of errors in variables and the different instruments, rural sector.

errors in item of expenditure	instrumental variables											
	c+o	o	c	f	c+o-f	f-c	(c+o)*ln*(c+o)	o*ln*o	c*ln*c	f*ln*f	(c+o-f)*ln*(c+o-f)	(f-c)*ln*(f-c)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(a) average value of correlation coefficients over states												
total exp.(x)	0.17	0.15	0.11	0.19	0.04	0.19	0.16	0.15	0.11	0.19	0.03	0.18
x*ln*x	0.17	0.16	0.11	0.20	0.05	0.19	0.18	0.16	0.11	0.20	0.04	0.20
clothing	0.16	0.14	0.10	0.18	0.03	0.18	0.16	0.15	0.10	0.19	0.02	0.18
footwear	0.11	0.12	0.04	0.12	0.04	0.13	0.11	0.12	0.04	0.12	0.04	0.13
durables	0.04	0.03	0.04	0.05	0.001	0.04	0.04	0.03	0.04	0.05	0.00	0.04
medical care	0.07	0.06	0.05	0.08	0.02	0.07	0.06	0.05	0.05	0.07	0.02	0.06
education	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.00
(b) no. of -ve signs among the statewise correlation coefficients												
total exp.(x)	0	0	0	0	1	0	0	0	0	0	2	0
x*ln*x	0	0	0	0	1	0	0	0	0	0	2	0
clothing	0	0	0	0	3	0	0	0	0	0	3	0
footwear	1	1	1	0	2	1	1	1	1	0	2	1
durables	3	3	3	3	3	2	3	2	3	3	4	2
medical care	0	0	1	0	3	0	0	0	1	0	3	0
education	5	5	5	6	8	4	5	6	6	6	9	5

Table 5.6U : Summary of 12 statewise correlation coefficients between estimates of errors in variables and the different instruments, urban sector.

errors in item	instrumental variables											
of expenditure	c+o	o	c	f	c+o-f	f-c	(c+o)*ln*(c+o)	o*ln*o	c*ln*c	f*ln*f	(c+o-f)*ln*(c+o-f)	(f-c)*ln*(f-c)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(a) average value of correlation coefficients over states												
total exp.(x)	0.09	0.08	0.05	0.11	0.02	0.10	0.09	0.08	0.05	0.11	0.02	0.11
x*ln*x	0.09	0.08	0.05	0.11	0.02	0.11	0.09	0.08	0.05	0.12	0.02	0.11
clothing	0.09	0.09	0.06	0.11	0.03	0.10	0.10	0.09	0.07	0.12	0.03	0.10
footwear	0.08	0.08	0.01	0.09	0.03	0.10	0.08	0.08	0.01	0.09	0.03	0.10
durables	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
medical care	0.05	0.06	0.04	0.08	0.02	0.07	0.06	0.06	0.04	0.08	0.01	0.07
education	0.00	0.00	0.00	0.00	-0.03	0.00	0.00	0.00	-0.01	0.00	-0.03	0.00
(b) no. of -ve signs among the statewise correlation coefficients												
total exp.(x)	1	1	2	0	3	0	1	2	1	0	4	1
x*ln*x	0	1	2	0	3	0	0	1	1	0	3	1
clothing	1	1	0	1	4	1	1	1	0	1	4	1
footwear	2	1	5	1	4	1	2	1	5	1	4	1
durables	5	5	4	5	8	6	5	5	4	6	8	6
medical care	0	0	2	1	3	1	1	1	2	1	5	1
education	5	6	5	5	8	6	5	7	5	5	8	5

5.6 Concluding Observations

Deaton (1997, p.89) notes that it is difficult to find instruments that are not correlated with the measurement errors while being related to the true values. The findings reported in Section 5.5 above suggest that some of the IVs tried here may have fairly low correlations with the errors in variables in the regressors or regressands considered. Consequently, IV estimates of engel elasticities based on 'last month' data may be taken as approximations to engel elasticities based on'last year' data. However, the approximation is not quite good, and if one tries to choose the best pair of IVs, the choice is not clear, being dependent on the item-sector combination in question. Different IVs give a range of estimates which may cover the last-year-based engel elasticity and, hopefully, the true engel elasticity.

Deaton states that seasonal patterns can be estimated and used to make corrections. But this would not remove the effects of other short-run fluctuations. Also, seasonal patterns can vary across regions, ethnic groups, occupational groups etc. In India, for the rural sector, one has a rough picture of seasonality in household consumption pattern, as a large proportion of households depend on cultivation and related activities. But all households do not depend on cultivation and related activities. Also, crop seasons and seasons for festivals or ceremonies need not be the same for all households within a region. So, subroundwise results by states do not show a very clear-cut picture of seasonality. Also, seasonal variation is less pronounced for the urban sector. These considerations may throw light on some of the results presented above.

The NSS data on household budgets are not above doubt, and Table 5.7 brings out one aspect of this. This table shows the average values of $x - X$, where $x =$ PCE (last month) and $X =$ PCE (per month, using last year data wherever available), separately for different class-intervals of X, for rural areas of five selected states. Note that $x - X$ is really the discrepancy between last month expenditure on the five items considered here and the corresponding expenditure during the last year ($\times \frac{30}{365}$). If the data were perfect, these averages would be close to zero for each interval of X. One, however, finds a preponderance of positive values for most of the states. Table 3.1 of Ghose and Bhattacharya (1995) shows that for all-India rural, the per capita expenditure per 30 days, on the five items taken together, was

Rs.18.67 for the last month but Rs.14.46 for the last year reference period. [5]

Table 5.7 : Average values of the difference between PCE using *last month* data(x) and PCE using *last year* data(X) wherever available, by size classes of PCE (X), rural sector, 5 selected states.

class interval of PCE (X in Rs.)	average values of ($x - X$)				
	Andhra Pradesh	Maha-rashtra	Tamil Nadu	Uttar Pradesh	West Bengal
(1)	(2)	(3)	(4)	(5)	(6)
0–30	-1.17	-3.28	0.78	1.08	-1.73
30–40	0.34	-1.87	0.17	-0.05	-0.96
40–50	1.33	-2.14	-0.04	-0.56	-1.18
50–60	0.36	-1.67	-0.45	0.03	-0.33
60–70	1.78	-0.44	0.25	0.96	-0.70
70–85	1.54	-0.40	-0.36	1.68	-1.52
85–100	4.75	1.66	-0.25	1.99	0.30
100–125	7.41	0.64	0.22	4.70	0.99
125–150	14.23	3.39	2.88	6.70	4.36
150–200	17.36	10.58	6.78	13.26	3.96
200–250	29.80	18.53	26.00	17.67	5.05
250–300	40.91	12.71	6.58	19.80	23.84
300–	54.29	28.79	110.17	25.77	21.92

While this may partly explain the large proportion of positive discrepancies $x - X$ in Table 5.7, it cannot explain the increasing trend in the discrepancies as one considers higher and higher values of X. Some kind of recall bias, perhaps due to telescoping, might have affected the data, especially for the relatively affluent sections (see United Nations, 1982).

Note that in the present case engel curve estimation even if based on available last year data cannot give perfect results, because for food and for many groups of non-food items last year data is simply not available. The PCE (last year) denoted X is not a very good approximation to permanent consumption expenditure of the household. Nevertheless, for items like clothing affected by transitory factors, WLS

[5]For all-India rural and urban, the average item expenditures, for the five items, per capita per 30 days, based on *last month* data and *last year* data, are as follows:

sector	reference period	items					
		foodgrains	clothing	footwear	durables	medical care	education
rural	last month	36.29	9.00	1.13	2.40	5.19	0.95
	last year	36.30	7.92	0.87	2.14	2.72	0.81
urban	last month	31.96	11.55	1.95	3.77	6.09	3.41
	last year	31.96	12.19	1.67	3.65	3.58	3.31

estimates of engel elasticities based on last month data appear to be seriously biased and WLS estimates based on available last year data should be nearer to the true elasticities. IV estimates based on last month data may be good approximations to WLS estimates based on last year data. So the IV estimates may be useful when only last month data have been collected.

Chapter 6

Method of Moments Estimation of an Errors-in-Variables Model: Application to Engel Curve Analysis*

6.1 Introduction

The possibility of IV estimation of engel curves with Indian NSS data has already been explored in the previous chapter. Pal (1980a,b, 1981) introduced some moment estimators, of the kind first proposed by Geary (1942), for the bivariate EIV problem (*vide* Chapter 1, Section 1.4.4), which may be applied to household budget data collected for the 'last month' reference period.

This chapter applies method of moments estimation for a bivariate errors-in-variables model (EVM) in the context of engel curve analysis based on disaggregated NSS 38th round (Jan.– Dec. 1983) household budget data.

The problem of estimation in a bivariate EVM is further aggravated when the errors in the regressor and the regressand are correlated, as in the present problem of engel curve estimation. Moreover, the error in the regressor may be heteroscedastic. These two complications have been tackled in the present chapter, making realistic assumptions about the errors.

In this chapter Pal's (1980b, 1981) approach has been applied to NSS 38th round disaggregated household budget data, generalizing his estimators to take account of

*The results of this chapter are presented in Ghose, Pal and Bhattacharya (1997).

the two complications mentioned above, with a view to estimating engel elasticities overcoming the problem of EIV's in the 'last month' data.

The problem has been tackled in two stages. First, the parameters of a reasonable univariate model, for the size distribution of (per capita) total consumer expenditure, have been estimated. Next, these estimates have been utilized for estimating the parameters of the bivariate model. This is done on the assumption that the regressor is an exogenous variable and is not dependent on the regressand.

Section 6.2 describes briefly the data used in this chapter. Sections 6.3 and 6.4 outline the methodology adopted for method of moments estimation for the univariate and bivariate models, respectively. Section 6.5 presents the empirical results and Section 6.6 concludes the chapter with some observations.

6.2 Material Analyzed

This chapter too is based on NSS 38th round (Jan.– Dec. 1983) ungrouped (household level) budget data. It utilizes the computer tapes provided to ISI, Calcutta, by the NSSO, Govt. of India.

NSS Central Sample data for 13 major states, namely, Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal, are analyzed here separately for the rural and urban sectors, together with all-India data. The sample size (number of sample households) and average PCE for each state-sector combination and for all-India is given in Table 6.1 below.

Table 6.1 : Sample size and average PCE (Rs.)(per person per 30 days) for major states and all-India, rural and urban.

	rural		urban	
states	sample size	avg. PCE	sample size	avg. PCE
(1)	(2)	(3)	(4)	(5)
Andhra Pradesh	5481	113.97	2605	147.74
Bihar	7908	93.62	2120	138.13
Gujarat	2482	120.39	1716	160.07
Karnataka	3316	115.47	2255	164.34
Kerala	3045	138.00	1312	166.66
Madhya Pradesh	5718	100.78	2440	141.85
Maharashtra	5569	109.94	5106	181.45
Orissa	3082	97.36	898	148.38
Punjab	2143	168.37	1628	180.99
Rajasthan	3337	121.04	1599	156.93
Tamil Nadu	4369	109.70	3658	154.10
Uttar Pradesh	10534	102.64	4298	135.40
West Bengal	5003	104.64	3344	165.64
all-India	76580	110.71	39754	159.93

The bottom 0.1% of the population and households with per capita total expenditure (PCE) > Rs.1000 (which amounts to almost the top 0.1% of the population) have been excluded from this analysis doubting the reliability of the data in these ranges.

Only the item group *clothing* is considered in the present chapter.

6.3 The Univariate Model and its Estimation

The univariate model starts from the decomposition

$$x_i = X_i + u_i, \quad i = 1, 2, \ldots\ldots, n \tag{6.3.1}$$

where x_i is the observed value of per capita total consumer expenditure (PCE) of the i-th household, X_i is the unobserved true component of x_i and u_i, the error component.

It is assumed that the u 's are mutually independent. It is also assumed that

$$E(u \mid X) = 0 \tag{6.3.2}$$

$$V(u \mid X) = a^2 X^b \tag{6.3.3}$$

where a and b are positive constants ; and

$$E(u^{2r+1} \mid X) = 0, \ \forall r = 1, 2, 3, \ldots. \tag{6.3.4}$$

One might go further and assume that $u \mid X$ is symmetrically distributed around expectation zero. But the assumptions (6.3.2) and (6.3.4) with $r = 1$ are milder than the symmetry assumption.

The special cases $b = 0$ and $b = 2$ are of particular interest. Observe that $b = 0$ if X and u are independent, as in standard EIV models. But if further, $u \sim N(0, \sigma_u^2)$ and X is also assumed to be normally distributed, the model is not identified. In fact, when X is normally distributed the model is not identified even if $u \mid X \sim N(0, a^2X^2)$ (see Ghose, Pal and Bhattacharya, 1997, Appendix A).

Though b was found to be slightly greater than 2, it is assumed that $b = 2$ for this analysis, for reasons of convenience. The case $b = 2$ has already been referred to by Friedman (1957). It can also be shown that if X varies from zero to infinity, as in lognormal or gamma distributions, and if x, the observed variate, is always positive then b must be equal to 2 (see Ghose, Pal and Bhattacharya, 1997, Appendix B, for the proof). Although $b \neq 2$ is theoretically impossible in the circumstances considered above, in practice one may not find X to be very small or very large, as assumed in the proof, in the sample data. So one need not always be confined to the case $b = 2$.

Fortunately, X is not normal. The distribution of PCE is positively skewed. In Indian analysis of budget data it is often assumed to be two-parameter lognormal (LN). Only occasionally the three-parameter LN has been considered in the literature (see Ahmed and Bhattacharya, 1972; Iyengar and Jain, 1974; Jain, 1977 and Bhattacharya, 1978b, among others). The three-parameter form has been assumed here, specifically:

$$X \sim \Lambda(\lambda, \mu, \sigma^2),$$

where λ denotes the threshold parameter. The introduction of the threshold parameter λ makes the estimation more difficult.

The assumption $u \mid X \sim N(0, a^2X^2)$ implies that x can take negative values, in principle. To ensure that $x = X + u \geq 0$ it was assumed that $u \mid X$ follows Pearsonian Type II distribution, which is symmetric and broadly resembles the normal distribution.

Thus, $u \mid X \sim P_{II}(-X, X, m)$ with p.d.f

$$\begin{aligned} p(u \mid X) &= X^{-1}K_m(1 - \frac{u^2}{X^2})^m, \; -X \leq u \leq X \text{ and } m > -1 \quad (6.3.5) \\ \text{where } K_m &= B^{-1}(m+1, \frac{1}{2}) = B^{-1}(m+1, m+1)2^{-2m-1} \end{aligned}$$

One may assume $m > 0$ since errors near zero are more probable than errors away from zero.

This distributional assumption has the additional advantage that one can utilize higher order moments and fractional moments for estimation.

Alternatively, the model defined by (6.3.1), (6.3.2) and (6.3.3) may be written as

$$\begin{aligned} x &= X(1 + \frac{u}{X}) \\ &= X(1 + u') \quad (6.3.6) \\ \text{where } u' &= \frac{u}{X} \end{aligned}$$

We then assume $u' \sim P_{II}(-1, 1, m) \; \forall X$

$$\begin{aligned} \text{Therefore } p(u') &= K_m(1 - u'^2)^m, \; -1 \leq u' \leq 1 \text{ and } m > -1 \\ \text{with } E(u'^{2r+1} \mid X) &= 0, \; \forall r = 0, 1, 2, \ldots.. \\ \text{and } E(u'^{2k}) &= \frac{B(k + \frac{1}{2}, m+1)}{B(\frac{1}{2}, m+1)} \\ \text{which gives } V(u') &= \frac{1}{2m+3} \; [= \theta^2 \text{ (say)}] \quad (6.3.7) \end{aligned}$$

The parameters of the univariate model to be estimated are thus λ, μ, σ^2 and θ^2.

The assumption about λ

There are some well-known difficulties in the estimation of the threshold parameter of a three-parameter LN distribution (see Munro and Wixley, 1970; Jain, 1977; Cohen and Whitten, 1980; Itoh and Sugiyama, 1980). These difficulties increase further in the presence of EIV's. Hence instead of trying to estimate λ from the model itself, the values of λ are chosen on a trial basis, through inspection of the observed PCE (x) distribution. Three different values of λ have initially been tried out in each case. For example, for all-India rural and also for all-India urban, the three trial values of λ were chosen to be (Rs.) 10, 15 and 20.

Estimation of μ, σ^2 and θ^2

For any value of λ, assumed *a priori*, the remaining three unknowns of the univariate model, namely, μ, σ^2 and θ^2 may be estimated by the ML method. But the NSS sampling design involves complications like stratification, multi-stage selection, pps and/or systematic sampling of units and this makes ML estimation almost impossible. Therefore method of moments has been resorted to. Various types of moments were tried (see Appendix E), some relatively sensitive to large values of x and others relatively sensitive to small values of x. Also truncation has been tried out, from below and from above, to eliminate the doubtful observations. All these experiments finally led to the following three moment equations :

$$\bar{x} = \lambda + e^{\mu + \frac{1}{2}\sigma^2} \tag{6.3.8}$$

$$\overline{\ln x} = E(\ln X) + E\ln(1+u') \tag{6.3.9}$$

$$\overline{\frac{1}{x}} = E(\frac{1}{X}).E(\frac{1}{1+u'}) \tag{6.3.10}$$

$$\text{where } E(\frac{1}{1+u'}) = \frac{2m+1}{2m} = \frac{1-2\theta^2}{1-3\theta^2} \text{ [where } \theta^2 = \frac{1}{2m+3}] \tag{6.3.11}$$

$$\text{and } E\ln(1+u') = E(u' - \frac{u'^2}{2} + \frac{u'^3}{3} - \frac{u'^4}{4} + \cdots)$$

$$= -\sum_{r=1}^{\infty} \frac{\mu_{2r}(u')}{2r} \tag{6.3.12}$$

$$\text{and } \mu_{2r}(u') = \frac{1.3.5.7....(2r-1)\theta^{2r}}{(1+2\theta^2)(1+4\theta^2)\ldots(1+(2r-2)\theta^2)} \tag{6.3.13}$$

Solving equations (6.3.8), (6.3.9), (6.3.10) one gets estimates of θ^2, σ^2 and μ. These estimates are later used in the bivariate model incorporating errors in item expenditure (y), as well as in total consumer expenditure (x).

Estimation of θ^2, that is, $V(u')$

As already mentioned, due to the difficulties involved in estimating λ, trial values of λ were initially used to estimate the univariate model.

Method of moments estimates of engel elasticities were found to be rather sensitive to changes in trial values of λ, particularly through its effect on θ^2 [*i.e*, $V(u')$]. In fact, sometimes no solution to the univariate model was found, θ^2 turning out to be negative, for some particular λ values, implying that the model rejects such a low value of the threshold parameter λ.

Hence the estimate of θ^2 was obtained as $\widehat{\theta^2} = \widehat{V(u')}$, where $u' = \frac{u}{X} = \frac{x-X}{X}$, directly from disaggregated sample data, where x is average PCE *last month* and X is average PCE *last year*.

Now varying λ, one got a series of estimates of θ^2, denoted $\widehat{\theta^2(\lambda)}$. Finally, $\hat{\lambda}$ was obtained by inverse interpolation such that $\widehat{\theta^2(\hat{\lambda})} = \widehat{\theta^2}$ (obtained directly). The entire bivariate model was then estimated with $\lambda = \hat{\lambda}$.

6.4 Estimation of the Bivariate Model

6.4.1 A Simple Linear Bivariate Model

In order to understand the problem in the context of a bivariate set-up where the regressor and the regressand contain correlated EIV's, one may first consider the following simple linear model :

$$Y_i = \alpha + \beta X_i + \epsilon_i, \quad i = 1, 2, \ldots, n \tag{6.4.1}$$

where X_i's and Y_i's are the true but non-observable magnitudes of monthly per capita total expenditure (x_i) (regressor) and item expenditure (y_i) (regressand), respectively; ϵ's are the disturbances assumed to be independent of other variables not involving ϵ with

$$E(\epsilon_i) = 0, \quad V(\epsilon_i) = \sigma_\epsilon^2, \quad \forall i = 1, 2, \ldots, n. \tag{6.4.2}$$

The observed values x_i and y_i (based on last month data, say) are

$$x_i = X_i + u_i \tag{6.4.3}$$

$$y_i = Y_i + v_i \tag{6.4.4}$$

where u_i's and v_i's are EIVs with

$$E(u_i) = E(v_i) = 0$$

$$V(u_i) = \sigma_u^2 \ and \ V(v_i) = \sigma_v^2 \quad \forall \ i = 1, 2, \ldots, n. \tag{6.4.5}$$

and they are also assumed to be non-autocorrelated and also uncorrelated with the true components X_i and Y_i.

In case of engel curve analysis, however, it must be recognized that $\text{Cov}(u_i, v_i) \neq 0$, necessarily.

This is only to be expected for items like clothing which are purchased/consumed in particular seasons, say, after harvest or for festivals. Note that the transitory components of item expenditures add up to generate the transitory component of total expenditure.

It is easily seen that

$$\underset{n \to \infty}{\text{plim}} \hat{\beta}_{\text{OLS}} = \frac{\beta\sigma_X^2 + \text{Cov}(u, v)}{(\sigma_X^2 + \sigma_u^2)}. \tag{6.4.6}$$

6.4.2 Estimation of the Bivariate Model Assuming the Working-Leser Form for the Engel Function

In this chapter, the three-parameter budget-share form of engel curve (Working-Leser form) is considered. This form was found to be one of the best-fitting forms for NSS 38th round household budget data (Ghose and Bhattacharya, 1995). Other suitable engel curve forms had $\ln y$ as regressand and these are more difficult to handle in view of zero observations on y for a good proportion of households.

The Working-Leser form is given by

$$\frac{Y}{X} = \alpha + \beta \ln X + \frac{\gamma}{X} \tag{6.4.7}$$

This was recast as

$$Y = \alpha X + \beta X \ln X + \gamma \tag{6.4.8}$$

to avoid the mixing up of EIV's u and v in the regressand.

A linear dependence is assumed between the errors in x and y, i.e.,

$$v_i = \delta u_i + w_i, \tag{6.4.9}$$

$$\text{with } E(w_i) = 0 \text{ and } V(w_i) = \sigma_w^2 \quad \forall i \tag{6.4.10}$$

Thus, for estimation of engel elasticity four unknowns had to be estimated in this bivariate model, namely, α, β, γ and δ.

Estimation of δ

Instead of using four bivariate moment equations to estimate the four unknowns α, β, γ and δ, an estimate of δ was first obtained treating the expenditures based on 'last year' reference period as the true values X and Y, or in other words, the differences ('last month' minus 'last year' expenditure) as the EIV's u and v. (See Appendix E in this connection.)

However, the means of u_i and v_i estimated in this way were not found to be close to zero, presumably due to non-sampling errors. Hence an adjustment was made, by introducing

$$u_i^* = x_i - c_1 X_i \quad (6.4.11)$$

$$v_i^* = y_i - c_2 Y_i \quad (6.4.12)$$

where $c_1 = \bar{x}/\bar{X}$ and $c_2 = \bar{y}/\bar{Y}$, such that u_i^* and v_i^* have zero means. The estimate of δ was then obtained as

$$\hat{\delta} = \frac{\overline{u^* v^*}}{\overline{u^{*2}}} \quad (6.4.13)$$

Estimation of α, β and γ

The remaining three unknown parameters, namely, α, β and γ were estimated from two out of three bivariate moment equations (6.4.14) to (6.4.16) together with a fourth equation (6.4.18), shown below :

$$\begin{aligned}
\overline{yx} - \bar{y}\bar{x} &= \alpha[E(X^2) - E^2(X)] + \beta[E(X^2 \ln X) - E(X)E(X \ln X)] \\
&\quad + \delta\theta^2 E(X^2) \qquad (6.4.14) \\
\overline{(\frac{y}{x})} - \bar{y}\overline{(\frac{1}{x})} &= \alpha E[\frac{X - E(X)}{X}]E(\frac{1}{1+u'}) + \beta E[\frac{X \ln X - E(X \ln X)}{X}]E(\frac{1}{1+u'}) \\
&\quad + \delta E(\frac{u'}{1+u'}) \qquad (6.4.15) \\
\overline{y \ln x} - \bar{y}\,\overline{\ln x} &= \alpha[E(X \ln X) - E(X)E(\ln X)] + \beta[E(X \ln^2 X) - \\
&\quad E(\ln X)E(X \ln X)] + \delta E[u' \ln(1+u')]E(X) \qquad (6.4.16) \\
\text{where, } E(u' \ln(1+u')) &= E[u'(u' - \frac{u'^2}{2} + \frac{u'^3}{3} - \frac{u'^4}{4} + \cdots)] \\
&= \sum \frac{\mu_{2r}(u')}{2r-1} \qquad (6.4.17) \\
\bar{y} &= \alpha E(X) + \beta E(X \ln X) + \gamma \qquad (6.4.18)
\end{aligned}$$

Depending on the choice of two equations from (6.4.14) to (6.4.16) three sets of estimates for α, β and γ are obtained and, corresponding to these, three estimates of engel elasticities were obtained.

The engel elasticity at average value of PCE ($\bar{x}$) is given by,

$$\eta_{\bar{x}} = 1 + \frac{\beta\bar{x} - \gamma}{E(y \mid \bar{x})} \quad (6.4.19)$$

6.5 Results

Tables 6.2R and 6.2U present the statewise and all-India results for rural and urban India, respectively. Cols.(2) and (3) of each table present the estimates of $V(u')$ ($\widehat{\theta^2}$) and of λ, the threshold parameter ($\hat{\lambda}$).

The estimates of engel elasticity of clothing at average PCE ($\bar{x}$) are presented in cols.(4) through (9). Cols.(4), (5) and (6) present the elasticities obtained from the three different moment estimators described in the previous section. The elasticities based on equations (6.4.14) and (6.4.15) is referred to as E1, those based on (6.4.14) and (6.4.16) as E2, and those based on (6.4.15) and (6.4.16) as E3. Cols.(7) through (9) present, for facility of comparison, estimates of the same elasticities obtained in previous chapters. Cols.(7) and (8) present the usual WLS estimates based on 'last month' data and 'last year' data, respectively (*vide* Chapter 4). One set of IV estimates, obtained in Chapter 5, is presented in col.(9). The instrument used is c+o, per capita consumption expenditure on relatively non-seasonal and stable items, i.e, total per capita expenditure excluding five item groups for which annual data were collected.

The estimates E1, E2 and E3 were obtained after excluding the bottom 0.1% and also roughly the top 0.1% of the population based on the PCE distribution. However, for urban Punjab, Rajasthan and Gujarat, sensible results were obtained only after the rejection of a higher percentage of the population from the bottom — 0.5% for Punjab and Rajasthan and 1% in case of Gujarat. Graphical tests for lognormality suggested these higher rates of rejection.

For urban Andhra Pradesh and Gujarat, $\widehat{\theta^2}$ turned out to be unrealistically high. So the frequency distribution of u' was examined and observations with $u' \geq 1$ and $u' \leq -0.4$ were rejected. For rural Gujarat, no reasonable results were obtained even after such double truncation on the distribution of u'.

For both the sectors, the three estimates E1, E2 and E3 are roughly equal for all the states, the estimate E2 tending to be slightly higher than E1 or E3. For rural Rajasthan, only E2 seems to be acceptable. For urban Maharashtra, E1 is unrealistically high. So, on the whole, E2 seems to be the most dependable among the three moment estimators.

Table 6.2R : Estimates of engel elasticities of clothing for different states and all-India, rural sector

	estimates from method of moments					other estimates		
						WLS		IV
states	$\widehat{\theta^2}$	$\hat{\lambda}$	E1	E2	E3	month	year	c+o
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Andhra Pradesh	0.048	29.86	1.28	1.36	1.29	2.08	1.22	1.45
Bihar	0.021	24.00	1.82	1.61	1.71	2.09	0.93	1.65
Gujarat	0.057	-	-	-	-	2.35	1.25	1.75
Karnataka	0.040	22.80	1.00	1.09	1.01	2.06	1.09	1.26
Kerala	0.032	36.00	1.49	1.58	1.52	1.98	1.28	1.73
Madhya Pradesh	0.029	27.71	1.51	1.55	1.52	1.98	0.90	1.75
Maharashtra	0.043	39.55	1.39	1.51	1.36	1.91	0.89	1.21
Orissa	0.024	10.00	1.46	1.36	1.42	1.86	0.94	1.13
Punjab	0.055	42.75	0.91	1.01	0.90	2.03	1.01	1.16
Rajasthan	0.075	38.00	0.58	0.86	0.42	1.76	0.84	1.26
Tamil Nadu	0.038	18.89	1.12	1.13	1.12	1.86	1.24	2.17
Uttar Pradesh	0.034	31.28	0.92	0.93	0.92	1.94	0.94	1.33
West Bengal	0.018	2.70	1.73	1.65	1.48	1.96	1.13	1.38
all-India	0.037	27.75	1.19	1.21	1.19	2.00	1.01	1.43

Table 6.2U : Estimates of engel elasticities of clothing for different states and all-India, urban sector

	estimates from method of moments					other estimates		
						WLS		IV
states	$\widehat{\theta^2}$	$\hat{\lambda}$	E1	E2	E3	month	year	c+o
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Andhra Pradesh	0.017	16.47	1.04	1.01	1.03	1.93	1.34	0.89
Bihar	0.049	47.00	1.30	1.48	1.27	1.96	1.09	1.15
Gujarat	0.024	46.35	1.13	1.21	1.13	2.33	1.13	1.66
Karnataka	0.039	24.50	1.27	1.38	1.35	1.98	1.12	2.45
Kerala	0.048	32.42	1.23	1.35	1.27	2.05	1.27	1.64
Madhya Pradesh	0.030	47.00	0.83	1.07	0.71	1.94	1.03	1.60
Maharashtra	0.036	24.00	1.80	1.04	1.05	1.70	0.89	1.11
Orissa	0.020	31.00	1.36	1.39	1.37	1.99	1.09	1.36
Punjab	0.045	20.71	1.53	1.56	1.58	1.88	0.95	1.24
Rajasthan	0.044	41.00	0.93	1.05	0.91	1.74	0.96	1.13
Tamil Nadu	0.038	29.00	1.08	1.20	1.11	1.98	1.20	0.79
Uttar Pradesh	0.030	39.00	1.23	1.35	1.23	1.91	1.08	1.32
West Bengal	0.022	27.00	1.26	1.14	1.21	1.87	1.06	1.19
all-India	0.041	30.51	1.00	1.11	1.02	1.91	1.06	1.36

6.6 Conclusions*

In the present chapter, method of moments estimation of engel elasticities, for clothing, is tried out utilizing last month data. Here an additional complication that the conditional variance $V(Y \mid X)$ is proportional to X^2 is also considered. The task is found to be fairly difficult and various realistic assumptions are made to overcome the hurdles. Thus, the distribution of the true value of x is taken as three-parameter lognormal; the distribution of the relative error in x is assumed to be Pearsonian type II in form; and the engel relation is assumed to be of the Working-Leser form. Even then, the moment equations did not yield sensible solutions in some cases; and truncation of observations with x-values too low or too high had to be resorted to.

Also, last year data on the five items had to be used at two stages and the way this was done implied that the true values X and Y of the bivariate EVM were not the unknown permanent components of the two variables but the same as the last year values. Naturally, the estimates obtained in this chapter (E1, E2 and E3 of Tables 6.2R and 6.2U) are rather close to the WLS estimates derived from last year data in Chapter 4 (Ghose and Bhattacharya, 1995). It would have been excellent if the model could be estimated solely from last month data treating the true X and Y as the unknown permanent components and not using any restrictive assumptions.

Tables 6.2R and 6.2U of this paper bring together the more important estimates of engel elasticities for clothing obtained in different ways.

WLS estimates based on 'last year' data range from 0.8 to 1.3, broadly speaking, for the different states and sectors. The WLS estimates based on 'last month' data are markedly different, ranging from 1.7 to 2.3. The 'last year' estimates seem to be nearer truth, and the 'last month' estimates are seriously biased, presumably due to the correlation between the transitory components of clothing expenditure and total expenditure.

The IV estimates tend to lie between the 'last month' and 'last year' estimates, and seem to be nearer the latter estimates than the former, for a majority of the cases. However, the IV estimates look doubtful, on the whole; they vary too much across the states compared to the 'last year' estimates. Probably the instrument used is itself affected by seasonality and only partially accomplishes the task for which it is used. The true elasticities may be nearer the 'last year' estimates. The estimate E2 may be safer than the IV estimates, as they vary less across the states; also they tend to be nearer the 'last year' estimates.

One thus has three estimates of the true engel elasticity – E2, WLS (last year)

*This section really offers concluding remarks on the main findings of this dissertation reported in Chapters 4 to 6.

and IV, and it is difficult to choose any one as the best. All that one can do is to consider all three and indicate an interval in which the true elasticity lies.

The conventional WLS estimates based on last month data are markedly different from estimates obtained by other approaches. However, these other approaches only indicate a range of plausible values of the engel elasticities and one cannot choose any *one* of them as the best. Evidently, there is need of considerable amount of research in this area of econometrics.

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Appendix A

Comparative Goodness of Fit of Different Engel Curve Forms

In this Appendix the values of the goodness of fit measures used, in Chapter 4, for choosing the best fitting engel curve form, are presented for the NSS 38th round, all-India data. These goodness of fit criteria — R^2, $\bar{R}^2$, $R_y^2 = r^2(y, \hat{y})$, W and DW statistics — have been described in detail in Chapter 3, Section 3.3 (see also Chapter 4, Section 4.3).

The estimates are presented for the six items studied in Chapter 4, namely, food-grains, clothing, footwear, durable goods, medical care and education, separately for the rural and the urban sectors. Tables A.1R and A.1U present the estimates based on the *last month* (last 30 days) data and Tables A.2R and A.2U are based on the *last year* (last 365 days) data.

Table A.1R : Comparative goodness of fit of different engel curve forms for six items, based on *last 30 days* data, rural India.

curve type	goodness of fit criteria					
	R^2	$\bar{R}^2$	R_y^2	W	DW	DW(adj)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
			foodgrains			
LI	0.985	0.983	0.975	0.971	0.80	1.00
LLI	0.995	0.994	0.992	0.992	1.71	1.10
SL	0.985	0.984	0.985	0.985	0.73	0.66
BS	0.978	0.974	0.762	0.749	1.04	0.78
			clothing			
DL	0.989	0.988	0.922	0.484	1.10	0.67
LLI	0.991	0.989	0.942	0.753	1.10	0.77
SL	0.679	0.649	0.679	0.679	0.36	0.45
BS	0.975	0.970	0.985	0.981	1.79	1.18
			footwear			
DL	0.984	0.983	0.904	0.345	1.06	1.00
LLI	0.988	0.985	0.936	0.746	1.17	1.07
SL	0.727	0.702	0.727	0.727	0.33	0.38
BS	0.961	0.953	0.979	0.966	1.88	1.35
			durable goods			
DL	0.993	0.993	0.999	0.995	0.83	2.30
LLI	0.996	0.995	0.999	0.978	1.20	2.46
SL	0.387	0.331	0.387	0.387	0.95	0.67
BS	0.824	0.789	0.956	0.900	1.20	0.71
			medical care			
DL	0.990	0.989	0.947	0.757	0.58	1.05
LLI	0.994	0.992	0.972	0.926	0.87	1.22
SL	0.772	0.751	0.772	0.772	0.48	0.47
BS	0.961	0.953	0.986	0.977	0.89	1.11
			education			
DL	0.979	0.977	0.940	0.564	1.02	1.31
LLI	0.983	0.980	0.969	0.881	1.20	1.79
SL	0.733	0.709	0.733	0.733	0.48	0.57
BS	0.960	0.952	0.991	0.984	1.18	1.86

Table A.1U : Comparative goodness of fit of different engel curve forms for six items, based on *last 30 days* data, urban India.

curve type	goodness of fit criteria					
	R^2	$\bar{R}^2$	R_y^2	W	DW	DW(adj)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
			foodgrains			
LI	0.988	0.987	0.994	0.993	1.42	1.42
LLI	0.988	0.986	0.993	0.992	1.52	1.15
SL	0.916	0.909	0.916	0.916	0.14	0.50
BS	0.979	0.975	0.660	0.585	0.64	0.92
			clothing			
DL	0.984	0.982	0.990	0.900	2.29	1.05
LLI	0.986	0.984	0.994	0.963	2.16	1.33
SL	0.745	0.722	0.745	0.745	0.33	0.82
BS	0.995	0.994	1.000	0.999	1.01	2.00
			footwear			
DL	0.965	0.962	0.987	0.946	1.00	1.21
LLI	0.965	0.958	0.985	0.925	1.14	1.15
SL	0.794	0.775	0.794	0.794	0.26	0.77
BS	0.978	0.974	0.998	0.996	1.55	1.80
			durable goods			
DL	0.938	0.932	0.996	0.930	1.48	1.44
LLI	0.973	0.967	0.999	0.977	2.45	1.76
SL	0.571	0.532	0.571	0.571	0.51	0.95
BS	0.907	0.888	0.979	0.964	0.89	1.11
			medical care			
DL	0.995	0.995	0.999	0.996	0.87	1.96
LLI	0.995	0.994	0.999	0.996	0.88	1.95
SL	0.827	0.811	0.827	0.827	0.32	0.89
BS	0.965	0.958	0.999	0.999	1.04	2.53
			education			
DL	0.972	0.969	0.973	0.912	1.16	0.76
LLI	0.972	0.967	0.970	0.888	1.25	0.76
SL	0.839	0.824	0.839	0.839	0.25	0.74
BS	0.928	0.914	0.989	0.980	1.15	0.86

Table A.2R : Comparative goodness of fit of different engel curve forms for six items, based on *last 365 days* data, rural India.

curve type	goodness of fit criteria R^2	$\bar{R}^2$	R_y^2	W	DW	DW(adj)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
			foodgrains			
LI	0.972	0.969	0.947	0.940	0.58	0.61
LLI	0.994	0.993	0.987	0.987	1.50	1.13
SL	0.986	0.985	0.986	0.986	1.51	1.10
BS	0.979	0.975	0.860	0.859	0.88	0.98
			clothing			
DL	0.997	0.997	0.995	0.995	1.03	0.95
LLI	0.998	0.997	0.992	0.990	1.32	1.18
SL	0.853	0.840	0.853	0.853	0.32	0.48
BS	0.409	0.291	0.992	0.990	1.33	1.18
			footwear			
DL	0.986	0.985	0.905	0.764	0.47	0.80
LLI	0.991	0.989	0.948	0.914	0.68	1.00
SL	0.887	0.877	0.887	0.887	0.26	0.56
BS	0.874	0.849	0.954	0.931	0.66	0.97
			durable goods			
DL	0.994	0.994	0.950	0.892	0.91	0.85
LLI	0.995	0.994	0.938	0.811	1.04	0.94
SL	0.634	0.600	0.634	0.634	0.37	0.47
BS	0.968	0.961	0.990	0.990	1.18	0.89
			medical care			
DL	0.993	0.992	0.950	0.929	1.63	1.52
LLI	0.993	0.991	0.955	0.939	1.62	1.51
SL	0.852	0.839	0.852	0.852	0.22	0.49
BS	0.853	0.823	0.960	0.949	1.57	1.40
			education			
DL	0.980	0.978	0.858	0.537	0.79	0.65
LLI	0.982	0.978	0.897	0.758	0.83	0.69
SL	0.849	0.836	0.849	0.849	0.22	0.44
BS	0.906	0.887	0.939	0.904	1.01	0.77

Table A.2U : Comparative goodness of fit of different engel curve forms for six items, based on *last 365 days* data, urban India.

curve type	goodness of fit criteria R^2	$\bar{R}^2$	R_y^2	W	DW	DW(adj)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
			foodgrains			
LI	0.984	0.983	0.994	0.994	1.47	2.15
LLI	0.985	0.982	0.992	0.992	1.57	1.74
SL	0.925	0.918	0.925	0.925	0.15	0.57
BS	0.981	0.978	0.777	0.748	0.43	1.08
			clothing			
DL	0.994	0.994	0.995	0.993	0.34	0.86
LLI	0.995	0.993	0.993	0.989	0.38	0.87
SL	0.905	0.897	0.905	0.905	0.21	0.64
BS	0.449	0.339	0.994	0.990	0.40	0.88
			footwear			
DL	0.971	0.968	0.971	0.944	0.38	0.95
LLI	0.971	0.965	0.968	0.935	0.39	0.94
SL	0.914	0.906	0.914	0.914	0.19	0.53
BS	0.623	0.548	0.974	0.956	0.43	1.01
			durable goods			
DL	0.975	0.973	0.996	0.995	0.46	0.88
LLI	0.986	0.983	0.987	0.933	1.15	0.96
SL	0.727	0.702	0.727	0.727	0.29	0.80
BS	0.985	0.982	0.999	0.999	1.03	1.14
			medical care			
DL	0.995	0.995	0.998	0.998	1.07	1.57
LLI	0.996	0.995	0.998	0.997	1.85	1.51
SL	0.879	0.868	0.879	0.879	0.25	0.83
BS	0.583	0.500	0.998	0.997	1.95	1.53
			education			
DL	0.974	0.972	0.968	0.902	0.44	0.66
LLI	0.974	0.969	0.972	0.922	0.41	0.66
SL	0.875	0.863	0.875	0.875	0.21	0.75
BS	0.905	0.886	0.987	0.978	0.36	0.72

Appendix B

Effect of the Reference Period on the Size Distribution of Population by PCE

In this appendix we report on the shift in the size distribution of population by PCE consequent upon a switch over from *conventional* to *adjusted* PCE mainly based on a re-tabulation done for NSS 38th round (Jan.–Dec.1983) data.

The main results can be seen from Tables 4.1R and 4.1U of Chapter 4, Section 4.4. The size distributions of PCE are shown in cols.(1),(2) and (10) of each table. It can be seen that for both rural and urban India, the distribution is more dispersed for conventional PCE than for adjusted PCE. Thus, for rural India, the percentage of population with PCE $\leq$ Rs 60 was 16.9 for conventional PCE but 14.55 for adjusted PCE; at the other end, 8.0 per cent of the population reported conventional PCE $\geq$ Rs 200 as against 6.02 per cent for adjusted PCE. These differences cannot be explained by the differences in the average of PCE.

Computations for constructing the Lorenz curve and estimating the Lorenz ratio and other measures of inequality of the size distribution of PCE were carried out separately for rural and urban India, and by half-samples, using information presented in cols.(2),(9),(10) and (17) of Tables 4.1R and 4.2U. The Lorenz curve was taken as the broken chain of straight lines joining points obtained from such data; thus, the convexity of the curve is ignored. The Lorenz curves based on conventional and adjusted PCE are shown in Figure 1, separately for rural and urban India.

Table B.1 presents the Lorenz ratios of the two sets of size distributions. It also presents shares of some fractile groups using both conventional and adjusted PCE, for rural and urban India.

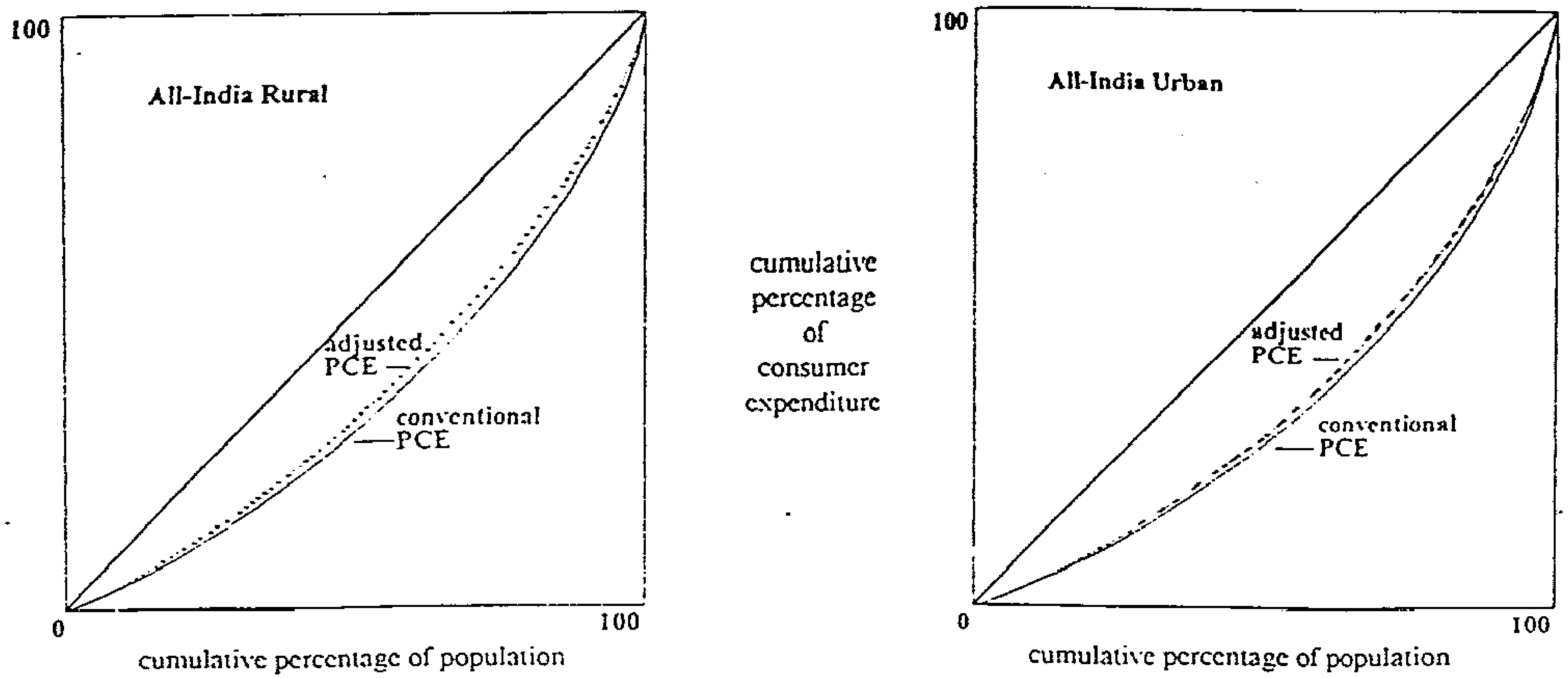

Fig. 1: Lorenz curves for the size distributions of *conventional* and *adjusted* PCE, based on NSS 38th round (Jan. - Dec. 1983) household budget data . All-India Rural and Urban

Table B.1 : Selected measures of inequality of the size distribution of population by *conventional* and *adjusted* PCE, based on NSS 38th round household budget data, all-India, rural and urban.

		conventional PCE				adjusted PCE			
	half	Lorenz	shares of different fractile groups			Lorenz	shares of different fractile groups		
sector	sample	ratio	bottom 25%	bottom 50%	top 10%	ratio	bottom 25%	bottom 50%	top 10%
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
rural	1	0.302	11.8	30.0	25.2	0.266	12.8	32.1	22.2
	2	0.298	11.9	30.1	24.6	0.263	12.9	32.1	21.9
	comb.	0.300	11.9	30.0	24.9	0.265	12.9	32.2	22.0
urban	1	0.334	10.8	27.5	27.6	0.307	11.5	29.2	25.4
	2	0.328	11.0	27.8	27.0	0.306	11.6	29.1	25.0
	comb.	0.321	10.9	27.6	27.3	0.306	11.6	29.2	25.1

It appears that the Lorenz ratio fell from 0.300 to 0.265 for the rural sector when adjusted PCE was used in place of conventional PCE. This is a considerable decline and half-samplewise results show that this decline is statistically significant. The corresponding decline is smaller, from 0.321 to 0.306, for urban India, but even here the differences seem to be statistically significant.

The shares of different fractile groups broadly corroborate the above. Figure 1 shows that the Lorenz curve for adjusted PCE is *interior* to that for conventional PCE, for both the sectors. The shift was significant for both the sectors and somewhat larger for the rural sector than for the urban.

It may be of interest to quote here similar results from NSS Report No.384 (*vide* NSSO, Govt. of India,1993) which examined the shifts in the size distribution of PCE based on NSS 43rd round (Jul.1987–Jun. 1988) data when last year data for clothing, footwear and durable goods were utilized in the same manner as done in the present study for NSS 38th round data.

The Lorenz ratios of PCE based on NSS 43rd round data are as follows (half-samplewise figures are not available):

	all-India rural	all-India urban
conventional PCE	0.297	0.347
adjusted PCE	0.273	0.327

Note that in the present study the adjustment was done for two more items—education and medical care. The effect of adjustment is larger here than for NSS 43rd round data (*vide* NSS Report No.384).

Appendix C

Statewise Engel Elasticities from NSS 38th Round Household Budget Data

In this Appendix we present the statewise elasticities of the selected items which have been studied in Chapter 4.

The estimates of elasticities are presented for the 13 selected states, namely, Andhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. The estimates of these statewise elasticities have been summarized and presented in Table 4.4 of Chapter 4, Section 4.4.

The statewise elasticities are presented here in Tables C.1R through C.6U, separately for the six items studied and separately for the rural and urban sectors. The elasticities based on both *last month* (last 30 days) data and on *last year* (last 365 days) data are given. Also, the elasticity at average of PCE (i.e., $\eta_{\bar{x}}$) as well as the average elasticity of the entire engel curve (i.e., $\bar{\eta}$) are presented in these tables.

Table C.1R : Estimates of engel elasticities for *foodgrains*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, rural, NSS 38th round.

state	reference period : *last 30 days*			reference period : *last 365 days*		
	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	LLI	0.40	0.43	LLI	0.41	0.44
	SL	0.41	0.43	LLI	0.41	0.44
Bihar	LLI	0.60	0.63	LLI	0.71	0.72
	SL	0.59	0.63	BS	0.73	0.72
Gujarat	SL	0.46	0.48	LLI	0.54	0.55
	BS	0.50	0.50	BS	0.55	0.55
Karnataka	LLI	0.60	0.62	LLI	0.73	0.73
	SL	0.58	0.58	BS	0.74	0.74
Kerala	LLI	0.50	0.53	LLI	0.57	0.59
	SL	0.49	0.49	BS	0.58	0.58
Madhya Pradesh	LI	0.37	0.44	LLI	0.49	0.53
	LLI	0.37	0.44	SL	0.50	0.53
Maharashtra	LLI	0.46	0.50	LLI	0.58	0.60
	SL	0.46	0.49	SL	0.58	0.61
Orissa	LI	0.50	0.55	LI	0.54	0.58
	LLI	0.53	0.57	BS	0.64	0.64
Punjab	LLI	0.50	0.52	LLI	0.61	0.62
	BS	0.49	0.49	SL	0.59	0.63
Rajasthan	LLI	0.28	0.24	LLI	0.38	0.40
	SL	0.29	0.31	SL	0.39	0.41
Tamil Nadu	LLI	0.52	0.57	LLI	0.61	0.63
	SL	0.51	0.57	SL	0.55	0.61
Uttar Pradesh	LLI	0.39	0.43	LLI	0.50	0.52
	SL	0.58	0.61	LLI	0.64	0.66
West Bengal	LLI	0.58	0.61	LLI	0.64	0.66
	SL	0.56	0.61	BS	0.65	0.65
all-India	LLI	0.40	0.45	LLI	0.49	0.52
	SL	0.41	0.44	SL	0.49	0.52

Table C.1U : Estimates of engel elasticities for *foodgrains*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, urban, NSS 38th round.

state	reference period : *last 30 days*			reference period : *last 365 days*		
	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	LI	0.28	0.34	LI	0.36	0.42
	LLI	0.28	0.35	SL	0.36	0.38
Bihar	LI	0.28	0.34	LI	0.33	0.38
	LLI	0.25	0.33	LLI	0.30	0.37
Gujarat	LLI	0.31	0.31	LLI	0.34	0.35
	SL	0.28	0.30	SL	0.29	0.30
Karnataka	LI	0.28	0.35	LLI	0.38	0.41
	LLI	0.33	0.38	SL	0.38	0.41
Kerala	LLI	0.34	0.41	LI	0.33	0.40
	BS	0.37	0.37	BS	0.42	0.42
Madhya Pradesh	LLI	0.26	0.31	LI	0.29	0.34
	BS	0.30	0.30	BS	0.33	0.33
Maharashtra	LI	0.22	0.29	LI	0.25	0.31
	LLI	0.23	0.29	LLI	0.26	0.31
Orissa	LI	0.21	0.26	LI	0.24	0.28
	LLI	0.14	0.23	LLI	0.16	0.25
Punjab	SL	0.36	0.39	LLI	0.48	0.47
	BS	0.38	0.39	BS	0.49	0.59
Rajasthan	LLI	0.24	0.30	LLI	0.31	0.33
	SL	0.27	0.39	SL	0.31	0.32
Tamil Nadu	LI	0.29	0.36	LI	0.32	0.39
	LLI	0.29	0.36	LLI	0.32	0.39
Uttar Pradesh	LI	0.21	0.26	LI	0.24	0.28
	LLI	0.21	0.26	LLI	0.24	0.29
West Bengal	LI	0.21	0.27	LI	0.23	0.29
	LLI	0.15	0.25	LLI	0.18	0.26
all-India	LI	0.22	0.28	LI	0.24	0.29
	LLI	0.22	0.28	LLI	0.25	0.30

Table C.2R : Estimates of engel elasticities for *clothing*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, rural, NSS 38th round.

state	reference period : *last 30 days*			reference period : *last 365 days*		
	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	BS	2.08	1.95	DL	1.20	1.20
	-	-	-	BS	1.22	1.22
Bihar	LLI	2.31	2.34	LLI	0.93	0.93
	BS	2.09	2.09	BS	0.91	0.91
Gujarat	LLI	2.68	2.62	LLI	1.25	1.25
	BS	2.35	2.37	BS	1.25	1.25
Karnataka	BS	2.06	2.05	LLI	1.10	1.09
	-	-	-	BS	1.09	1.09
Kerala	LLI	2.28	2.13	DL	1.30	1.30
	BS	1.98	1.98	BS	1.28	1.28
Madhya Pradesh	LLI	2.23	2.14	DL	0.90	0.90
	BS	1.98	1.98	LLI	0.90	0.90
Maharashtra	LLI	2.18	1.98	LLI	0.88	0.88
	BS	1.91	1.90	BS	0.89	0.89
Orissa	DL	1.84	1.84	LLI	0.95	0.94
	BS	1.86	1.86	BS	0.94	0.94
Punjab	LLI	2.45	2.36	LLI	1.01	1.01
	BS	2.03	2.03	BS	1.01	1.01
Rajasthan	BS	1.76	1.74	LLI	0.83	0.83
	-	-	-	BS	0.84	0.84
Tamil Nadu	BS	1.86	1.85	LLI	1.25	1.25
	-	-	-	BS	1.24	1.24
Uttar Pradesh	LLI	2.17	1.94	DL	0.94	0.94
	BS	1.94	1.93	LLI	0.94	0.94
West Bengal	LLI	2.11	2.04	LLI	1.12	1.13
	BS	1.96	1.97	BS	1.13	1.13
all-India	LLI	2.17	2.11	DL	1.02	1.02
	BS	1.94	1.94	LLI	1.04	1.04

Table C.2U : Estimates of engel elasticities for *clothing*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, urban, NSS 38th round.

	reference period : *last 30 days*			reference period : *last 365 days*		
state	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	DL	2.33	2.33	DL	1.26	1.26
	BS	1.93	1.93	BS	1.34	1.34
Bihar	LLI	2.34	1.88	DL	1.08	1.08
	BS	1.96	1.96	LLI	1.09	1.10
Gujarat	DL	2.37	2.37	DL	1.12	1.12
	LLI	2.33	2.31	LLI	1.13	1.13
Karnataka	LLI	2.30	2.16	DL	1.16	1.16
	BS	1.98	1.99	LLI	1.12	1.12
Kerala	DL	2.06	2.06	LLI	1.29	1.28
	LLI	2.05	2.04	BS	1.27	1.27
Madhya Pradesh	LLI	2.31	1.93	LLI	1.03	1.02
	BS	1.94	1.94	BS	1.03	1.03
Maharashtra	LLI	1.80	1.71	DL	0.90	0.90
	BS	1.70	1.70	LLI	0.89	0.89
Orissa	LLI	2.37	2.09	DL	1.08	1.08
	BS	1.99	1.99	LLI	1.04	1.09
Punjab	DL	2.30	2.30	DL	0.96	0.96
	BS	1.88	1.88	LLI	0.95	0.95
Rajasthan	LLI	2.05	1.94	LLI	0.95	0.95
	BS	1.74	1.72	BS	0.96	0.97
Tamil Nadu	LLI	2.35	1.99	DL	1.20	1.20
	BS	1.98	1.99	BS	1.20	1.20
Uttar Pradesh	LLI	2.31	2.01	DL	1.08	1.08
	BS	1.91	1.91	LLI	1.08	1.08
West Bengal	LLI	2.11	2.01	DL	1.05	1.05
	BS	1.87	1.87	LLI	1.06	1.06
all-India	LLI	2.13	2.07	DL	1.07	1.07
	BS	1.85	1.86	LLI	1.08	1.08

Table C.3R : Estimates of engel elasticities for *footwear*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, rural, NSS 38th round.

state	reference period : *last 30 days*			reference period : *last 365 days*		
	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	LLI	2.27	1.93	LLI	1.49	1.48
	BS	1.89	1.88	BS	1.40	1.40
Bihar	BS	2.33	2.32	DL	1.91	1.91
	-	-	-	LLI	1.89	1.87
Gujarat	DL	2.00	2.00	LLI	1.24	1.20
	BS	1.75	1.76	SL	1.10	1.22
Karnataka	DL	1.95	1.95	LLI	1.56	1.49
	BS	1.93	1.94	BS	1.45	1.45
Kerala	LLI	2.02	1.84	LLI	1.48	1.42
	BS	1.70	1.69	BS	1.52	1.51
Madhya Pradesh	LLI	1.86	1.82	LLI	1.25	1.23
	BS	1.76	1.76	SL	1.16	1.32
Maharashtra	LLI	1.79	1.72	DL	1.28	1.28
	BS	1.66	1.66	LLI	1.24	1.21
Orissa	DL	2.90	2.90	LLI	2.35	2.36
	BS	2.75	2.78	BS	2.02	2.02
Punjab	DL	1.53	1.53	DL	0.74	0.74
	BS	1.51	1.50	LLI	0.79	0.78
Rajasthan	LLI	1.50	1.32	DL	0.85	0.85
	BS	1.32	1.31	LLI	0.79	0.81
Tamil Nadu	LLI	1.99	1.93	LLI	1.71	1.54
	BS	1.83	1.83	BS	1.51	1.49
Uttar Pradesh	LLI	2.02	1.92	DL	1.19	1.19
	BS	1.85	1.85	LLI	1.17	1.17
West Bengal	BS	2.30	2.31	LLI	1.89	1.80
	-	-	-	BS	1.68	1.67
all-India	LLI	2.07	1.98	LLI	1.41	1.38
	BS	1.91	1.90	BS	1.35	1.35

Table C.3U : Estimates of engel elasticities for *footwear*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, urban, NSS 38th round.

	reference period : *last 30 days*			reference period : *last 365 days*		
state	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	LLI	2.12	1.83	DL	1.54	1.54
	BS	1.84	1.83	BS	1.61	1.60
Bihar	LLI	2.46	1.74	LLI	1.76	1.72
	BS	2.02	2.02	BS	1.68	1.67
Gujarat	LLI	1.69	1.76	DL	1.07	1.07
	BS	1.69	1.70	LLI	1.21	1.21
Karnataka	DL	1.80	1.80	LLI	1.46	1.43
	BS	1.85	1.84	BS	1.44	1.44
Kerala	LLI	1.86	1.43	LLI	1.29	1.17
	BS	1.60	1.60	BS	1.33	1.33
Madhya Pradesh	LLI	1.69	1.59	LLI	1.29	1.25
	BS	1.57	1.57	SL	1.15	1.33
Maharashtra	LLI	1.90	1.80	LLI	1.26	1.24
	BS	1.76	1.76	BS	1.20	1.20
Orissa	BS	2.12	2.10	LLI	1.74	1.67
	-	-	-	BS	1.63	1.63
Punjab	DL	1.79	1.79	DL	0.93	0.93
	BS	1.57	1.57	LLI	0.90	0.90
Rajasthan	LLI	1.59	1.48	LLI	1.02	1.02
	BS	1.46	1.45	BS	1.05	1.05
Tamil Nadu	LLI	2.12	2.02	DL	1.65	1.65
	BS	1.66	1.66	LLI	2.21	2.12
Uttar Pradesh	LLI	1.89	1.79	DL	1.24	1.24
	BS	1.73	1.72	LLI	1.22	1.20
West Bengal	LLI	1.88	1.49	LLI	1.31	1.29
	BS	1.70	1.69	BS	1.24	1.24
all-India	DL	1.85	1.85	DL	1.28	1.28
	BS	1.71	1.71	BS	1.24	1.24

Table C.4R : Estimates of engel elasticities for *durable goods*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, rural, NSS 38th round.

state	reference period : *last 30 days*			reference period : *last 365 days*		
	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	DL	3.20	3.20	DL	2.62	2.62
	BS	2.57	2.64	BS	2.23	2.23
Bihar	DL	2.92	2.92	DL	1.91	1.91
	LLI	2.88	2.74	BS	2.00	2.01
Gujarat	DL	3.31	3.31	BS	2.37	2.37
	LLI	3.34	3.97	-	-	-
Karnataka	LLI	3.30	3.17	LLI	2.29	2.26
	BS	2.46	2.52	BS	2.08	2.08
Kerala	DL	3.10	3.10	LLI	1.75	1.87
	LLI	3.23	3.69	BS	1.75	1.75
Madhya Pradesh	LLI	3.26	2.62	LLI	2.09	1.96
	BS	2.36	2.38	BS	1.97	1.96
Maharashtra	DL	3.06	3.06	DL	2.58	2.58
	LLI	3.16	3.43	BS	2.47	2.47
Orissa	DL	2.65	2.65	LLI	1.88	1.82
	LLI	2.81	3.16	BS	1.75	1.74
Punjab	DL	2.68	2.68	DL	2.02	2.02
	LLI	2.79	2.94	BS	2.00	2.01
Rajasthan	DL	2.87	2.87	LLI	2.28	2.18
	LLI	2.84	2.77	BS	2.08	2.08
Tamil Nadu	DL	2.79	2.79	LLI	1.79	1.78
	LLI	2.78	2.74	BS	1.71	1.70
Uttar Pradesh	DL	2.40	2.40	DL	2.04	2.04
	LLI	2.41	2.45	BS	2.02	2.01
West Bengal	DL	2.70	2.70	LLI	2.05	2.03
	LLI	2.86	3.12	BS	1.93	1.93
all-India	DL	2.75	2.75	DL	2.11	2.11
	LLI	2.80	2.94	BS	2.03	2.03

Table C.4U : Estimates of engel elasticities for *durable goods*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, urban, NSS 38th round.

state	reference period : *last 30 days*			reference period : *last 365 days*		
	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	DL	3.45	3.45	DL	2.36	2.36
	BS	2.42	2.51	BS	2.22	2.23
Bihar	LLI	3.40	3.85	DL	2.29	2.29
	BS	2.84	2.97	BS	2.21	2.22
Gujarat	DL	2.71	2.71	LLI	2.23	2.31
	LLI	2.84	3.11	BS	2.11	2.13
Karnataka	DL	2.92	2.92	LLI	2.25	2.22
	LLI	2.76	2.54	BS	1.99	1.99
Kerala	DL	3.07	3.07	LLI	1.76	1.89
	LLI	3.05	3.02	BS	1.65	1.66
Madhya Pradesh	DL	2.86	2.86	DL	2.26	2.26
	LLI	2.86	2.83	LLI	2.26	2.27
Maharashtra	DL	2.73	2.73	LLI	2.04	1.92
	LLI	2.88	3.10	BS	1.79	1.79
Orissa	DL	1.83	1.83	LLI	1.81	1.89
	BS	1.75	1.75	BS	1.81	1.81
Punjab	LLI	3.01	3.32	DL	1.95	1.95
	BS	2.36	2.43	LLI	2.00	2.03
Rajasthan	DL	2.37	2.37	LLI	1.98	1.97
	BS	2.05	2.09	BS	1.76	1.75
Tamil Nadu	DL	2.34	2.34	DL	2.01	2.01
	LLI	2.33	2.32	BS	1.91	1.91
Uttar Pradesh	DL	2.91	2.91	DL	2.22	2.22
	LLI	2.92	2.96	BS	2.08	2.07
West Bengal	LLI	2.75	2.36	LLI	2.44	2.29
	BS	2.15	2.16	BS	2.13	2.14
all-India	DL	2.57	2.57	DL	2.08	2.08
	LLI	2.81	3.18	BS	1.97	1.97

Table C.5R : Estimates of engel elasticities for *medical care*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, rural, NSS 38th round.

state	reference period : *last 30 days*			reference period : *last 365 days*		
	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	LLI	1.78	1.78	DL	1.23	1.23
	BS	1.62	1.61	LLI	1.29	1.31
Bihar	DL	1.75	1.75	DL	1.21	1.21
	BS	1.76	1.76	LLI	1.20	1.19
Gujarat	LLI	2.05	2.01	LLI	1.44	1.43
	BS	1.92	1.91	BS	1.45	1.45
Karnataka	DL	1.73	1.73	DL	1.29	1.29
	LLI	1.71	1.70	LLI	1.30	1.30
Kerala	LLI	1.33	1.30	LLI	0.98	0.99
	BS	1.29	1.29	-	-	-
Madhya Pradesh	LLI	1.91	1.88	LLI	1.47	1.46
	BS	1.77	1.76	BS	1.43	1.42
Maharashtra	LLI	1.82	1.78	LLI	1.37	1.37
	BS	1.72	1.72	BS	1.35	1.35
Orissa	BS	2.02	2.01	LLI	1.77	1.71
	-	-	-	BS	1.63	1.63
Punjab	LLI	1.22	1.23	DL	0.86	0.86
	BS	1.21	1.21	LLI	0.94	0.93
Rajasthan	LLI	1.72	1.58	LLI	1.21	1.17
	BS	1.53	1.52	BS	1.19	1.19
Tamil Nadu	LLI	1.62	1.53	LLI	1.22	1.21
	BS	1.51	1.49	BS	1.26	1.25
Uttar Pradesh	LLI	1.71	1.65	LLI	1.28	1.28
	BS	1.60	1.59	BS	1.29	1.29
West Bengal	LLI	1.66	1.59	DL	1.28	1.28
	BS	1.58	1.58	BS	1.37	1.37
all-India	LLI	1.69	1.65	LLI	1.27	1.27
	BS	1.59	1.59	BS	1.26	1.26

Table C.5U : Estimates of engel elasticities for *medical care*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, urban, NSS 38th round.

state	reference period : *last 30 days*			reference period : *last 365 days*		
	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	DL	1.62	1.62	DL	1.16	1.16
	BS	1.51	1.50	LLI	1.18	1.19
Bihar	DL	1.41	1.41	DL	0.74	0.74
	LLI	1.28	1.23	LLI	0.73	0.73
Gujarat	DL	1.82	1.82	DL	1.11	1.11
	LLI	1.88	1.92	LLI	1.12	1.12
Karnataka	LLI	1.20	1.15	DL	1.15	1.15
	BS	1.20	1.20	LLI	1.14	1.14
Kerala	DL	1.04	1.04	DL	0.91	0.91
	LLI	1.06	1.06	LLI	0.92	0.92
Madhya Pradesh	LLI	1.66	1.56	LLI	1.01	1.01
	BS	1.62	1.62	-	-	-
Maharashtra	DL	1.22	1.22	DL	1.06	1.06
	LLI	1.18	1.17	LLI	1.04	1.04
Orissa	DL	1.58	1.58	LLI	1.26	1.22
	BS	1.58	1.58	BS	1.28	1.28
Punjab	DL	1.12	1.12	DL	1.25	1.25
	LLI	1.07	1.06	LLI	1.37	1.40
Rajasthan	DL	0.92	0.92	DL	1.01	1.01
	LLI	0.93	0.93	LLI	0.98	0.98
Tamil Nadu	LLI	1.61	1.53	DL	1.50	1.50
	BS	1.49	1.49	BS	1.44	1.45
Uttar Pradesh	DL	1.42	1.42	DL	1.00	1.00
	BS	1.32	1.32	LLI	0.99	0.99
West Bengal	DL	1.50	1.50	DL	1.17	1.17
	LLI	1.48	1.48	LLI	1.16	1.16
all-India	DL	1.37	1.37	DL	1.08	1.08
	BS	1.33	1.33	BS	1.10	1.10

Table C.6R : Estimates of engel elasticities for *education*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, rural, NSS 38th round.

state	reference period : *last 30 days*			reference period : *last 365 days*		
	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	LLI	2.05	1.92	DL	1.88	1.88
	BS	1.91	1.89	BS	1.80	1.79
Bihar	DL	2.45	2.45	BS	2.18	2.17
	LLI	2.38	2.22	-	-	-
Gujarat	LLI	1.94	1.79	LLI	1.56	1.54
	-	-	-	BS	1.49	1.49
Karnataka	LLI	1.81	1.70	LLI	1.69	1.56
	BS	1.73	1.72	BS	1.54	1.54
Kerala	LLI	1.57	1.46	DL	1.27	1.27
	BS	1.50	1.50	LLI	1.27	1.27
Madhya Pradesh	LLI	1.90	1.62	-	-	-
	BS	1.80	1.78	-	-	-
Maharashtra	LLI	1.37	1.37	LLI	1.29	1.24
	SL	1.17	1.40	BS	1.34	1.34
Orissa	LLI	2.60	2.33	SL	1.65	1.98
	BS	2.20	2.18	BS	1.99	1.99
Punjab	DL	1.38	1.38	DL	1.00	1.00
	BS	1.31	1.30	LLI	1.11	1.11
Rajasthan	DL	2.42	2.42	LLI	1.40	1.33
	BS	1.99	2.02	BS	1.29	1.29
Tamil Nadu	SL	1.15	1.54	SL	1.13	1.41
	-	-	-	-	-	-
Uttar Pradesh	LLI	1.42	1.33	LLI	1.37	1.34
	SL	1.15	1.36	SL	1.20	1.37
West Bengal	BS	2.08	2.06	BS	2.12	2.10
	-	-	-	-	-	-
all-India	LLI	1.92	1.86	LLI	1.71	1.67
	BS	1.77	1.76	BS	1.63	1.63

Table C.6U : Estimates of engel elasticities for *education*, separately for the two reference periods, for the two best fitting engel curve types, for selected states and all-India, urban, NSS 38th round.

state	reference period : *last 30 days*			reference period : *last 365 days*		
	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$	curve type	$\eta_{\bar{x}}$	$\bar{\eta}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra Pradesh	LLI	2.21	1.88	DL	1.95	1.95
	BS	1.81	1.81	BS	1.74	1.73
Bihar	LLI	2.32	1.90	LLI	2.06	1.88
	BS	1.97	1.97	BS	1.86	1.85
Gujarat	DL	2.35	2.35	DL	1.78	1.78
	BS	2.05	2.03	BS	1.88	1.89
Karnataka	LLI	1.77	1.57	LLI	1.58	1.51
	BS	1.67	1.67	BS	1.47	1.46
Kerala	DL	1.71	1.71	LLI	1.47	1.51
	BS	1.60	1.60	BS	1.46	1.47
Madhya Pradesh	LLI	1.81	1.70	LLI	1.79	1.67
	BS	1.66	1.66	BS	1.66	1.66
Maharashtra	LLI	1.63	1.59	DL	1.73	1.73
	BS	1.51	1.50	LLI	1.66	1.62
Orissa	LLI	2.32	2.11	LLI	1.98	1.86
	BS	1.93	1.92	BS	1.69	1.69
Punjab	LLI	1.62	1.50	DL	1.06	1.06
	BS	1.53	1.52	LLI	1.19	1.20
Rajasthan	DL	1.21	1.21	LLI	1.49	1.48
	LLI	1.13	1.13	BS	1.41	1.40
Tamil Nadu	DL	2.36	2.36	DL	1.65	1.65
	LLI	2.36	2.37	BS	1.58	1.58
Uttar Pradesh	LLI	1.59	1.46	LLI	1.66	1.51
	BS	1.48	1.47	-	-	-
West Bengal	LLI	1.63	1.54	LLI	1.66	1.59
	BS	1.49	1.48	BS	1.53	1.52
all-India	DL	1.73	1.73	LLI	1.62	1.61
	BS	1.61	1.60	BS	1.50	1.49

Appendix D

Some Results from IV Estimation

The different statewise IV estimates of engel elasticities for clothing have been presented in Tables 5.1R and 5.1U, in Chapter 5, for the rural and urban sectors, respectively. Four other item groups were also studied – these are footwear, durable goods, medical care and education. Analogous tables for these items are presented in this appendix.

The estimates of elasticities for footwear are presented in Tables D.1R and D.1U for the rural and urban sectors, respectively. The statewise elasticities for durable goods for the rural and urban sectors, respectively, are presented in Tables D.2R and D.2U. Tables D.3R and D.3U present similar estimates for medical care and Tables D.4R and D.4U, for education, for the rural and urban sectors, respectively.

Cols.(5)-(13) of these tables present the different IV estimates described in Chapter 5, Section 5.2, of engel elasticities for the 13 states. They also show the conventional WLS estimates, of Chapter 4, from 'last month' and 'last year' data (*vide* cols.(3)-(4)).

A summary picture of the distances between different pairs of statewise estimates for clothing for the rural sector is presented in Table 5.3 (*vide* Chapter 5, Section 5.3); similar tables for clothing for the urban sector and for the other four items studied, namely, footwear, durable goods, medical care and education, for both the sectors are also presented in this appendix, from Table D.5U through Table D.9U.

Table D.1R : Estimates of engel elasticities for *footwear*, for 13 major states, obtained by different methods, rural sector.

states	no. of sample hhs.	WLS estimates		IV estimates based on last month data								
		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	5419	1.89	1.40	1.60	1.73	1.26	1.02	1.18	1.56	1.48	1.43	1.38
Bihar	7879	2.33	1.89	2.14	2.65	1.35	1.07	0.81	2.16	1.44	0.75	1.12
Gujarat	2477	1.75	1.24	0.74	0.65	1.07	0.87	0.80	0.83	0.71	0.58	0.62
Karnataka	3263	1.93	1.45	1.49	1.60	1.27	0.41	3.97	1.46	1.38	1.86	0.89
Kerala	3009	1.70	1.52	1.63	1.68	1.42	1.33	1.19	1.63	1.47	1.06	1.34
Madhya Pradesh	5719	1.76	1.16	1.50	2.09	-0.39	-0.61	0.83	1.45	0.49	0.27	-0.14
Maharashtra	5517	1.66	1.24	1.37	1.55	0.94	0.67	0.38	1.37	1.02	2.67	11.9
Orissa	3052	2.75	2.02	2.38	2.66	2.12	2.20	2.22	2.44	1.94	2.23	2.18
Punjab	2095	1.51	0.79	1.20	1.17	1.26	1.67	1.66	1.21	1.22	1.66	1.61
Rajasthan	3530	1.32	0.79	0.89	0.96	0.45	0.35	0.11	1.86	0.74	0.72	0.77
Tamil Nadu	4540	1.83	1.51	2.72	2.85	2.89	2.04	1.91	2.51	3.52	1.48	1.90
Uttar Pradesh	10517	1.85	1.17	1.18	1.34	0.59	-1.6	1.71	1.15	0.91	0.83	0.17
West Bengal	4996	2.30	1.68	1.24	1.28	1.25	1.24	1.25	1.29	1.13	1.02	0.85

Table D.1U : Estimates of engel elasticities for *footwear*, for 13 major states, obtained by different methods, urban sector.

states	no. of sample hhs.	WLS estimates		IV estimates based on last month data								
		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	2494	1.84	1.61	1.49	1.58	1.18	1.24	0.98	1.58	0.98	0.47	0.81
Bihar	1992	2.02	1.68	1.25	1.31	-1.2	1.44	1.46	1.27	0.37	1.77	1.94
Gujarat	1663	1.69	1.21	0.65	0.65	0.28	0.11	-.33	0.69	0.60	-.63	0.35
Karnataka	2097	1.85	1.44	2.37	2.14	3.24	0.26	5.00	2.47	2.77	2.25	2.40
Kerala	1225	1.60	1.33	1.38	1.45	1.40	1.34	1.35	1.38	1.34	1.39	1.36
Madhya Pradesh	2376	1.57	1.29	1.50	1.67	0.48	1.71	1.72	1.54	0.88	1.00	1.71
Maharashtra	4797	1.76	1.20	1.14	1.12	1.33	1.21	1.28	1.41	1.24	1.26	1.20
Orissa	824	2.12	1.63	1.04	1.14	0.40	1.12	1.31	1.14	0.38	1.36	1.62
Punjab	1557	1.57	0.90	1.26	1.32	0.52	0.81	1.16	1.33	0.89	1.36	0.82
Rajasthan	1579	1.46	1.05	1.19	1.22	0.64	1.18	1.18	1.94	0.92	1.17	1.22
Tamil Nadu	3499	1.66	2.21	-.35	-.98	-.44	-1.0	-1.1	0.12	-.60	-.96	-.93
Uttar Pradesh	4180	1.89	1.22	1.31	1.33	1.04	1.36	1.41	1.32	1.25	1.36	1.31
West Bengal	3138	1.70	1.24	1.03	1.03	-1.0	0.99	1.03	1.05	0.77	1.09	1.02

Table D.2R : Estimates of engel elasticities for *durable goods*, for 13 major states, obtained by different methods, rural sector.

states	no. of sample hhs.	WLS estimates		IV estimates based on last month data								
		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	5419	2.57	2.23	2.51	1.73	1.24	-.01	-.86	2.62	1.32	-.92	0.37
Bihar	7879	2.88	2.00	1.62	1.51	1.39	1.11	0.94	1.57	1.48	0.81	1.12
Gujarat	2477	3.34	2.37	-.04	0.44	-2.1	-1.3	-1.2	0.02	-1.7	-1.3	-1.6
Karnataka	3263	2.46	2.08	2.00	1.60	1.87	2.64	0.31	1.99	1.91	2.18	1.73
Kerala	3009	3.23	1.75	2.03	2.07	1.90	1.84	1.78	2.04	1.97	2.04	1.98
Madhya Pradesh	5719	2.36	1.97	1.45	1.71	1.12	2.55	3.57	1.40	1.21	3.63	2.31
Maharashtra	5517	3.16	2.47	1.53	1.67	1.14	0.86	0.61	1.50	1.33	2.38	17.7
Orissa	3052	2.81	1.75	2.25	2.59	1.76	2.05	2.06	2.19	2.00	2.07	2.06
Punjab	2095	2.79	2.00	1.72	1.80	1.66	1.38	1.40	1.72	1.67	1.42	1.41
Rajasthan	3530	2.84	2.08	2.27	2.20	2.68	3.38	3.87	2.35	2.12	3.47	2.88
Tamil Nadu	4540	2.78	1.71	4.26	4.10	0.33	7.05	8.22	4.10	3.82	6.04	5.51
Uttar Pradesh	10517	2.41	2.02	1.64	1.60	1.87	-.61	6.01	1.64	1.76	8.76	-.65
West Bengal	4996	2.86	1.93	1.77	1.71	1.97	1.70	1.67	2.06	1.51	1.38	1.27

Table D.2U : Estimates of engel elasticities for *durables goods*, for 13 major states, obtained by different methods, urban sector.

states	no. of sample hhs.	WLS estimates		IV estimates based on last month data								
		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	2494	2.42	2.22	2.83	2.39	3.69	5.00	6.00	2.94	3.14	3.99	3.70
Bihar	1992	2.84	2.21	2.64	2.84	-2.0	2.96	3.03	2.81	0.45	3.93	3.84
Gujarat	1663	2.84	2.11	0.72	0.76	1.67	0.88	0.68	0.81	-.16	-.25	1.39
Karnataka	2097	2.76	1.99	0.82	1.01	0.18	2.62	-1.1	0.78	0.35	2.25	0.94
Kerala	1225	3.05	1.65	1.94	1.44	2.25	1.82	1.78	1.94	2.05	1.69	1.77
Madhya Pradesh	2376	2.86	2.26	1.79	1.22	6.44	0.94	0.58	1.75	3.98	3.09	0.88
Maharashtra	4797	2.88	1.79	1.66	1.61	1.94	1.58	1.76	1.66	1.82	1.26	1.60
Orissa	824	1.75	1.81	0.85	0.87	0.95	0.88	1.04	0.85	0.80	1.74	1.10
Punjab	1557	2.36	2.00	0.69	10.80	-.55	-.17	0.49	0.82	-.02	0.82	-.13
Rajasthan	1579	2.05	1.76	1.34	1.48	0.62	1.33	1.30	1.42	0.67	1.31	1.46
Tamil Nadu	3499	2.33	1.91	1.59	1.65	2.82	1.83	1.88	1.61	1.64	1.65	1.62
Uttar Pradesh	4180	2.92	2.08	1.91	1.97	1.25	1.75	1.86	2.04	1.11	1.42	1.39
West Bengal	3138	2.15	2.13	1.44	1.48	1.88	1.43	1.46	1.46	1.28	1.48	1.44

Table D.3R : *Estimates of engel* elasticities for *medical care*, for 13 major states, obtained by different methods, rural sector.

	no. of	WLS estimates		IV estimates based on last month data								
states	sample hhs.	last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	5419	1.62	1.29	1.08	1.14	0.94	0.79	0.85	1.03	1.09	1.14	1.09
Bihar	7879	1.76	1.20	1.08	1.30	0.81	0.63	0.49	1.06	0.88	0.51	0.70
Gujarat	2477	1.92	1.45	1.65	1.88	-.29	1.36	1.50	1.66	0.85	-1.3	-1.6
Karnataka	3263	1.71	1.30	1.28	1.34	1.12	0.26	4.11	1.26	1.24	1.48	1.02
Kerala	3009	1.29	0.98	0.87	0.92	0.73	0.69	0.62	0.87	0.77	0.65	0.71
Madhya Pradesh	5719	1.77	1.43	1.41	1.80	-.24	-.85	-.39	1.43	0.41	-.65	-.29
Maharashtra	5517	1.72	1.35	1.40	1.51	1.14	1.03	0.86	1.42	1.13	2.34	6.92
Orissa	3052	2.02	1.63	1.55	1.61	1.41	1.57	1.58	1.56	1.50	1.59	1.58
Punjab	2095	1.21	0.94	0.85	0.95	0.60	0.33	0.39	0.86	0.63	0.40	0.35
Rajasthan	3530	1.53	1.19	0.98	1.04	0.74	0.65	0.62	0.98	0.82	0.88	0.84
Tamil Nadu	4540	1.51	1.26	1.07	1.04	1.36	0.96	0.89	1.07	1.27	0.58	0.73
Uttar Pradesh	10517	1.60	1.29	0.93	1.08	0.37	-.83	5.11	0.93	0.57	5.41	-.35
West Bengal	4996	1.58	1.37	1.17	1.18	1.16	1.17	1.19	1.23	1.09	1.09	1.15

Table D.3U : *Estimates of engel elasticities for medical care*, for 13 major states, obtained by different methods, urban sector.

states	no. of sample hhs.	WLS estimates		IV estimates based on last month data								
		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	2494	1.51	1.18	1.01	1.08	0.79	0.61	0.57	1.00	0.91	0.93	0.91
Bihar	1992	1.28	0.73	0.52	0.59	0.80	0.89	1.04	0.49	0.27	1.00	0.74
Gujarat	1663	1.92	1.45	0.11	0.31	-1.2	0.88	5.39	-.14	-.15	4.50	1.24
Karnataka	2097	1.20	1.14	0.86	0.84	0.87	0.69	0.88	0.85	0.89	0.75	0.82
Kerala	1225	1.06	0.92	0.93	0.99	1.08	1.05	1.06	0.92	0.97	1.15	1.06
Madhya Pradesh	2376	1.62	1.01	1.32	1.49	0.49	1.56	1.60	1.28	0.86	0.92	1.42
Maharashtra	4797	1.18	1.04	0.63	0.65	0.43	0.70	0.58	0.61	0.58	0.62	0.67
Orissa	824	1.58	1.28	0.77	0.96	-.29	0.92	1.23	0.81	0.08	1.22	1.34
Punjab	1557	1.07	1.37	0.07	0.05	0.30	0.30	0.15	0.09	0.07	0.16	0.21
Rajasthan	1579	0.93	0.98	0.56	0.54	1.29	0.58	0.57	0.57	0.89	0.59	0.55
Tamil Nadu	3499	1.49	1.44	0.87	0.83	0.94	0.95	0.95	0.93	0.83	0.82	0.82
Uttar Pradesh	4180	1.32	0.99	0.86	0.94	0.40	0.54	0.64	0.85	0.75	0.77	0.76
West Bengal	3138	1.49	1.16	1.56	1.48	1.41	1.54	1.57	1.48	1.75	1.47	1.50

Table D.4R : Estimates of engel elasticities for *education*, for 13 major states, obtained by different methods, rural sector.

states	no. of sample hhs.	WLS estimates		IV estimates based on last month data								
		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	5419	1.91	1.80	2.16	2.29	1.52	0.68	-.41	2.24	1.56	-.48	0.78
Bihar	7879	2.38	2.18	2.80	2.85	2.97	3.41	3.74	2.73	3.09	4.36	3.70
Gujarat	2477	1.94	1.49	0.43	0.67	-1.2	-.14	-.61	0.44	-.35	0.36	0.06
Karnataka	3263	1.73	1.54	1.4	1.32	0.78	-.33	5.84	1.17	0.83	2.33	-.35
Kerala	3009	1.50	1.27	1.12	1.19	0.85	0.74	0.57	1.18	0.77	-.01	0.46
Madhya Pradesh	5719	1.80	–	1.49	1.80	0.76	1.13	2.60	1.49	0.97	0.78	0.35
Maharashtra	5517	1.37	1.34	1.00	1.10	0.68	0.64	0.54	1.08	0.61	1.97	3.04
Orissa	3052	2.20	1.99	2.53	2.84	1.73	2.27	2.28	2.49	2.02	2.31	2.26
Punjab	2095	1.31	1.11	0.60	0.55	0.87	0.57	0.51	0.69	0.52	0.51	0.47
Rajasthan	3530	1.99	1.29	0.95	0.98	1.23	0.79	0.72	0.98	0.96	0.41	0.64
Tamil Nadu	4540	1.15	1.13	0.93	0.85	1.36	0.88	0.80	0.98	1.09	0.42	0.58
Uttar Pradesh	10517	1.42	1.37	0.85	1.11	-.36	-4.4	2.51	0.93	-.14	5.14	-3.2
West Bengal	4996	2.08	2.12	2.00	2.03	2.11	2.01	2.07	2.17	1.77	1.85	2.22

Table D.4U : Estimates of engel elasticities for *education*, for 13 major states, obtained by different methods, urban sector.

	no. of	WLS estimates		IV estimates based on last month data								
states	sample hhs.	last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	2494	1.81	1.74	1.54	1.57	1.27	1.05	1.00	1.58	1.34	0.88	1.08
Bihar	1992	1.97	1.86	1.35	1.32	3.35	1.25	1.16	1.39	1.87	1.24	1.33
Gujarat	1663	2.05	1.88	1.53	0.67	2.04	1.69	2.07	0.55	0.12	0.78	1.82
Karnataka	2097	1.67	1.47	1.29	1.52	0.70	3.34	-.77	1.21	1.01	1.50	1.30
Kerala	1225	1.60	1.46	1.46	1.60	1.54	1.20	1.18	1.46	1.37	1.05	1.12
Madhya Pradesh	2376	1.66	1.66	1.24	1.29	1.13	1.25	1.14	1.31	0.95	0.85	1.31
Maharashtra	4797	1.51	1.66	1.04	1.04	1.05	1.12	1.10	1.02	1.10	1.13	1.09
Orissa	824	1.93	1.69	1.65	1.79	0.77	1.74	1.91	1.69	1.10	1.28	1.96
Punjab	1557	1.53	1.19	1.32	1.57	-1.7	0.05	1.34	1.25	0.69	1.27	0.69
Rajasthan	1579	1.13	1.41	1.35	1.46	0.35	1.34	1.33	1.48	0.32	1.36	1.52
Tamil Nadu	3499	2.36	1.58	3.90	4.41	0.93	0.61	0.67	3.96	2.46	2.30	2.32
Uttar Pradesh	4180	1.48	1.66	1.10	1.21	-.01	0.43	0.61	1.17	0.39	0.55	0.58
West Bengal	3138	1.49	1.53	1.05	1.10	0.80	1.02	1.08	1.05	0.88	1.07	1.03

Table D.5U : Pairwise comparisons of statewise elasticities for *clothing*, obtained by different methods, urban sector.

type of estimate		WLS estimate: last month	WLS estimate: last year	type of IV estimate (based on last month data): c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						$\sum(Z_i - Z_j)$						
WLS :	last month	0.00										
	: last year	-11.05	0.00									
IV :	c+o,c+o	-7.73	3.32	0.00								
	: o,o	-8.30	2.75	-0.57	0.00							
	: c,c	-7.46	3.59	0.27	0.84	0.00						
	: c,o	-9.55	1.50	-1.82	-1.25	-2.09	0.00					
	: o,c	-5.66	5.39	2.07	2.64	1.80	3.89	0.00				
	: f,f	-7.26	3.79	0.47	1.04	0.20	2.29	-1.60	0.00			
	: c+o-f,c+o-f	-8.54	2.51	-0.81	-0.24	-1.08	1.01	-2.88	-1.28	0.00		
	: f,c+o-f	-9.23	1.82	-1.50	-0.93	-1.77	0.32	-3.57	-1.97	-0.69	0.00	
	: c+o-f,f	-8.47	2.58	-0.74	-0.17	-1.01	1.08	-2.81	-1.21	0.07	0.76	0.00
						$\sum \mid Z_i - Z_j \mid$						
WLS :	last month	0.00										
	: last year	11.05	0.00									
IV :	c+o,c+o	8.67	5.04	0.00								
	: o,o	8.66	5.19	1.09	0.00							
	: c,c	10.50	7.67	5.85	6.86	0.00						
	: c,o	9.55	3.93	4.38	4.39	8.35	0.00					
	: o,c	11.74	8.49	6.11	6.64	8.48	5.87	0.00				
	: f,f	8.36	5.11	0.61	1.48	5.64	4.59	6.18	0.00			
	: c+o-f,c+o-f	10.36	4.63	2.93	3.82	3.92	5.43	6.50	2.98	0.00		
	: f,c+o-f	9.69	5.18	3.06	3.41	6.35	4.48	5.63	3.13	3.65	0.00	
	: c+o-f,f	9.65	5.20	2.44	2.87	6.95	3.90	4.73	2.53	3.21	2.46	0.00

Table D.6R : Pairwise comparisons of statewise elasticities for *footwear*, obtained by different methods, rural sector.

	WLS estimate		type of IV estimate (based on last month data)								
type of estimate	last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
				$\sum(Z_i - Z_j)$							
WLS : last month	0.00										
: last year	-6.71	0.00									
IV : c+o,c+o	-4.49	2.22	0.00								
: o,o	-2.36	4.35	2.13	0.00							
: c,c	-9.09	-2.38	-4.60	-6.73	0.00						
: c,o	-13.94	-7.23	-9.45	-11.58	-4.85	0.00					
: o,c	-6.55	0.16	-2.06	-4.19	2.54	7.39	0.00				
: f,f	-4.65	2.06	-0.16	-2.29	4.44	9.29	1.90	0.00			
: c+o-f,c+o-f	-7.12	-0.41	-2.63	-4.76	1.97	6.82	-0.57	-2.47	0.00		
: f,c+o-f	-8.01	-1.30	-3.52	-5.65	1.08	5.93	-1.46	-3.36	-0.89	0.00	
: c+o-f,f	0.02	6.73	4.51	2.38	9.11	13.96	6.57	4.67	7.14	8.03	0.00
				$\sum \mid Z_i - Z_j \mid$							
WLS : last month	0.00										
: last year	6.71	0.00									
IV : c+o,c+o	6.27	4.10	0.00								
: o,o	5.70	6.33	2.37	0.00							
: c,c	11.21	6.28	5.74	7.38	0.00						
: c,o	14.68	10.41	10.65	13.02	5.83	0.00					
: o,c	11.09	8.90	9.14	10.95	5.84	9.67	0.00				
: f,f	6.01	3.70	0.62	2.75	5.78	10.29	8.94	0.00			
: c+o-f,c+o-f	10.50	5.45	4.27	6.32	3.37	8.78	8.75	4.51	0.00		
: f,c+o-f	10.33	7.20	7.78	9.39	7.26	9.27	7.78	7.66	6.61	0.00	
: c+o-f,f	20.80	17.33	17.37	19.20	15.01	15.68	19.11	17.19	15.94	12.75	0.00

Table D.6U : Pairwise comparisons of statewise elasticities for *footwear*, obtained by different methods, urban sector.

type of estimate	WLS estimates: last month	WLS estimates: last year	type of IV estimate (based on last month data): c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
					$\sum(Z_i - Z_j)$						
WLS : last month	0.00										
: last year	-4.72	0.00									
IV : c+o,c+o	-7.47	-2.75	0.00								
: o,o	-7.75	-3.03	-0.28	0.00							
: c,c	-15.56	-10.84	-8.09	-7.81	0.00						
: c,o	-10.96	-6.24	-3.49	-3.21	4.60	0.00					
: o,c	-6.28	-1.56	1.19	1.47	9.28	4.68	0.00				
: f,f	-5.49	-0.77	1.98	2.26	10.07	5.47	0.79	0.00			
: c+o-f,c+o-f	-10.94	-6.22	-3.47	-3.19	4.62	0.02	-4.66	-5.45	0.00		
: f,c+o-f	-9.84	-5.12	-2.37	-2.09	5.72	1.12	-3.56	-4.35	-1.10	0.00	
: c+o-f,f	-7.90	-3.18	-0.43	-0.15	7.66	3.06	-1.62	-2.41	3.04	1.94	0.00
					$\sum \mid Z_i - Z_j \mid$						
WLS : last month	0.00										
: last year	5.82	0.00									
IV : c+o,c+o	8.51	6.31	0.00								
: o,o	8.53	6.83	1.48	0.00							
: c,c	18.34	14.84	10.25	11.51	0.00						
: c,o	11.24	7.66	4.69	3.79	12.38	0.00					
: o,c	12.88	10.90	5.95	5.47	12.42	6.28	0.00				
: f,f	7.69	6.69	1.98	2.76	11.65	6.23	7.11	0.00			
: c+o-f,c+o-f	12.78	9.04	4.47	5.45	6.62	7.00	7.52	6.05	0.00		
: f,c+o-f	10.64	8.60	4.73	4.25	12.14	5.58	5.16	6.03	6.34	0.00	
: c+o-f,f	9.28	7.04	3.63	3.23	11.40	4.04	5.00	5.05	5.50	3.44	0.00

Table D.7R : Pairwise comparisons of statewise elasticities for *durable goods*, obtained by different methods, rural sector.

type of estimate	WLS estimates		type of IV estimate (based on last month data)								
	last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
				$\sum(Z_i - Z_j)$							
WLS : last month	0.00										
: last year	-10.13	0.00									
IV : c+o,c+o	-11.48	-1.35	0.00								
: o,o	-11.76	-1.63	-0.28	0.00							
: c,c	-19.68	-9.55	-8.20	-7.92	0.00						
: c,o	-13.92	-3.79	-2.44	-2.16	5.76	0.00					
: o,c	-8.13	2.00	3.35	3.63	11.55	5.79	0.00				
: f,f	-11.29	-1.16	0.19	0.47	8.39	2.63	-3.16	0.00			
: c+o-f,c+o-f	-16.12	-5.99	-4.64	-4.36	3.56	-2.20	-7.99	-4.83	0.00		
: f,c+o-f	-4.51	5.62	6.97	7.25	15.17	9.41	3.62	6.78	11.61	0.00	
: c+o-f,f	-0.37	9.76	11.11	11.39	19.31	13.55	7.76	10.92	15.75	4.14	0.00
				$\sum\mid Z_i - Z_j \mid$							
WLS : last month	0.00										
: last year	10.13	0.00									
IV : c+o,c+o	14.44	8.95	0.00								
: o,o	14.40	8.97	2.96	0.00							
: c,c	19.68	11.15	9.88	10.48	0.00						
: c,o	24.28	20.13	13.72	14.18	15.56	0.00					
: o,c	30.69	26.46	20.75	20.49	22.19	13.17	0.00				
: f,f	14.03	8.98	0.91	3.29	9.51	14.19	21.20	0.00			
: c+o-f,c+o-f	18.20	11.23	4.88	5.30	5.82	12.12	18.99	5.07	0.00		
: f,c+o-f	27.53	24.04	19.67	19.91	22.31	15.41	9.86	20.18	18.19	0.00	
: c+o-f,f	34.97	31.64	26.65	26.29	28.81	21.25	32.48	27.16	24.55	29.68	0.00

Table D.7U : Pairwise comparisons of statewise elasticities for *durable goods*, obtained by different methods, urban sector.

		WLS estimate		type of IV estimate (based on last month data)								
type of estimate		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						$\sum(Z_i - Z_j)$						
WLS :	last month	0.00										
	: last year	-7.29	0.00									
IV :	c+o,c+o	-13.09	-5.80	0.00								
	: o,o	-13.69	-6.40	-0.60	0.00							
	: c,c	-12.07	-4.78	1.02	1.62	0.00						
	: c,o	-10.36	-3.07	2.73	3.33	1.71	0.00					
	: o,c	-12.45	-5.16	0.64	1.24	-0.38	-2.09	0.00				
	: f,f	-12.32	-5.03	0.77	1.37	-0.25	-1.96	0.13	0.00			
	: c+o-f,c+o-f	-16.10	-8.81	-3.01	-2.41	-4.03	-5.74	-3.65	-3.78	0.00		
	: f,c+o-f	-8.83	-1.54	4.26	4.86	3.24	1.53	3.62	3.49	7.27	0.00	
	: c+o-f,f	-12.21	-4.92	0.88	1.48	-0.14	-1.85	0.24	0.11	3.89	-3.38	0.00
						$\sum \mid Z_i - Z_j \mid$						
WLS :	last month	0.00										
	: last year	7.41	0.00									
IV :	c+o,c+o	13.91	8.46	0.00								
	: o,o	13.69	8.00	2.52	0.00							
	: c,c	22.75	19.40	16.62	18.82	0.00						
	: c,o	15.76	11.73	6.91	6.73	18.89	0.00					
	: o,c	19.99	14.62	7.68	8.14	19.90	6.61	0.00				
	: f,f	13.36	8.25	0.85	2.17	16.99	6.78	7.81	0.00			
	: c+o-f,c+o-f	19.78	14.95	8.65	11.07	10.43	13.06	14.01	9.24	0.00		
	: f,c+o-f	14.61	10.78	8.54	9.02	19.40	8.51	12.02	8.37	11.07	0.00	
	: c+o-f,f	16.77	11.38	5.84	5.52	16.46	5.47	7.92	5.55	11.35	7.80	0.00

Table D.8R : Pairwise comparisons of statewise elasticities for *medical care*, obtained by different methods, rural sector.

	WLS estimate		type of IV estimate (based on last month data)									
type of estimate		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
						$\sum(Z_i - Z_j)$						
WLS :	last month	0.00										
	: last year	-4.56	0.00									
IV :	c+o,c+o	-5.92	-1.36	0.00								
	: o,o	-4.45	0.11	1.47	0.00							
	: c,c	-11.39	-6.83	5.47	-6.94	0.00						
	: c,o	-13.48	-8.92	-7.56	-9.03	-2.09	0.00					
	: o,c	-3.40	1.16	2.52	1.05	7.99	10.08	0.00				
	: f,f	-5.88	-1.32	0.04	-1.43	5.51	7.60	-2.48	0.00			
	: c+o-f,c+o-f	-8.99	-4.43	-3.07	-4.54	2.40	4.49	-5.59	-3.11	0.00		
	: f,c+o-f	-7.12	-2.56	-1.20	-2.67	4.27	6.36	-3.72	-1.24	1.87	0.00	
	: c+o-f,f	-8.39	-3.83	-2.47	-3.94	3.00	5.09	-4.99	-2.51	0.60	-1.27	0.00
						$\sum \mid Z_i - Z_j \mid$						
WLS :	last month	0.00										
	: last year	4.56	0.00									
IV :	c+o,c+o	5.92	1.86	0.00								
	: o,o	4.51	2.11	1.53	0.00							
	: c,c	11.39	7.03	6.05	7.58	0.00						
	: c,o	13.48	8.92	7.60	9.03	5.73	0.00					
	: o,c	15.22	12.20	11.60	12.57	11.45	11.00	0.00				
	: f,f	5.88	1.88	0.22	1.59	6.09	7.62	11.62	0.00			
	: c+o-f,c+o-f	8.99	4.45	3.49	5.00	2.74	5.81	10.89	3.63	0.00		
	: f,c+o-f	15.98	13.14	12.64	13.27	9.97	12.92	8.48	12.76	11.11	0.00	
	: c+o-f,f	18.79	14.97	13.59	14.76	9.40	11.51	18.79	13.67	11.30	12.07	0.00

Table D.8U : Pairwise comparisons of statewise elasticities for *medical care*, obtained by different methods, urban sector.

	WLS estimate		type of IV estimate (based on last month data)								
type of estimate	last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
				$\sum(Z_i - Z_j)$							
WLS : last month	0.00										
: last year	-2.96	0.00									
IV : c+o,c+o	-7.58	-4.62	0.00								
: o,o	-6.90	-3.94	0.68	0.00							
: c,c	-10.34	-7.38	-2.76	-3.44	0.00						
: c,o	-6.44	-3.48	1.14	0.46	3.90	0.00					
: o,c	-1.49	1.47	6.09	5.41	8.85	4.95	0.00				
: f,f	-7.91	-4.95	-0.33	-1.01	2.43	-1.47	-6.42	0.00			
: c+o-f,c+o-f	-8.95	-5.99	-1.37	-2.05	1.39	-2.51	-7.46	-1.04	0.00		
: f,c+o-f	-2.75	0.21	4.83	4.15	7.59	3.69	-1.26	-5.16	6.20	0.00	
: c+o-f,f	-5.61	-2.65	1.97	1.29	4.73	0.83	-4.12	2.30	3.34	-2.86	0.00
				$\sum \mid Z_i - Z_j \mid$							
WLS : last month	0.00										
: last year	3.66	0.00									
IV : c+o,c+o	7.72	6.06	0.00								
: o,o	6.90	5.68	1.04	0.00							
: c,c	11.10	8.96	5.70	6.32	0.00						
: c,o	6.54	5.92	2.96	2.58	6.10	0.00					
: o,c	8.59	9.31	7.61	7.23	11.19	5.59	0.00				
: f,f	7.91	6.13	0.59	1.37	5.29	3.19	7.84	0.00			
: c+o-f,c+o-f	9.47	7.27	2.55	3.43	4.15	4.97	9.52	2.40	0.00		
: f,c+o-f	8.09	7.51	6.49	6.21	9.75	5.81	2.56	6.62	7.66	0.00	
: c+o-f,f	5.63	4.57	2.69	2.19	6.89	2.05	5.58	2.98	4.68	4.50	0.00

Table D.9R : Pairwise comparisons of statewise elasticities for *education*, obtained by different methods, rural sector.

type of estimate	WLS estimate		type of IV estimate (based on last month data)								
	last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
				$\sum(Z_i - Z_j)$							
WLS : last month	0.00										
: last year	-4.15	0.00									
IV : c+o,c+o	-4.78	-0.63	0.00								
: o,o	-3.20	-0.95	1.58	0.00							
: c,c	-9.58	-5.43	-4.80	-6.38	0.00						
: c,o	-14.53	-10.38	-9.75	-11.33	-4.95	0.00					
: o,c	-1.62	2.53	3.16	1.58	7.96	12.91	0.00				
: f,f	-4.21	-0.06	0.57	-1.01	5.37	10.32	-2.59	0.00			
: c+o-f,c+o-f	-9.08	-4.93	-4.30	-5.88	0.50	5.45	-7.46	-4.87	0.00		
: f,c+o-f	-2.83	1.32	1.95	0.37	6.75	11.70	-1.21	1.38	6.25	0.00	
: c+o-f,f	11.77	-7.62	-6.99	-8.57	-2.19	2.76	-10.15	-7.56	-2.69	-8.94	0.00
				$\sum \mid Z_i - Z_j \mid$							
WLS : last month	0.00										
: last year	4.23	0.00									
IV : c+o,c+o	6.78	6.65	0.00								
: o,o	6.18	6.67	1.84	0.00							
: c,c	11.24	8.99	7.32	8.94	0.00						
: c,o	16.73	15.66	10.99	12.55	9.97	0.00					
: o,c	16.50	17.25	13.80	13.72	15.60	16.99	0.00				
: f,f	6.33	6.12	0.79	1.83	7.47	11.68	14.15	0.00			
: c+o-f,c+o-f	10.50	8.75	5.22	6.84	3.26	7.97	13.54	5.81	0.00		
: f,c+o-f	16.85	15.62	14.07	14.47	17.23	18.34	12.57	14.40	14.73	0.00	
: c+o-f,f	18.15	15.50	13.31	14.53	12.37	6.04	19.17	13.52	10.97	16.06	0.00

Table D.9U : Pairwise comparisons of statewise elasticities for *education*, obtained by different methods, urban sector.

type of estimate		WLS estimate		type of IV estimate (based on last month data)								
		last month	last year	c+o,c+o	o,o	c,c	c,o	o,c	f,f	c+o-f,c+o-f	f,c+o-f	c+o-f,f
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
					$\sum(Z_i - Z_j)$							
WLS :	last month	0.00										
	: last year	-1.40	0.00									
IV :	c+o,c+o	-2.37	-0.97	0.00								
	: o,o	-1.64	-0.24	0.73	0.00							
	: c,c	-10.07	-8.67	-7.70	-8.43	0.00						
	: c,o	-6.10	-4.70	-3.73	-4.46	3.97	0.00					
	: o,c	-8.37	-6.97	-6.00	-6.73	1.70	-2.27	0.00				
	: f,f	-3.07	-1.67	0.70	-1.43	7.00	3.03	5.30	0.00			
	: c+o-f,c+o-f	-9.21	-7.81	-6.84	-7.57	0.86	-3.11	-0.84	-6.14	0.00		
	: f,c+o-f	-6.93	-5.53	-4.56	-5.29	3.14	-0.83	1.44	-3.86	2.28	0.00	
	: c+o-f,f	-5.04	-3.64	-2.67	-3.40	5.03	1.06	3.33	-1.97	4.17	-1.89	0.00
					$\sum \mid Z_i - Z_j \mid$							
WLS :	last month	0.00										
	: last year	2.70	0.00									
IV :	c+o,c+o	5.89	5.87	0.00								
	: o,o	6.48	7.34	2.51	0.00							
	: c,c	12.83	12.13	12.90	15.25	0.00						
	: c,o	9.86	8.54	8.51	10.30	10.63	0.00					
	: o,c	8.81	8.09	7.82	9.89	10.80	6.55	0.00				
	: f,f	6.97	6.69	1.60	1.67	14.12	9.87	9.18	0.00			
	: c+o-f,c+o-f	9.41	9.59	8.00	8.79	8.42	9.01	10.46	7.26	0.00		
	: f,c+o-f	7.39	7.19	5.22	5.69	12.20	7.05	6.64	5.20	5.62	0.00	
	: c+o-f,f	5.88	5.88	4.47	6.32	10.73	5.36	5.43	5.45	6.57	3.61	0.00

Appendix E

Notes on Method of Moments Estimation

E.1 The Univariate Case

Recall the univariate model as defined by (6.3.1), (6.3.5) along with the assumption of lognormality of X. The following three moments of x were initially considered, i.e.,

$$
\begin{aligned}
E(x-\lambda) &= e^{\mu+\frac{1}{2}\sigma^2}(= m'_1, \text{ say} && \text{(E.1.1)}\\
E(x-\lambda)^2 &= m_1'^2 e^{\sigma^2} + \theta^2 m_1'^{2b} e^{(2b^2-b)\sigma^2} && \text{(E.1.2)}\\
E(x-\lambda)^3 &= m_1'^3 e^{3\sigma^2} + 3\theta^2 [m_1'^{(2b+1)} e^{(2b^2+b)\sigma^2} - \lambda m_1'^2 e^{(b^2-b)\sigma^2}] && \text{(E.1.3)}\\
&\quad \text{with } 1 \leq b \leq 2
\end{aligned}
$$

The use of these moment equations did not yield results in all cases. For some states the model could be solved only after the bottom 0.2% or even 0.5% of the population was rejected. In many cases, however, the results of the univariate model were quite sensible, i.e, sensible values of μ, θ^2 and σ^2 were available.

E.2 The Bivariate Case

The bivariate moment equations which were initially considered were :

$$
\begin{aligned}
m'_1(y) &= E(Y) = \alpha E(X) + \beta E(X \ln X) + \gamma && \text{(E.2.1)}\\
m_{11}(x,y) &= E[(y-E(y))(x-E(x))]\\
&= \alpha V(X) + \beta[E(X^2 \ln X) - E(X)E(X \ln X)] && \text{(E.2.2)}
\end{aligned}
$$

$$
\begin{aligned}
m_{12}(x,y) &= \alpha[\mu_3(X) + \theta^2(E(X^{2b+1}) - E(X^{2b})E(X))] + \\
&\quad \beta[(X^2 \ln X) - E(X^2)E(X \ln X) - \\
&\quad 2(E(X^2 \ln X)E(X) - E(X \ln X)E^2(X)) + \\
&\quad \theta^2(E(X^{2b+1} \ln X) - E(X^{2b})E(X \ln X))] \qquad \text{(E.2.3)} \\
m_{13}(x,y) &= \alpha[E(X - E(X))^4 + 3\theta^2 E(X^{2b}(X - E(X))^2)] + \\
&\quad \beta[E((X \ln X - E(X \ln X))(X - E(X))^3) \\
&\quad + 3\theta^2 E(X^{2b}(X - E(X))(X \ln X - E(X \ln X)))] + \\
&\quad \delta[3\theta^2 E(X^{2b}(X - E(X))^2) + E(u^4)] \qquad \text{(E.2.4)}
\end{aligned}
$$

Only the case $b = 1$ was considered here. α, β and δ were estimated from (E.2.2),(E.2.3) and (E.2.4) and then γ was estimated from (E.2.1). However, the use of these higher order moments failed to yield any sensible results for the bivariate model and had to be rejected. Estimation of δ from the model was in fact given up and δ was estimated from outside the model. This was necessary because in the trials made these equations gave fluctuating (unstable) estimates of δ. This may be due to the multicollinearity problem usually faced in this kind of situation. It appeared that for this method of estimation $V(\hat{\delta})$ would have been very high.

A two-parameter budget-share equation was also tried out i.e with $\gamma = 0$, α, β and δ were estimated from any two equations from (E.2.2) to (E.2.4) and equation (E.2.1). However, as this did not improve the situation much, the three-parameter form continued to be estimated.

Appendix F

Some Results on the Performance of the Budget Share Form

In Chapters 5 and 6 we have worked only with the budget-share (Working-Leser) form of engel function (eqn.(3.3.5)). In this Appendix we present some tables to compare the performance of this form with the other forms which fitted the NSS 38th round ungrouped (household level) budget data best, for each item-state-sector combination for the 13 selected states and for the all-India data.

In Chapter 4, five forms of engel functions from (eqns.(3.3.1) through (3.3.5)) were fitted to NSS 38th round grouped (PCE classwise) data, for five item groups — clothing, footwear, durable goods, medical care and education. On the basis of certain statistical criteria (*vide* Chapters 3 and 4), it was found that the three-parameter LLI form of engel curve (eqn.(3.3.4)) is the best fitting form in a large number of cases. The three-parameter budget-share form (eqn.(3.3.5)) was also found to be best fitting in many cases. The DL form (eqn.(3.3.2)) also fitted the data best in some cases. The elasticities estimated in Chapter 4 are from the best fitting form.

However, when estimation is done on the basis of ungrouped (household level) data (as was the case in Chapters 5 and 6), there are some cases of recorded zero expenditures, particularly for last month data. It is not possible to estimate the LLI (or DL) form involving a term in $\ln y$ if there are zero values for y. Rejection of all households with zero item expenditures, however, seemed to be improper. We simplified the problem by using only the three-parameter budget-share equation (3.3.5) in the analysis of the last two chapters which use household level data including zero item expenditures.

This Appendix presents a comparison of the BS form with the best fitting form in terms of both the criteria used to judge the goodness of fit and the estimated elasticities.

In Tables F.1R and F.1U we present, as an example, a comparison of the measures of goodness of fit (*vide* Chapter 3, Section 3.3) for the best fitting form and the BS form, whenever the BS is not the best fitting one, for *clothing*. It can be seen from these tables and also similar tables for other items not presented here, that there is not much difference in the performance of the BS form and that of the best fitting form, in most cases, in terms of ${R^2}_y$, W, DW and DW(adj.). Note that R^2 and $\bar{R}^2$ are sometimes extremely low for the BS form.

Tables F.2 through F.6 compare the estimates of engel elasticities at average PCE ($\eta_{\bar{x}}$) from the BS form and the best fitting form for different items.

Table F.1R : Comparative goodness of fit of the best fitting form and the BS form, for *clothing*, rural India, NSS 38th round.

	reference period : last 30 days							reference period : last 365 days						
state	curve type	R^2	$\bar{R}^2$	R^2_y	W	DW	DW(adj.)	curve type	R^2	$\bar{R}^2$	R^2_y	W	DW	DW(adj.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Andhra Pradesh	BS	0.947	0.937	0.960	0.948	1.93	1.66	DL	0.988	0.987	0.983	0.982	1.96	2.47
	-	-	-	-	-	-	-	BS	0.781	0.737	0.979	0.974	2.48	2.69
Bihar	BS	0.979	0.975	0.992	0.992	1.83	1.71	LLI	0.995	0.994	0.993	0.993	2.48	1.76
	-	-	-	-	-	-	-	BS	0.657	0.589	0.993	0.993	2.40	1.76
Gujarat	BS	0.925	0.910	0.990	0.987	0.83	1.45	LLI	0.993	0.992	0.971	0.968	1.77	1.84
	-	-	-	-	-	-	-	BS	0.846	0.815	0.973	0.969	1.48	1.72
Karnataka	BS	0.910	0.891	0.941	0.918	1.60	1.51	LLI	0.990	0.988	0.977	0.976	1.83	1.73
	-	-	-	-	-	-	-	BS	0.709	0.651	0.973	0.971	1.63	1.72
Kerala	BS	0.993	0.991	0.999	0.999	2.36	2.30	BS	0.857	0.828	0.991	0.989	1.34	3.22
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Madhya Pradesh	BS	0.965	0.958	0.977	0.968	1.84	2.16	DL	0.989	0.988	0.963	0.956	0.96	1.65
	-	-	-	-	-	-	-	BS	0.583	0.499	0.955	0.942	0.93	1.76
Maharashtra	LLI	0.987	0.984	0.987	0.981	-0.51	1.70	LLI	0.997	0.997	0.998	0.998	1.27	3.28
	BS	0.822	0.786	0.977	0.953	0.47	1.73	BS	0.821	0.785	0.998	0.998	1.20	3.34
Orissa	BS	0.941	0.929	0.979	0.975	2.20	2.42	LLI	0.989	0.987	0.982	0.980	1.02	1.09
	-	-	-	-	-	-	-	BS	0.682	0.618	0.983	0.981	1.06	1.07
Punjab	BS	0.905	0.886	0.979	0.978	2.08	2.53	LLI	0.975	0.970	0.982	0.976	1.35	1.57
	-	-	-	-	-	-	-	BS	0.582	0.498	0.976	0.964	1.27	1.33
Rajasthan	BS	0.905	0.886	0.956	0.925	1.73	1.66	LLI	0.991	0.989	0.976	0.973	1.27	2.18
	-	-	-	-	-	-	-	BS	0.791	0.749	0.977	0.972	1.35	2.43
Tamil Nadu	BS	0.943	0.931	0.985	0.976	1.98	1.71	LLI	0.994	0.993	0.995	0.993	2.08	2.63
	-	-	-	-	-	-	-	BS	0.884	0.860	0.996	0.995	2.15	2.64
Uttar Pradesh	LLI	0.980	0.976	0.923	0.887	0.83	2.08	DL	0.993	0.993	0.987	0.987	1.88	1.82
	BS	0.555	0.466	0.945	0.934	1.10	1.91	BS	0.477	0.373	0.983	0.981	2.17	2.28
West Bengal	LLI	0.985	0.983	0.993	0.986	2.10	2.49	BS	0.813	0.775	0.975	0.972	1.45	2.02
	BS	0.953	0.944	0.985	0.979	2.15	2.44	-	-	-	-	-	-	-
all-India	BS	0.975	0.970	0.985	0.981	1.79	1.18	LLI	0.998	0.997	0.992	0.990	1.32	1.18
	-	-	-	-	-	-	-	BS	0.409	0.291	0.992	0.990	1.33	1.18

Table F.1U : Comparative goodness of fit of the best fitting form and the BS form, for *clothing*, urban India, NSS 38th round

	reference period : last 30 days							reference period : last 365 days						
state	curve type	R^2	$\bar{R}^2$	R^2_y	W	DW	DW(adj.)	curve type	R^2	$\bar{R}^2$	R^2_y	W	DW	DW(adj.)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Andhra Pradesh	BS	0.960	0.952	0.994	0.993	1.79	2.17	DL	0.939	0.934	0.983	0.983	1.36	1.04
	-	-	-	-	-	-	-	BS	0.723	0.668	0.965	0.939	2.54	1.12
Bihar	LLI	0.958	0.948	0.975	0.975	2.45	2.18	DL	0.992	0.991	0.989	0.989	0.79	2.29
	BS	0.901	0.881	0.959	0.952	1.93	2.22	BS	0.461	0.354	0.986	0.983	0.95	2.38
Gujarat	LLI	0.820	0.775	0.983	0.980	2.13	2.64	LLI	0.958	0.950	0.991	0.990	1.06	1.34
	BS	0.763	0.715	0.984	0.971	1.24	1.47	BS	0.0.47	-.144	0.991	0.991	1.12	1.31
Karnataka	LLI	0.956	0.945	0.998	0.998	2.00	2.29	LLI	0.986	0.983	0.967	0.985	1.26	2.68
	BS	0.961	0.953	0.997	0.995	0.79	1.60	BS	0.583	0.499	0.986	0.985	1.32	2.66
Kerala	LLI	0.964	0.957	0.996	0.992	1.87	1.82	LLI	0.979	0.975	0.987	0.985	1.55	2.93
	BS	0.939	0.926	0.993	0.991	1.65	2.11	BS	0.706	0.648	0.998	0.987	1.76	3.00
Madhya Pradesh	BS	0.972	0.967	0.998	0.997	1.95	2.67	LLI	0.993	0.992	0.995	0.995	0.74	2.97
	-	-	-	-	-	-	-	BS	0.769	0.718	0.995	0.994	0.72	2.89
Maharashtra	BS	0.933	0.919	0.991	0.989	1.73	2.92	DL	0.994	0.993	0.998	0.998	2.23	2.85
	-	-	-	-	-	-	-	BS	0.650	0.580	0.977	0.953	3.01	2.86
Orissa	BS	0.960	0.952	0.993	0.993	2.32	3.03	LLI	0.988	0.985	0.996	0.996	2.91	2.17
	-	-	-	-	-	-	-	BS	0.342	0.211	0.996	0.996	2.86	2.15
Punjab	BS	0.962	0.955	0.955	0.994	2.06	1.99	LLI	0.948	0.938	0.954	0.952	3.00	1.98
	-	-	-	-	-	-	-	BS	0.056	-.133	0.954	0.953	2.79	1.89
Rajasthan	BS	0.876	0.851	0.971	0.941	0.93	1.04	LLI	0.970	0.964	0.943	0.906	0.90	0.85
	-	-	-	-	-	-	-	BS	0.697	0.637	0.928	0.857	0.94	0.82
Tamil Nadu	LLI	0.990	0.988	0.995	0.984	2.60	2.55	DL	0.989	0.988	0.991	0.985	0.51	1.31
	BS	0.953	0.943	0.993	0.987	1.00	1.32	BS	0.740	0.668	0.991	0.986	0.63	1.28
Uttar Pradesh	BS	0.969	0.963	0.995	0.994	1.23	1.80	DL	0.996	0.996	0.998	0.997	1.91	1.65
	-	-	-	-	-	-	-	BS	0.561	0.474	0.998	0.997	1.83	1.50
West Bengal	LLI	0.984	0.980	0.994	0.983	2.13	2.87	DL	0.979	0.977	0.986	0.982	0.34	0.96
	BS	0.979	0.975	0.997	0.997	1.23	3.30	BS	0.112	-.066	0.982	0.973	0.43	0.91
all-India	BS	0.995	0.994	1.000	0.999	1.01	2.00	DL	0.994	0.994	0.995	0.993	0.34	0.86
	-	-	-	-	-	-	-	BS	0.449	0.339	0.994	0.990	0.40	0.88

Table F.2 : Engel elasticities ($\eta_{\bar{x}}$), for *clothing*, from the best fitting form and the BS form, for major states and all India, rural and urban, NSS 38th round

	rural						urban					
	last month			last year			last month			last year		
		elasticity from			elasticity from			elasticity from			elasticity from	
state	best form	best form	BS	best form	best form	BS	best form	best form	BS	best form	best form	BS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	BS	-	2.08	DL	1.20	1.22	BS	-	1.93	DL	1.26	1.34
Bihar	BS	-	2.09	LLI	0.93	0.93	LLI	2.34	1.96	LLI	1.08	1.09
Gujarat	BS	-	2.09	LLI	1.25	1.25	LLI	2.33	2.08	LLI	1.13	1.08
Karnataka	BS	-	2.06	LLI	1.10	1.09	LLI	2.30	1.98	LLI	1.12	1.12
Kerala	BS	-	1.98	BS	-	1.28	LLI	2.05	1.80	LLI	1.29	1.27
Madhya Pradesh	BS	-	1.98	DL	0.90	0.90	BS	-	1.94	LLI	1.03	1.03
Maharashtra	LLI	2.18	1.91	LLI	0.88	0.89	BS	-	1.70	DL	0.90	0.88
Orissa	BS	-	1.86	LLI	0.95	0.94	BS	-	1.99	LLI	1.09	1.08
Punjab	BS	-	2.03	LLI	1.01	1.01	BS	-	1.88	LLI	0.95	0.94
Rajasthan	BS	-	1.76	LLI	0.83	0.84	BS	-	1.74	LLI	0.95	0.96
Tamil Nadu	BS	-	1.86	LLI	1.25	1.24	LLI	2.35	1.98	DL	1.20	1.20
Uttar Pradesh	LLI	2.17	1.94	DL	0.94	0.94	BS	-	1.91	DL	1.08	1.08
West Bengal	LLI	2.11	1.96	BS	-	1.13	LLI	2.11	1.87	DL	1.07	1.08
all-India	BS	-	1.95	LLI	1.00	1.04	BS	-	1.85	DL	1.07	1.08

Table F.3 : Engel elasticities ($\eta_{\bar{x}}$), for *footwear*, from the best fitting form and the BS form, for major states and all India, rural and urban, NSS 38th round

	rural						urban					
	last month			last year			last month			last year		
		elasticity from			elasticity from			elasticity from			elasticity from	
state	best form	best form	BS	best form	best form	BS	best form	best form	BS	best form	best form	BS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	LLI	2.27	1.89	BS	-	1.40	LLI	2.12	1.84	DL	1.54	1.61
Bihar	BS	-	2.33	DL	1.91	1.88	BS	-	2.02	BS	-	1.68
Gujarat	BS	-	1.75	LLI	1.10	1.20	LLI	1.69	1.69	DL	1.07	1.19
Karnataka	DL	1.95	1.93	BS	-	1.45	DL	1.80	1.85	BS	-	1.44
Kerala	BS	-	1.70	BS	-	1.52	BS	-	1.60	LLI	1.29	1.33
Madhya Pradesh	BS	-	1.76	LLI	1.16	1.25	BS	-	1.57	LLI	1.15	1.24
Maharashtra	BS	-	1.66	LLI	1.24	1.22	BS	-	1.76	BS	-	1.20
Orissa	BS	-	2.75	BS	-	2.02	BS	-	2.12	LLI	1.74	1.63
Punjab	DL	1.53	1.51	LLI	0.79	0.83	BS	-	1.57	LLI	0.90	0.88
Rajasthan	LLI	1.50	1.32	LLI	0.79	0.81	LLI	1.59	1.46	LLI	1.02	1.05
Tamil Nadu	BS	-	1.83	BS	-	1.51	BS	-	1.66	DL	1.65	1.53
Uttar Pradesh	LLI	2.02	1.85	LLI	1.17	1.17	LLI	1.89	1.73	LLI	1.22	1.19
West Bengal	BS	-	2.30	BS	-	1.68	BS	-	1.70	LLI	1.31	1.24
all-India	BS	-	1.91	LLI	1.41	1.35	BS	-	1.71	BS	-	1.24

Table F.4 : Engel elasticities ($\eta_{\bar{x}}$), for ***durable goods***, from the best fitting form and the BS form, for major states and all India, rural and urban, NSS 38th round

	rural						urban					
	last month			last year			last month			last year		
		elasticity from			elasticity from			elasticity from			elasticity from	
state	best form	best form	BS	best form	best form	BS	best form	best form	BS	best form	best form	BS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	DL	3.20	2.57	BS	-	2.23	DL	3.45	2.42	BS	-	2.22
Bihar	LLI	2.88	2.69	BS	-	2.00	LLI	3.40	2.84	BS	-	2.21
Gujarat	LLI	3.34	2.92	BS	-	2.37	LLI	2.84	2.52	LLI	2.23	2.11
Karnataka	BS	-	2.46	BS	-	2.08	DL	2.92	2.23	BS	-	1.99
Kerala	LLI	3.23	2.53	BS	-	1.75	LLI	3.05	2.16	BS	-	1.65
Madhya Pradesh	BS	-	2.36	BS	-	1.97	DL	2.86	2.42	DL	2.26	2.11
Maharashtra	LLI	3.16	3.06	BS	-	2.47	DL	2.73	1.79	BS	-	1.79
Orissa	LLI	2.81	2.89	BS	-	1.75	DL	1.83	1.75	LLI	1.81	1.81
Punjab	DL	2.68	2.34	BS	-	2.00	LLI	3.01	2.36	LLI	2.00	1.90
Rajasthan	LLI	2.84	2.28	BS	-	2.08	DL	2.37	2.05	BS	-	1.76
Tamil Nadu	LLI	2.78	2.12	BS	-	1.71	DL	2.34	1.97	BS	-	1.91
Uttar Pradesh	BS	2.41	2.36	BS	-	2.02	BS	-	2.40	BS	-	2.08
West Bengal	LLI	2.86	2.58	BS	-	1.93	BS	-	2.15	LLI	2.44	2.13
all-India	DL	2.75	2.47	BS	-	2.03	LLI	2.81	2.31	BS	-	1.97

Table F.5 : Engel elasticities ($\eta_{\bar{x}}$), for *medical care*, from the best fitting form and the BS form, for major states and all India, rural and urban, NSS 38th round

	rural						urban					
	last month			last year			last month			last year		
		elasticity from			elasticity from			elasticity from			elasticity from	
state	best form	best form	BS	best form	best form	BS	best form	best form	BS	best form	best form	BS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	BS	-	1.62	DL	1.23	1.28	BS	-	1.51	DL	1.16	1.18
Bihar	BS	-	1.76	DL	1.21	1.41	DL	1.41	1.26	LLI	0.73	0.73
Gujarat	BS	-	1.92	LLI	1.44	1.45	LLI	1.88	1.85	LLI	1.12	1.09
Karnataka	LLI	1.71	1.70	DL	1.29	1.29	LLI	1.20	1.20	DL	1.15	1.14
Kerala	LLI	1.33	1.29	LLI	0.98	0.99	DL	1.04	1.07	LLI	0.92	0.92
Madhya Pradesh	BS	-	1.77	BS	-	1.43	BS	-	1.62	DL	1.01	
Maharashtra	LLI	1.82	1.72	LLI	1.37	1.35	LLI	1.18	1.16	LLI	1.04	1.07
Orissa	BS	-	2.02	LLI	1.77	1.63	DL	1.58	1.58	LLI	1.26	1.28
Punjab	LLI	1.22	1.21	DL	0.86	0.96	LLI	1.07	1.07	DL	1.25	1.36
Rajasthan	BS	-	1.53	LLI	1.21	1.19	LLI	0.93	0.91	LLI	0.98	0.99
Tamil Nadu	BS	-	1.51	LLI	1.22	1.26	LLI	1.61	1.49	DL	1.50	1.44
Uttar Pradesh	LLI	1.71	1.60	BS	-	1.29	BS	-	1.32	LLI	0.99	0.99
West Bengal	LLI	1.66	1.58	DL	1.28	1.37	LLI	1.49	1.49	DL	1.17	1.16
all-India	LLI	1.69	1.59	LLI	1.27	1.26	BS	-	1.33	DL	1.08	1.10

Table F.6 : Engel elasticities ($\eta_{\bar{x}}$), for *education*, from the best fitting form and the BS form, for major states and all India, rural and urban, NSS 38th round

	rural						urban					
	last month			last year			last month			last year		
		elasticity from			elasticity from			elasticity from			elasticity from	
state	best form	best form	BS	best form	best form	BS	best form	best form	BS	best form	best form	BS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Andhra Pradesh	LLI	2.05	1.91	BS	-	1.80	BS	-	1.81	BS	-	1.74
Bihar	DL	2.45	2.31	BS	-	2.18	LLI	2.32	1.97	LLI	2.06	1.86
Gujarat	LLI	1.94	1.73	LLI	1.56	1.49	BS	-	2.05	BS	-	1.88
Karnataka	LLI	1.81	1.73	LLI	1.69	1.54	LLI	1.77	1.67	BS	-	1.47
Kerala	LLI	1.57	1.50	LLI	1.27	1.26	BS	-	1.60	LLI	1.47	1.46
Madhya Pradesh	LLI	1.90	1.80	-	-	-	BS	-	1.66	LLI	1.79	1.66
Maharashtra	LLI	1.37	1.33	LLI	1.29	1.34	LLI	1.63	1.51	LLI	1.66	1.52
Orissa	LLI	2.60	2.20	BS	-	1.99	LLI	2.32	1.93	BS	-	1.69
Punjab	DL	1.38	1.30	DL	1.00	1.15	LLI	1.62	1.53	DL	1.06	1.21
Rajasthan	DL	2.42	1.99	LLI	1.40	1.29	LLI	1.13	1.08	LLI	1.49	1.41
Tamil Nadu	SL	1.15	1.40	SL	1.13	1.31	DL	2.36	2.00	BS	-	1.58
Uttar Pradesh	SL	1.15	1.36	SL	1.20	1.35	LLI	1.59	1.48	LLI	1.66	1.53
West Bengal	BS	-	2.08	BS	-	2.12	LLI	1.63	1.49	LLI	1.66	1.53
all-India	BS	-	1.77	BS	-	1.63	BS	-	1.61	BS	-	1.50