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CONTRIBUTIONS TO THE ANALYSIS OF CONSUMER BEHAVIOUR

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Preface and Acknowledgements

This thesis presents studies on some methodological problems of engel curve analysis and also throws up some empirical results regarding the effects of household size, household occupation etc. on the consumer expenditure pattern of Indian households based on available National Sample Survey data.

The structure of the thesis is as follows :

Chapter I attempts a broad survey of the methodology of cross-sectional and time series demand analysis and also briefly highlights the Indian contributions to this branch of econometric application.

Chapter II deals with the analytical problems of estimating the effects of household composition on consumption pattern from household budget data. The methods of estimating unit consumer scales have been reviewed, and an analytical solution to 'Forsyth's Problem' regarding the estimability of effect of household composition on household consumption has been presented here. Finally, the method of solution of 'Forsyth's Problem' has been numerically illustrated.

Chapters III and IV present the results of an analysis of the effect of household size on consumption pattern of Indian households. Chapter III describes the material used, reports the results of household sizewise engel curve analysis in respect of selected items and indicates the nature of economies of scale as revealed by constant elasticity engel curves. Chapter IV sets out two methods of estimation of the parameters indicating economies/diseconomies of scale in Prais-Houthakker's formulation and presents the empirical results based on them.

Chapter V attempts to explore the differences in expenditure pattern of Indian middle class and working class households at selected urban centres in India on the basis of household budget data collected in the NSS Family Living Surveys of 1958-59. For each centre, itemwise per capita formulation of engel functions for the two social classes have been compared through analysis of covariance technique. A detailed graphical analysis has also been made to examine the extent to which inter-class differences in household size could be held responsible for the observed variations in expenditure patterns.

Chapter VI is concerned with an empirical verification of Houthakker's conjecture regarding international variation of engel elasticity for any specific commodity that international differences in engel elasticity might be explained in terms of variation of the relative price of the commodity concerned. To be precise, the present study examines the extent to which intertemporal variation of engel elasticity for cereals could be explained by movement of relative price of cereals and also by the movement of the ratio of prices of superior and inferior cereals.

Chapter VII is concerned with the examination of differences in expenditure patterns of rural households in India having different types of agricultural occupation. To be precise, the patterns of itemwise cash, kind and total (cash plus kind) consumer expenditure has been analysed for each occupation category and the inter-occupational differences in expenditure patterns have been examined here.

Appendix A is an extension of the analysis reported in Chapter V. Here, an attempt has been made to examine the pattern of intercentre variations in expenditure patterns of the middle class and working class households in India. Appendix B reports on an empirical study on the choice of classificatory variable in engel curve analysis. Some results of comparison of double logarithmic engel curves estimated from expenditure data classified by levels of per capita income with those estimated from the data classified by levels of per capita total consumer expenditure have been reported here. Appendix C presents the formulas for the different F-tests implied in the analysis of covariance technique, derived for the case where one works with grouped expenditure data. Finally, Appendix D reports an empirical study which compares the magnitudes of two alternative estimates of sampling variance of engel parameters estimated from grouped survey data, viz., that estimated by classical least squares formula and that estimated on the basis of sub-sample divergence of the estimated engel parameter.

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Contents

Chapter 0

Abstract of Chapters I-VII and Appendices A-D

Chapter I : Studies on consumer behaviour : A survey

This Chapter briefly reviews the methodology, implications and limitations of various approaches to empirical demand analysis and also summarises the important Indian contributions to this branch of econometric applications.

The Hicks-Allen theory of consumer equilibrium has been outlined first to indicate the nature of empirically observable restrictions that ensure consistent consumer behaviour in an essentially static world dealing solely with non-durable commodities. The role of the assumption of separability of the utility function in quantitative applications has also been stressed here. Finally, the scope and limitation of this theory has been discussed in the light of empirical exercises based on time-series and cross-sectional data.

In reviewing the methodology of engel curve analysis from cross-sectional data on household incomes and expenditures, different aspects of this approach, viz., choice of variables and functional form in engel curve analysis, and problems of measuring effects of various household characteristics on consumption pattern, are discussed. The economic-theoretical as well as statistical criteria of choosing the variables and functional form for engel curve analysis have been considered and references have been made to some problems of analysis of survey data on household budgets, for instance, the presence of seasonal elements in the data, application of least squares method to data from samples which are not simple random ones.

The discussion of the effects of various household characteristics highlights the role played by them in household decision-making process and describes the problems of incorporating these variables in engel curve analysis. There is also a separate discussion on effects of household size and composition on consumption pattern — a description of the standard formulations of engel curve involving the size and composition variables. Specifically, Prais-Houthakker's formulation of the engel curve is the basis of discussion which ends with a review of the implications and limitations of the unit consumer scales.

Coming to the discussion of time series-based demand analyses, alternative models of demand systems e.g., the Linear Expenditure System, the Rotterdam models, Direct and Indirect Addilog models etc., have been reviewed. There are also discussions on extensions, estimation procedures and comparative performances of these models.

There is a separate discussion on dynamic demand functions which seek to remove the static nature of system-models used in time series studies. Two approaches to the investigation of dynamics of consumer behaviour, i.e., the utility-theoretic approach of Boulding, Cramer, Phlips and others and the more straightforward approach of Stone and Houthakker and Taylor have been reviewed here. The empirical results based on these dynamic models have been surveyed briefly.

The final section of the present survey concentrates on Indian studies on empirical demand analysis covering, broadly, a review of methodology of engel curve analysis and demand projections based on cross-section data and also studies based on time-series and time-series of cross section data.

First of all, the method of engel curve analysis as adopted in Indian studies based on grouped expenditure data from the National Sample Survey, and the performances of alternative forms of engel curve to Indian data are examined. Next, the contributions to the methodology of demand projections based on cross-sectional engel curves is reviewed. Precisely, formulas of projection, derived on the basis of different assumptions regarding the shape of income distribution and its change over time, are reviewed. The specific concentration curve (SCC), a tool introduced by Professor Mahalanobis for measuring disparity in the consumption of a specific commodity among person in different brackets of per capita income/expenditure, and the application of SCC in estimating engel elasticity has also been discussed.

Empirical studies on engel curve have been surveyed under three heads, viz., the methods as well as the empirical results of analysis of effects of household size and composition on consumption pattern, studies examining regional variation in consumer expenditure pattern, and finally studies dealing with occupational variations in consumption, role of monetized transactions in consumption, application of clustering techniques etc.

In the survey of Indian studies with time series data on consumer expenditure, the results of fitting different variants of the Linear Expenditure System and projections of demand based on these systems have been discussed. There is also discussion on other studies dealing with dynamic consumer behaviour of agricultural households, intertemporal shifts in cross-sectional engel curves etc.

Chapter II : Effect of household composition on household consumption

Cross-sectional studies of the effects of household composition on consumption pattern are frequently based on the formulation of engel curve suggested by Sydenstricker and King (later rediscovered by Prais and Houthakker). In symbol this formulation is

$$\frac{y_i}{\Sigma g_{id}\ n_d} = f_i\left(\frac{x}{\Sigma g_{od}\ n_d}\right) \qquad \ldots (0.1)$$

where y_i and x are household expenditure on the ith commodity and total expenditure respectively, n_d is the number of person of d-th age-sex category present in the household, and g_{id}'s and g_{od}'s are parameters measuring the equivalence of a person of d-th age-sex category with a person of standard category (say an adult male) for expenditure on the i-th commodity and total expenditure respectively. Prais and Houthakker demonstrated that the g_{od} for each d is linearly related to corresponding g_{id}'s, restrictions that follow from the budget constraint $\Sigma y_i = x$. Forsyth, however, raised an objection to this formulation arguing that it would not be possible to estimate g_{id}'s and g_{od}'s (in general, specific and overall effects of household composition on household consumption) uniquely from observed data since the equations involving the unknown g_{id}'s would themselves be linearly dependent.

The principal objective of the present Chapter is to reexamine Forsyth's problem mentioned above and to indicate a solution for this. First of all, various methods of estimating the effects of household composition on consumption pattern (more exactly, the methods of estimating g_{id}'s and/or g_{od}'s in Equation (0.1)) are reviewed. Forsyth's problem is then discussed in a general frame work due to Barten. In Barten's formulation the engel curves are

$$\frac{y_i}{S_i} = f_i \left(\frac{x}{S_o}\right) \qquad \ldots (0.2)$$

where $S_i = S_i\,(n_d,\ d = 1, 2, \ldots, k),\quad i = 0, 1, \ldots, m$ measure the household size in respect of total expenditure (S_o) and the specific commodity expenditures (S_i, $i \neq 0$) respectively. Following this formulation

$$f_{id} = G_{id} - \pi_i\, G_{od} \qquad \ldots (0.3)$$

where f_{id}, G_{id} and G_{od} are the (partial) elasticity of y_i, S_i and S_o with respect to n_d and π_i is the (partial) engel elasticity $\left(\frac{\delta \log y_i}{\delta \log x}\right)$. Here the adding-up property $\Sigma\, y_i \equiv x$ leads to

$$G_{od} = \Sigma\, w_i\, G_{id} \qquad \text{for each } d \qquad \ldots (0.4)$$

where w_i's ($= \frac{y_i}{x}$) are the engel ratios. Given f_{id}'s , π_i's and w_i's it might be possible to estimate G_{id}'s and G_{od}'s using equations (0.3)-(0.4). But Forsyth observed that for each d only m equations of the (m+1) equation system (0.3)-(0.4) are linearly independent and thus concluded that it is not possible to obtain unique estimates of G_{id}'s and G_{od} (for each d) from actual observations. Barten offered a solution to this problem. Examining this solution it has been shown here that the merit of such a solution is dubious. Next, Barten's analysis has been extended further to yield a solution to Forsyth's problem. Precisely, a new independent restriction

$$\Sigma w_i \quad \pi_i \, G_{id} = G_{od} \qquad \text{for each } d \qquad \ldots. \ (0.5)$$

has been introduced to ensure that G_{od} obtained from (0.4) would be independent of x (so that the initial specification that S_o depends only on $n_1, n_2, \ldots, n_k$ may hold good). Now, it is shown that equations (0.3)-(0.5) is a consistent system from which G_{id}'s and G_{od}'s can be solved uniquely.

Apart from showing the general theoretical possibility of solving Forsyth's problem, the present Chapter also demonstrates that even in Prais-Houthakker's formulation (0.1) the g_{id}'s and g_{od}'s can be uniquely estimated from actual budget data if the form of $f_1(.)$ in (0.1) satisfies the adding-up criterion. As a concrete illustration, Working's form of engel curve has been used to indicate methods of estimating g_{id}'s and g_{od}'s and the structural parameters consistently from actual data.

Finally, an attempt has been made for an empirical verification of the arguments for solving Forsyth's problem. The empirical results reported are based on Forsyth's own results of household compositionwise constant elasticity engel curves fitted to the budget data from the U.K. Ministry of Labour (1953-54). It is shown that meaningful estimates of the specific and overall effects of household composition (in this case of G_{id}'s and G_{od}'s) could be obtained without making any unwarranted assumption.

Chapter III : Effect of household size on household consumption in India-I.

This Chapter and the one following it present the results of an analysis of the effect of household size on consumption pattern of Indian households. This is based on half-samplewise estimates of average per capita expenditure on (i) cereals and cereal substitutes, (ii) milk products, (iii) meat, fish and egg, and (iv) fuel and light by levels of per capita total consumer expenditure for each of household sizes 1-10 obtained separately for the rural and urban sector of the country from the 18th Round NSS (February 1963-January 1964). The present Chapter describes the material used, reports the results of household sizewise engel curve analysis in respect of the items mentioned above and also the nature of economies of scale in consumption as revealed by constant elasticity engel curves. Chapter 4 sets out two methods of estimation of the parameters indicating economies/diseconomies of scale in Prais-Houthakker's formulation and presents the empirical results based on them.

For each item four forms of engel curves, viz., semi-log (SL), double-log (DL), log-inverse (LI) and log-log-inverse (LLI), are fitted separately for each household size, sector and half-sample combination. The household sizewise engel elasticities obtained from DL curves have been compared to detect possible correlation between household size and engel elasticity. The tests based on ANOVA and Spearman's rank correlation coefficient indicate that, by and large, the itemwise engel elasticities do not bear significant correlation with household size.

To investigate the nature of scale effects implicit in expenditure patterns of sepcific items, constant elasticity engel curves

$$\log \left(\frac{y_i}{n} \right) = \alpha_i + \beta_i \log \left(\frac{x}{n} \right) + \gamma_i \log n \qquad \ldots \quad (0.6)$$

have been fitted, where $\left(\frac{y_i}{n} \right)$ and $\left(\frac{x}{n} \right)$ are per capita item and total consumer expenditure respectively, n is household size and α_i, β_i and γ_i are structural parameters. In this formulation $\gamma_i < 0$ (> 0) indicates presence of economies (diseconomies) of scale in the consumption of the specific item. Least squares estimates of γ_i shows that (i) for fuel and light considerable scale economies are present for rural and urban households, (ii) for cereals and substitutes γ_i is negative but small in absolute value indicating negligible economies in consumption, and (ii) for the other two items $\gamma_i > 0$ indicating some diseconomies of scale.

Finally, in order to have some idea about the extent of bias involved in the estimated engel elasticity when possibilities of economies of scale are ignored, the engel elasticity estimated from the usual per capita formulation, viz.,

$$\log\left(\frac{y_i}{n}\right) = \alpha_i + \beta_i \log\left(\frac{x}{n}\right)$$

has been compared with the estimates of engel elasticity obtained (i) on the basis of equation (0.6) and (ii) as the weighted average of household sizewise DL elasticities. The conclusion that emerges from the above comparison are essentially that presence of economies (diseconomies) of scale in consumption lead to overestimation (underestimation) of the true elasticity when the usual per capital formulation is used, and the weighted average of household sizewise DL engel elasticities closely approximate the corresponding elasticity obtained from the specification (0.6).

Chapter IV : Effect of household size on household consumption in India-II

Prais and Houthakker examined the effect of household size on consumer expenditure pattern by employing an elaborate formulation of engel curve which incorporates household size (n) explicitly, viz.,

$$\frac{y_i}{n^{\theta_i}} = f_i\left(\frac{x}{n^{\theta_o}}\right) \qquad \ldots (0.7)$$

where y_i and x are household expenditure on the i-th commodity and total expenditure respectively and θ_i and θ_o reflect scale effects in household consumption. More exactly, $(1 - \theta_i)$ and $(1 - \theta_o)$ measure the specific and the overall economies of scale respectively. The present chapter sets out two methods of estimating economies of scale based on the formulation (0.7) and also reports the empirical results obtained by applying these methods to Indian data on household consumption collected in the NSS.

The essential idea underlying the first method is as follows : If a variable elasticity form (e.g., linear, hyperbolic, semi-log, log-inverse or log-log-inverse) of (0.7) is specified for any commodity, then estimates of θ_i and θ_o could be obtained by relating the shifts in the parameters of household sizewise engel curves to household size. Thus for example, if (0.7) is of the semi-log form

$$\frac{y_i}{n^{\theta_i}} = \alpha_i + \beta_i \log \left(\frac{x}{n^{\theta_o}} \right) \qquad \ldots (0.8)$$

i.e.,

$$y_i = \alpha_{in} + \beta_{in} \log x \qquad \ldots (0.9)$$

where

$$\alpha_{in} = n^{\theta_i} \, \alpha_i - \theta_o \beta_i \log n \qquad \ldots (0.10)$$

$$\beta_{in} = \beta_i n^{\theta_i} \qquad \ldots (0.11)$$

and

$$\frac{\alpha_{in}}{\beta_{in}} = \frac{\alpha_i}{\beta_i} - \theta_o \log n \qquad \ldots (0.12)$$

then by fitting (0.9) separately for each n one would obtain estimates of α_{in} and β_{in} and θ_i and θ_o could then be consistently estimated from (0.11) and (0.12) through appropriate least squares technique. The method proposed here has some advantages. Unlike Prais and Houthakker's method (which requires special effort like establishing the 'quality equation' for estimating θ_o) the present method can be used to estimate θ_i and θ_o

by directly observing the shifts in the household sizewise engel curves. The method has the additional advantage that by examining expenditure data for a single commodity one would obtain estimate of θ_i for the specific commodity as also of θ_o. This method, however, in no way guarantees that θ_o's estimated from data for different commodities would be same apart from sampling fluctuations. But if the engel curve (0.7) is correctly specified for each commodity, one may expect that the resulting θ_o's would be close to one another.

The method outlined above has been applied to budget data from the 18th Round NSS (Feb. 1963 - Jan. 1964) covering the whole of rural and urban India. For each sector, the extent of specific and overall economies of scale present in household consumption has been examined for four commodity groups, viz., cereals and cereal substitutes, meat, fish and egg, milk products and fuel and light, on the basis of SL, LI and LLI engel curves.

Graphical examinations of the shifts in the parameters of household sizewise fitted SL and LI engel curves for different items revealed that the underlying specific and overall scale coefficients were sensible in most of the cases for the rural sector. The scatter diagrams for the urban sector, however, showed considerable fluctuations in many cases. As regards the magnitudes of the estimated θ_i's and θ_o, it may be mentioned that plausible estimates of these parameters could be obtained for most of the items in the rural sector. The discripancies between half-sample estimates were also often small. To illustrate, θ_i for cereals and cereal substitutes was estimated to be around 0.80 from both SL and LI engel curves. The corresponding estimate of θ_o was around 0.80-0.85. For fuel and light in the rural sector the estimated θ_i's were around 0.60 thus showing considerable specific economies of scale, and the corresponding θ_o was around 0.80 - 0.90. The estimated θ_i for meat, fish and egg was around 0.70 and the estimated θ_o was lightly below 0.80. Milk products present some anomalous results : for this item the estimate of θ_i indicated specific diseconomies of scale and the results obtained from SL and LI curves showed some divergences. As regards the estimates of θ_i's and θ_o for the urban sector, the results were less encouraging. Among the estimates that appeared reasonable were the estimate of θ_i around 0.60 - 0.65 for fuel and light and the estimate of θ_i around 0.85 for cereals and cereal subst A reason for this might be that for this sector household preferences cha drastically as houdehold size increases.

An attempt was also made to estimate θ_i and θ_o from the itemwise LLI curves as well. For this form

$$\log\left(\frac{y_i}{n^{\theta_i}}\right) = \alpha_i + \beta_i \log\left(\frac{x}{n^{\theta_o}}\right) + \gamma_i \frac{n^{\theta_o}}{x} \qquad \ldots (0.13)$$

i.e., $\log y_i = \alpha_{in} + \beta_{in} \log x + \gamma_{in}/x \qquad \ldots (0.14)$

where,

$$\alpha_{in} = \alpha_i + (\theta_i - \beta_i \theta_o) \log n \qquad \ldots (0.15)$$

$$\beta_{in} = \beta_i \qquad \ldots (0.16)$$

and $\gamma_{in} = \gamma_i \, n^{\theta_o} \qquad \ldots (0.17)$

The household sizewise estimates of α_{in}, β_{in} and γ_{in} failed to conform to the systematic relationships specified in (0.15)-(0.17). Thus the method of estimating θ_i and θ_o from the shifts of household sizewise enge parameters could not be pursued. An alternative search procedure was employed to estimate θ_i and θ_o from the LLI engel curves. Here, different values of θ_o in the range 0.70-1.00 were tried and for each θ_o (0.13) was estimated for each item and a θ_o was sought which minimized the sum of itemwise residual sum of squares of the LLI curves. Numerical results of this procedure indicated that for the rural sector θ_o in the range 0.80-0.85 was the most plausible estimate and the corresponding θ_i's were close to those obtained from the SL and LI curves. For the urban sector, however, this method did not work satisfactorily as in no case a unique θ_i could be located in the range 0.70-1.00.

The second method of estimating economies of scale in household consumption is essentially due to Nicholson. Here, the assumption is that engel ratio for food is a perfect indicator of a household's level of living. This implies that θ_i for food is equal to θ_o. Thus one gets the 'level of living function'

$$\left(\frac{Y}{x}\right) = g\left(\frac{x}{n^{\theta}}\right) \qquad \theta = \theta_o = \theta_{food} \qquad \ldots (0.18)$$

from which the common scale coefficient θ could be estimated. This idea has been utilized here to estimate θ from a suitable LLI specification (0.18) arrived at on the basis of combined sample estimates of food expenditure from NSS 19th Round (July 1964 - June 1965).

Chapter V : Consumption Patterns of Middle class and Working class household in India : A Comparative Study

This analysis, based on the budget data collected in the NSS Family Living Surveys of 1958-59, attempts to explore the differences in expenditure pattern of Indian middle class and working class households at selected urban centres viz., Ahmedabad, Calcutta, Kanpur and Madras. Precisely, the middle class covers households which derived their incomes mainly from non-manual jobs in the non-agricultural sector (i.e., households supported by professional, technical and related workers, administrative, executive and managerial workers etc.). The working class, on the otherhand, includes households supported by manual workers in registered factories, mines or plantation.

At each centre mentioned above, expenditure pattern of the two social classes have been compared in respect of nine food items and ten non-food items of consumption. As a preliminary investigation the trends in engel ratios for four broad groups of items namely, food and beve clothing, housing and other miscellaneous expenditures, over size classes of per capita income have been examined for the two social classes at each centre. These show that for middle class households at all the centres the engel ratio for food declines systematically as per capita income rises. A comparison of the engel ratio for food between two social classes reveal that the Working class has a higher consumption of food. Engel ratios for other items fail to show any such general pattern of difference.

In the detailed analysis DL and LLI engel curves (relating per capita item expenditure to per capita income/total expenditure) have been fitted for each item, social class and centre combination. Comparison of the goodness of fit of DL and LLI curves reveals that for luxury items DL form is as good as the corresponding LLI form, while for necessary food items LLI is clearly superior in many cases. The DL elasticities, by and large, approximate satisfactorily the average elasticity obtained from the corresponding LLI curve.

Inter-class differences in expenditure patterns in respect of various items have been examined graphically (by comparing the itemwise fitted LLI curves for the two classes at each centre) and the analysis of covariance technique has been applied to test statistically the inter-class differences in itemwise engel curves. The covariance tests have been applied to test inter class homogeneity of the itemwise DL and LLI curves. The results of these tests indicate considerable inter-class *divergences in expenditure patterns.*

Noticing that there exist considerable differences in household size of the two social classes at comparable levels of living in all the centres, an attempt has been made to eliminate any possible effect of economies of scale in consumption of the social classes and then to compare the income responses. Due to non-availability of appropriate data the following procedure has been adopted for such a comparison : using expenditure data for the middle class household at each centre classifiby per capita income and household size respectively the following generalised LLI curve has been estimated

$$\log\left(\frac{y}{n}\right) = \alpha + \beta \log\left(\frac{x}{n}\right) + \gamma \frac{n}{x} + \delta \log n \qquad \ldots (0.19)$$

where $\frac{y}{n}$ and $\frac{x}{n}$ are per capita item expenditure and total expenditure respectively, n is household size and α, β, γ and δ are the structural parameters. From this function expected per capita item expenditures have been estimated when the household sizes of middle class and working class households are equalized. These estimates have been graphically compared with the corresponding estimates of per capita item expenditures obtained from the ordinary LLI curves for working class households. Such comparisons have been done separately for each centre in respect of four broad groups of items mentioned at the outset. The results indicate that at all the centres the working class households spend relatively more on foodstuff than comparable middleclass households even when the effects of differential household sizes are eliminated. The graphs for other items, by and large, exhibit considerable differences although the pattern of differences vary over centres.

Chapter VI : Effect of relative prices on engel elasticity for cereals in India

An explanation of international variation of engel elasticity for any specific commodity, in particular for food, is offered in terms of international differences in income level. Houthakker pointed out the inadequacies of such an explanation and proposed another hypothesis, namely, that international differences in engel elasticity might be explained by variation in the price of the commodity concerned relative to the general price level and also by the variation in the relative prices of different subgroups of commodities within the commodity as a whole (e.g., relative price of superior and inferior varieties). The present study attempts an empirical verification of Houthakker's conjecture. Precisely, the extent to which intertemporal variation of engel elasticity for cereals and cereal substitutes (as a group) can be explained by movement of relative price of this item-group and also by the ratio of prices of superior and inferior cereals has been examined here.

The analysis is based on time series of cross-sectional estimates of engel elasticity for cereals and cereal substitutes obtained from different Rounds of the NSS separately for the rural and urban sector of India. Corresponding relative prices have been constructed on the basis of official wholesale price indices (and also on the basis of retail price indices for cereals and cereal substitutes from the NSS).

To examine the influence of prices on engel elasticity the following regression models have been specified :

$$\log \pi_{vt} = \alpha + \beta \log \left(\frac{P}{\bar{P}}\right)_t \qquad \ldots (0.20)$$

and

$$\log \pi_{vt} = \alpha + \beta \log \left(\frac{P}{\bar{P}}\right)_t + \gamma \log \left(\frac{P_s}{P_i}\right)_t \qquad \ldots (0.21)$$

where π_{vt} is the estimated engel elasticity (value) of cereals and cereal substitutes for the t-th NSS Round (t = 4, 5, 7-19, 22), $\left(\frac{P}{\bar{P}}\right)_t$

is the relative price of cereals and cereal substitutes (wholesale or NSS retail) for the t-th NSS Round, $\left(\frac{P_s}{P_i}\right)_t$ is the superior-inferior price ratio for cereals for the t-th Round, and α, β and γ are the structural parameters. Empirical results indicate that for the rural sector $\left(\frac{P}{\bar{P}}\right)_t$ is an important determinant of π_{vt}, but $\left(\frac{P_s}{P_i}\right)_t$ does not have significant influence on π_{vt}. In fact, the estimate of β for the rural sector is always positive and significant. For the urban sector, on the otherhand, the results show that (0.20) and (0.21) cannot explain intertemporal variation of π_{vt}. –This may be due to the facts that urban consumers are generally better off and hence are less sensitive to price changes at least for consumption of cereals, and also that during the period in view distributional restrictions were imposed in several occasions on the consumption of cereals by the urban population, so that one cannot expect to see the normal interplay of supply and demand in the urban markets for cereals.

Finally, noticing that for rural India the engel elasticity for cereals and cereal substitutes depend on its relative price, an attempt has been made to derive an empirical demand function for cereals and cereal substitutes appropriate for the rural sector that pays due attention to the role of prices. The possibility of deriving demand functions by correlating the intertemporal shifts in the parameters of cross-sectional engel curves with movements of the relative price has also been discussed with illustrations.

Chapter VII : Occupational variation in the Pattern of Consumer Expenditure in Rural India

The present study based on a special tabulation of 18th Round NSS data (February 1963-January 1964) covering the whole of rural India, is concerned primarily with the examination of differences in expenditure patterns of rural households having different types of agricultural occupations. Since rural households in India are predominantly engaged in various types of agricultural activities, it is natural to expect considerable variation in the patterns of consumption among households having different types of activities. Further, a considerable part of total consumer expenditure of a rural household is of the nature of expenditure in kind incurred through consumption out of home-grown stocks or through barter exchange. The pattern of such non-monetized transactions would normally vary across households depending, among other things, on the type of occupation and regional factors. In the present study, itemwise expenditure patterns of four groups of rural households, viz., cultivators, agricultural labourers, other agricultural occupation-holders and non-agricultural households, have been compared in respect of total expenditures on items as also their cash and kind components.

The analysis has been designed in two stages. In the first stage occupationwise engel curves for each of 15 items (relating item-specific per capita total expenditure (e) to all-items per capita total expenditure (E)) have been compared; in the final stage of the analysis the cash (e_m) and kind (e_k) components of item-specific total expenditures (e) have been examined through the cash and kind expenditure functions, $e_m = f(E_m)$ and $e_k = f(E_k)$ respectively where E_m and E_k are the cash and kind components of all-items per capita total expenditure (E). At both the stages four two-parameter forms of expenditure function, viz., linear (L), double-log (DL), semi-log (SL) and log-inverse (LI), and the log-log-inverse (LLI) form have been fitted for each item-occupation combination.

In comparing the expenditure pattern in respect of total expenditures (i.e., on the basis of item-specific e) across occupation groups the engel elasticities (i.e., elasticity of e with respect to E) have been compared. For this purpose, engel elasticity at occupation-specific average per capita total expenditure (E), at all-occupation average per capita total expenditure, and the average elasticity have been computed from the best-fitting two-parameter forms and also from the LLI form of expenditure curve. In order to get a clear picture of the divergence of engel elasticities across occupation groups the items have been classified into luxuries and necessities on the basis of average elasticity calculated from the LLI and the best-fitting two-parameter form. It has been noted that such classifications exhibit considerable inter-occupational variation in expenditure patterns.

To examine the homogeneity of the functions $e=f(E)$ for each item across occupation groups, the covariance-analysis technique has been adopted. The results of these tests reveal that, by and large, agricultural labourers have a different pattern of expenditure than the other three occupation-groups, the expenditure patterns of cultivators, other agricultural and non-agricultural households are more or less similar.

Coming to the detailed analysis of cash and kind components of item expenditures and the pattern of differences of these components across occupation-groups, first of all, the rates of non-monetization for different items have been compared across occupation-groups. In subsequent analysis the inter-occupational homogeneity of the itemwise cash and kind expenditure functions, viz., $e_m = f(E_m)$ and $e_k = f(E_k)$, have been tested through analysis of covariance technique. Here also, the results suggest that the pattern of cash and kind expenditures for households of agricultural labourers are clearly distinct from those for the rest. The picture about the differences in kind expenditure functions could not be estimated satisfactorily.

Appendix A : Consumption Patterns of Middleclass and Workingclass households in India : A Regional Comparison

The pattern of interregional variations of consumer expenditure has been examined in a number of Indian Studies. In these studies so far as only regional factors were considered as the source of differences of expenditure pattern, these studies bring out the overall effects of regional variations on consumption pattern. Here, an attempt has been made to examine the inter-centre differences in consumption pattern separately for the middleclass and working class households. The advantage of this type of analysis is essentially that by considering each social class separately, it is possible to eliminate the effect of social class/occupation on consumption pattern. This helps in obtaining a more clear picture of regional differences in consumer expenditure pattern.

Using the Family Living Survey data mentioned above, inter-centre comparison of expenditure pattern has been made in respect of 12 food and non-food items. Precisely, the homogeneity of itemwise DL engel curves across centres have been tested through analysis of covariance technique for each social class separately. The results of these tests indicate significant inter-centre differences in the levels of consumption of different items for both the social classes. Since inter-centre variation in household size is seen to be small for both the social classes, it may be concluded that the results of comparison based on per capita formulation of DL engel curve does not vitiate the true picture of underlying differences in consumption pattern.

Appendix B : Choice of Classificatory Character in Engel Curve Analysis

In Chapter V the itemwise engel curves for the two social classes have been estimated on the basis of estimates of per capita item expenditure and per capita total consumer expenditure by levels of per capita income. It might be argued that expenditure data classified by levels of per capita total consumer expenditure would have been more appropriate in this context. Here, some results of comparison of DL engel curves estimated from the data classified by per capita income with those estimated from the data classified by per capita total consumer expenditure have been presented. In both the cases logarithm of per capita total consumer expenditure has been used as the regressor and the engel curves have been fitted by weighted least squares method where the weights are number of sample households in each class of per capita income/per capita total consumer expenditure. These results are based on the estimates of expenditures thrown up by the Middleclass Family Living Surveys at different centres mentioned earlier.

The results show that the divergences of the estimates of DL elasticity for individual items obtained from the income and expenditure classifications are not same for all the centres. For example, for Ahmedabad the discripancies of the two estimates of engel elasticity for all the items are relatively large, while for the other three centres the corresponding discripancies are usually less pronounced. As regards the goodness of fit of the estimated engel curve obtained from the two classifications, no clear pattern of divergences in R^2 could be identified.

Appendix C : Analysis of Covariance

The analysis of covariance technique has been applied in many contexts in the earlier chapters. In all the cases this technique has been applied to expenditure data grouped by levels of per capita income/total consumer expenditure. In the present Appendix the formulas for the different F. tests implied in the analysis of covariance technique have been derived for the case where one works with grouped expenditure data.

Appendix D : Estimation of sampling errors of engel parameters from grouped survey data

Household budget enquiries usually cover samples of households drawn according to complicated sampling designs, often involving stratification, multi-stage selection, etc. This makes it difficult, if not impossible, to estimate the standard errors of the estimated parameters of engel curves fitted to the data and hence of estimated engel elasticities. Generally, one applies the classical least squares formula of standard errors of estimated engel parameters ignoring the complications arising due to sample design. In the present Appendix are reported an empirical study on the comparative magnitudes of two alternative estimates of sampling variance of engel parameters viz., that estimated by classical least squares formula and that estimated on the basis of subsample divergences of the estimated engel parameter. This study is based on the study of Bhattacharya and Maitra (1969) of itemwise engel curves for 14 rounds of National Sample Survey. It appears that the two methods sometimes yield significantly different estimates of sampling variance. The sign and magnitude of the discripancies are found to depend on the algebraic form of the engel curve. However, the results are curious in certain respects and could not be satisfactorily explained in terms of known results of econometric theory.

Chapter I

Studies on Consumer Behaviour : A Survey

1.1 Introduction :

The interest in quantitative analysis of consumer behaviour dates back to the days of Ernst Engel who formulated the famous empirical law of food consumption in 1857. Since then numerous empirical studies have been undertaken to testify various theoretical postulates regarding consumer behaviour and to quantify the extent of response of the consumers to changes in economic factors such as income, prices, stock of wealth and so on and also to changes in other socio-demographic factors such as household size and composition, occupation etc. Apart from being tests of postulates regarding the behaviour of the consumers, these studies have immense importance in the formulation of planning programmes and fiscal policies. Since developmental programmes lead to changes in the levels and the structure of demand for various goods and services by improving the level of income and by redistributing it among the population, the success of such programmes necessitates that supplies of goods and services be scheduled according to expected demand pattern so that different markets may not exert excess-demand or excess-supply pressure on the functioning of the economic system. All these presuppose a fairly detailed empirical research regarding consumer behaviour.

Depending upon the nature of data available, there can be three approaches to the analysis of consumer behaviour : first, demand analysis based on time series data of average per capita quantity consumption, average per capita income/total expenditure and prices may be used to estimate the complete commodity demand functions and the price and income responses for each individual goods. Next, analysis of cross-sectional household budget data may be conveniently used to measure the income responses through eliminating the effects of various extra-economic factors which characterize a particular household. Finally, the continuous cross-section or Panel data on household budgets (which give continuous records of consumer expenditure of individual sample households over time) are helpful in studying dynamic aspects of consumer behaviour.

As regards the theoretical basis of empirical studies, it may be mentioned that while most of the time series studies are designed to examine system of demand equations based on Hicks-Allen theory of consumer behaviour for non-durable commodities in a static framework, the cross-sectional studies examining income-expenditure relationships do not benefit much from the existing economic theory. Analysis of demand patterns for durable commodities offer special problems arising due to the possibility of accumulating stocks and incurring depreciation costs in respect of these items and it is well known that such studies need be essentially based on dynamic models. Time series and continuous cross-section data are used for studying such dynamic model. However, as it has been shown the dynamic models may also be meaningfully applied to non-durables as well since for many of these items there is the possibility of habit-formation in respect of consumption which introduces elements of dynamic adjustments in consumer behaviour.

In what follows we have reviewed the methodology and problems of empirical demand analysis and also summarised the Indian contribution to this branch of econometric applications. Section 1.2 briefly outlines the static theory of consumer's equilibrium; Section 1.3 examines the methodology of cross-sectional studies; Section 1.4 describes the approaches to measuring effects of various household characteristics on consumption pattern in a cross-sectional set up; Section 1.5 reviews the time series studies of complete (static) demand system while Section 1.6 discusses the problems and procedures of estimation of dynamic demand functions; finally, Section 1.7 reviews the Indian contributions in empirical analysis of consumer behaviour.

1.2 The Static Theory of Consumer Behaviour :

The static theory of consumer's equilibrium deals with the problem of allocation of a given money income of a single consumer among different commodities when all prices facing the consumer are assumed fixed, and indicates the nature of the consumer's reaction when price(s) and/or income change. This is a simplified exposition of reality and to some extent approximates the actual situation where all the commodities available to the consumer are non-durable in nature. The problems arising in case of a durable commodity are essentially dynamic in nature. Since such a commodity is consumed over time periods, its utility is enjoyed for a number periods. Further, there is depreciation as also accumulation of stock of a durable commodity. Finally, in view of the fact that durable commodities, by and large, are costly, the decision to purchase durables frequently depends upon not only on the current income but also on the expected income pattern of the consumer. All these necessitate a dynamic model of consumer's equilibrium. It has been pointed out that similar dynamic considerations are necessary for habit-forming non-durables as well for which the consumer's current purchase decisions are largely influenced by his past purchase behaviour.

The problem of the traditional consumer's equilibrium model is essentially a constrained maximization problem where the consumer's utility function $V(q_1, \ldots, q_n)$ (dependent upon the level of consumption q_i $(i = 1, \ldots, n)$ of n commodities) is maximized subject to the budget constraint $\Sigma_i p_i q_i = x$, p_i' s being the fixed prices and x being the given level of money income. The first order conditions for this maximisation problem are

$$\left.\begin{aligned} u - \lambda p &= 0 \\ p'q &= x \end{aligned}\right\} \qquad \ldots (1.2.1)$$

where $u = \left[\frac{\delta V}{\delta q_i}\right]$ is the vector of marginal utilities, p is the vector of n prices, q is the vector of n quantities, and λ is the Lagrangean multiplier interpreted as the marginal utility of x. The second order condition for a maximum is that $U = \left[\frac{\delta^2 V}{\delta q_i q_j}\right]$, the matrix of second order partial derivatives of V, is negative definite. The system of (n+1) equations in the n unknown q_i's and λ may be used to yield the n demand functions

$$q_i = q_i\,(x, p_1, \ldots, p_n) \text{ for all } i \qquad \ldots (1.2.2)$$

The restrictions on the demand function (1.2.2) follow from the system of differential equations obtained by total differentiation of (1.2.1) which yields

$$\begin{bmatrix} U & p \\ p' & 0 \end{bmatrix} \begin{bmatrix} dq \\ -d\lambda \end{bmatrix} = \begin{bmatrix} \lambda\, dp \\ dx - q'\,dp \end{bmatrix} \qquad \ldots (1.2.3)$$

The slutsky decomposition of price response into income and substitution effects may be derived from (1.2.3) as

$$Q_p = \left[\frac{\delta q_i}{\delta p_j}\right] = \lambda U^{-1} - q_x' q_x\, \phi\, x - q_x\, q' \qquad \ldots (1.2.4)$$

where $q_x = \left[\frac{\delta q_i}{\delta x}\right]$ and $\phi = \left[\frac{\delta \log \lambda}{\delta \log x}\right]^{-1}$. (1.2.4) yields the income-compensated price derivatives of quantities

$$S = \left[s_{ij}\right] = \left[\lambda\, U^{-1} - q_x\, q_x'\, \phi\, x\right] = Q_p + q_x\, q' \qquad \ldots (1.2.5)$$

obtained by setting income such that after a price change the utility is left unaltered. (1.2.5) forms the pivot for all restrictions on demand functions that follow from this theory. In brief, these restrictions are

(i) the aggregation restrictions

$$p' q_x = 1 \quad \text{and} \quad p' S = 0 \qquad \ldots (1.2.6)$$

i.e., the reallocations of the budget due to income and/or price change must exhaust total income,

(ii) the homogeneity restrictions

$$Sp = 0 \qquad \ldots (1.2.7)$$

which suggest that proportional changes in all prices and income must leave demand functions unaltered,

(iii) the symmetry restriction

$$S = S' \qquad \ldots (1.2.8)$$

asserts that specific substitution effects are symmetric, and finally

(iv) the negativity restriction on the substitution matrix, S.

These restrictions, derived from the point of view of a single consumer's utility maximization, provide a description of consistent consumer behaviour. When confronted with the problem of estimation of demand equations from actual consumption data, one may take advantage of these restrictions and thus reduce the number of unknown parameters to be estimated.

At this point the notion of separable utility functions may briefly be mentioned. The basic idea underlying the separability of utility functions is to group commodities in such a way that the marginal utilities of goods belonging ~~to~~ specific groups become independent of the level of consumption of goods outside the group[1]. The assumption of separability of utility function can be of considerable importance in the sense that the introduction of the notion of separability to demand analysis offers quite a few restrictions on income and price responses. Several estimable models of consumer demand have been obtained by solving the consumer's equilibrium problem in which various specific forms of additive direct or indirect utility function are assumed[2]. Two such models based on additivity of utility functions have been used very widely; the linear expenditure system which assumes direct additivity, and the indirect addilog model due to Leser (1941-42) and Houthakker (1960) which assumes indirect additivity. In addition to these, models of Frisch (1959) and Powell (1966) have also found practical application in many contexts. In a recent study, however, Deaton (1974) have seriously questioned the practical applicability of the consumer demand models based on additivity assumptions. It has been

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[1] For alternative definitions of separability see Leontief (1947), Frisch (1959), Sono (1960) and Pearce (1964).

[2] The direct utility function relates utility from consumption to the quantities consumed of different commodities. The indirect utility, on the other hand, conceptually depends upon the income of the consumer and prices. It has been shown that maximization of a direct utility function subject to a budget constraint is the mirror-image problem of minimization of a corresponding indirect utility function subject to quantity constraints (Houthakker, 1960).

shown that both the additivity assumptions imply approximately linear relationships between own-price and income elasticity, phenomena that are a priori implausible and there exists no evidence in favour of them. Deaton argues that in spite of the enormous practical advantages that the assumption of additivity leads to, the suitability of additive utility models should be seriously reconsidered.

Coming to the question of applicability of the theory described above to empirical demand analysis, it may be stated that since actual data frequently relate to groups of consumers rather than to single individuals, it is necessary that the micro-demand relations should be capable of being extended to the case of aggregate demand. Unfortunately, the conditions under which consistent aggregation of demand functions over individual is possible are quite stringent and hence are seldom stressed in actual quantitative studies[3]. In practice, thus, the common approach has been to ignore the problem of aggregation altogether and to use the relationships obtained from the micro-theory with the supposition that they describe the behaviour of the average consumer to a satisfactory approximation.

It must now be mentioned that the theoretical restrictions are far more relevant for time-series based demand analysis than for cross-sectional analyses. The time-series data depict simultaneous variation in quantities, prices and income and hence provide a scope for checking

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[3] Vide Gorman (1953), Green (1964), Theil (1965, 1971), Pearce (1964) and Barten and Turnovsky (1966) for discussions on the problems of consistent aggregation of micro-demand relations.

whether the restrictions of the theory are valid in real life or not. Cross-sectional studies, on the other hand, are usually based on the assumption that variation of prices in cross-section data are negligible and as such only income responses may be computed from such studies. Thus most of the theoretical restrictions find little use in cross-section studies.

1.3 Cross-sectional Studies : Methodology of engel curve analysis:

The static theory of Section 1.2 suggests that demand for each non-durable commodity (y_i) by a single consumer may be expressed as a function of the consumer's disposable income (x) and all the market prices ($p_1, \ldots, p_n$, there being n commodities). Since the preference (U) and prices in a cross-section study are assumed fixed

$$y_i = f_i\,(x \mid p_1, \ldots, p_n, U) \qquad \ldots (1.3.1)$$

where $f_i(.)$ is the functional symbol. (1.3.1) relating y_i to x with given prices and preferences, popularly known as the engel relation/function, is the basic relation estimated from cross-sectional household budget data.[4/] The mainstay of such analyses is the postulate that, on an average, differences in consumption pattern of rich and poor households can be ascribed to the differences in their current income positions. That is, for a group of households with identical environment as represented by their socio-cultural attitudes, household

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[4/] It is generally assumed in family budget enquiries that prices are constant over the enquiry period and for all households interviewed in the enquiry. Both these assumptions are only approximately true.

characteristics and wealth position, in short, with identical taste and needs (i.e., preferences), cross-sectional studies based on household budgets bring out the partial income effects of consumption. In order that prices and the tastes and needs of households may show as little variation as possible, the data should be collected from a sufficiently small geographical region over a short span of time and for a homogeneous group of households. In actual practice, however, these ideal conditions are rarely met and therefore estimational techniques capable of handling such situations are employed.

At this point it may be pertinent to indicate the nature of income effect that is estimated from cross-sectional studies. Variation in income between households in a cross-sectional survey results primarily from variations in such factors as household size and composition, age, level of education and occupation of the head, and so on. These variables generally change slowly over time. The cross-sectional estimates of income elasticities may, therefore, be regarded as the long-run elasticity[5]. Next, although prices are assumed constant in cross-section analyses they are rarely so, and vary during the enquiry period. This introduces elements of seasonal variation in expenditure data and may bias the estimated income elasticity for different items, the direction of such bias depending upon the nature of correlation that the

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[5] As compared with this the time-series estimates of income elasticities are relatively short-run in nature since the variation in time-series data of income etc., are usually affected by short-run dynamic factors.

prices bear with income and other factors included in engel curve analysis. Finally, in so far as the consumption of any commodity depends upon the stock held, at the beginning of the period, whether physical or psychological, of the commodity concerned, the income-expenditure relationship becomes essentially dynamic. Neglect of this dynamism frequently introduces bias in the cross-sectional estimates of income effects (Houthakker and Taylor, 1970, Chap. 6).

Briefly, the advantages of cross-sectional studies lie essentialy in the following facts : first, the household budget data provide "the quasi-experimental conditions" under which the income-consumption relationship may be studied in isolation from such phenomena as price changes. Next, wide variation in income between households enables us to drew inferences about the response of consumption to income for large variations in income, whereas pure theory is concerned with small changes from an initial equilibrium (Brown and Deaton, 1972). Finally, since the sample size is usually large, there are ample opportunities for studying the influence of such factors as household size and composition, occupation, education and age of the head of the household, locational characteristics, etc., on the expenditure pattern of the households.

1.3.1 Choice of variables in engel curve analysis :

So far as the dependent variable in engel curve analysis is concerned, the expenditure on the particular item/group of items seems to be a convenient choice for the following reasons : (i) Frequently the interest centres around an item/item group for which the quantities of the constituent commodities cannot be meaningfully added to obtain a quantitative measure of consumption of the item/item group under study. (ii) For many items such as services, amusements etc., the notion of quantity is not easily perceived whereas expenditure provides a fairly straightforward measure of the consumption level. Finally, (iii) for many items different varieties or qualities may be available for consumption and it is wellknown that the quality of goods consumed improves with the level of income. So far as the quality of a commodity is directly related to its price, use of the quantity as the dependent variable in the engel curve would yield a biased estimate of the true quantity elasticity. This happens because the estimated quantity elasticity contains a price effect resulting from the omission of the price differentials associated with quality variations. It is suggested that the correct decision in these cases would be to analyse separately the dependence of item expenditure and the price on income, and to derive the implied quantity elasticity therefrom (Prais and Houthakker, 1955, p. 80).

The choice of an appropriate regressor in engel curve analyses raises more serious difficulties. It cannot be settled by economic theory alone, but must depend as much on statistical considerations. Theoretically, disposable income (satisfying the budget constraint, i.e., equalling the sum of item expenditures) should be taken as the explanatory variable. If income accruing to the consumer and his needs are steady overtime, it may be argued that the conditions of static theory of consumer behaviour are satisfied and that net income received will be the appropriate explanatory variable. Following Friedman (1957) income and consumption can each be divided into permanent and transitory components. Friedman asserts that permanent income determines permanent consumption and the transitory components are independent of the permanent components and of each other. It, therefore, follows that the income concept to be used should come as close as possible to permanent income. Technically, the recorded income figures obtained through budget surveys frequently deviate from the true permanent income position of households due to under-reporting and presence of seasonal and other short-run random errors. In such cases use of recorded income as a proxy for permanent income may lead to under-estimates of income elasticity.

The alternative to recorded income that finds wide use in budget studies is total consumer expenditure obtained as the sum of all item expenditures. This usually is less affected by the transitory elements as the transitory elements in item expenditures may get cancelled as a result of aggregation. Furthermore, item expenditures, unlike income, may be recorded more or less accurately and the same seems to be true of total expenditure. However, as Liviatan (1961) pointed out, the use of total consumer expenditure as the independent variable in an engel curve analysis raises some problems of estimation. For any item expenditure there are permanent and transitory components. When item expenditures are aggregated to obtain total expenditure the transitory component of total expenditure is simply the sum of transitory item expenditures. It is then obvious that the transitory elements of the item and the total expenditures would be correlated. In such a case, use of total expenditure as the regressor would yield inconsistent estimates of the engel parameters. Liviatan suggested an instrumental variable estimation procedure for overcoming such a difficulty.

In spite of the arguments cited above total consumer expenditure finds wide acceptance as the explanatory variable in engel curve analysis. The reason is that in most of the household budget surveys, it is total consumer expenditure and not recorded income, which appears to be stable over time and thus more closely correlated with the underlying permanent income and therefore with observed patterns of household consumption. An empirical investigation by Houthakker and Taylor (1970, pp. 255-59), clearly points to this conclusion. In this investigation principal component analysis was applied to (logarithms of) householdwise expenditures on 36 distinct items of consumption. The first principal component was seen to be much more closely correlated with total consumer expenditure than with income. In fact, the former correlation was so high that the first component could be safely described as a close relative of total consumer expenditure. This result might have obtained because while total expenditure itself depends upon the time pattern of earnings in a complicated manner, the allocation of total expenditure among various items, especially non-durables, depends largely on the level of total expenditure. Lack of reliability of the reported incomes may also provide a partial explanation.

1.3.2 Choice of functional form of the engel curve

The choice of the functional form of the engel curve is governed by certain economic-theoretical as also by some statistical criteria. Unfortunately, the theory of consumer behaviour offers very little in the context of specification of engel curves. In fact, the only theoretical restriction on the form of the engel curves stems from the budget constraint which implies that the functional form of the engel curves should be such that the expenditures predicted for different items from the respective engel curves should add up to the corresponding disposable income (or total consumer expenditure). Usually, this restriction, labelled as the adding-up criterion, proves to be too stringent and limits the choice to a few functional forms that may not fit actual expenditure data very well. The other restrictions are concerned with the shape of the engel curve. The first, the saturation criterion, stipulates that the level of predicted physical consumption should approach a satiety level as income increases indefinitely (at given prices). It should be clear that the notion of demand saturation applies specifically to quantity of consumption. In most cases, the quality of consumption (as reflected by the average price paid for the item) is positively correlated with income/total expenditure, and the item expenditure may rise with income throughout the observed range of income without showing any tendency towards saturation. Actually, the adding-up criterion and the saturation criterion, if applied to item expenditures, are mutually inconsistent since the former may be true only when the latter does not hold for at least one item. Another criterion, more partinent for luxury items, suggests that the engel curve should possess a threshold level of income below which the consumption of the specific item would be zero. Next, since empirical evidence frequently indicates a negative correlation between average income/total expenditure of the community and the engel elasticity at average income/total expenditure estimated for that community, it is expected that the nature of many items of consumption changes from luxury to necessary and even finally to inferior as income level rises. Ideally, therefore, an engel curve should be sufficiently flexible to allow for realistic variation of the engel elasticity along the engel curve. In fact, engel curves for many necessary items estimated for a given community show declining engel elasticities with rising income. Finally, it is desirable that the parameters of the engel curve should have simple economic interpretation.

The principal statistical criteria governing the choice of the functional form centre around such properties as (i) goodness of fit, i.e., the capacity to explain observed variation in item expenditures, (ii) tractability in the context of demand projections and other applications and (iii) simplicity of estimation of parameters. Other minor criteria include (i) availability of graphical test, (ii) handling of heteroscedastic disturbances, (iii) treatment of zero observations and so on.

By far the most important statistical criterion is that of the goodness of fit of the specific form of engel curve. This stresses that the observed variation in the dependent variable of the engel curve should be explained as far as possible by the engel relation. It is clear that if there is mis-specification of the functional form the regression residuals would be fairly autocorrelated reflecting systematic component of the residuals. Thus the criterion of goodness of fit requires that the degree of autocorrelation in the regression residuals of an engel curve should be as small as possible. Next, in view of the fact that a principal application of engel curve analysis is made in forecasting of consumer demand, it is desirable that the form of engel curve should be convenient for this kind of applications[6/]. Finally, the criterion of simplicity of estimation ordinarily means that least squares regression technique should be applicable after appropriate transformation of the variables. Furthermore, to guarantee computational ease the engel function should be capable of showing sufficient flexibility in shape with as few parameters as possible.

[6/] Vide Section 1.7.2 infra.

1.3.3 Popular algebraic forms of engel curve :

Algebraically, an engel curve of sigmoid form, i.e., with $f(o) = 0$, $f(\infty)$ = some finite constant, and a point of inflexion at some $x > 0$, is capable of representing luxuries at the lower levels of x and necessaries at higher levels. The lognormal and logistic distribution functions and the log-inverse function $\log y = \alpha - \beta/x$ $(\alpha, \beta > 0)$ belong to this category. In practice, however, the observed range of x is rarely wide enough to show a single commodity as a luxury, a necessary and even as an inferior good over different parts of the range of x.

The commonly used two-parameter forms may be regarded as approximations to different sections of a full-fledged sigmoid curve. The linear form, $y = \alpha + \beta x$, often proves insufficient since the observed expenditure data frequently show non-linearity. The double-logarithmic (or constant elasticity) form $\log y = \alpha + \beta \log x$ is, in fact, the most popular among the two-parameter forms; here the ergel elasticity is constant (β) at all levels of x. Empirical results suggest that the double-logarithmic (DL) form is suitable specially for luxury items. For necessaries, on the other hand, the semi-logarithmic (SL) engel curve $y = \alpha + \beta \log x$, often proves to be satisfactory. For this form the engel elasticity $(= \frac{\beta}{y})$ decreases continuously towards zero as the consumption increases. For necessaries approaching saturation, the log-inverse form $\log y = \alpha - \frac{\beta}{x}$ is suitable, where the elasticity $(= \frac{\beta}{x})$ declines to zero with rising x. Finally, the hyperbola $y = \alpha - \frac{\beta}{x}$ is also found to be suitable for some necessaries. It may be mentioned that among these five forms, only the hyperbola possesses both a threshold (at $x = \frac{\beta}{\alpha}$) and a saturation level ($y = \alpha$). The semi-logarithmic form form and the linear form possess thresholds (at $x = e^{-\frac{\alpha}{\beta}}$ and at $x = -\frac{\alpha}{\beta}$ respectively) but no saturation level. The log-inverse form possesses only the saturation level ($y = e^{\alpha}$), and double-logarithmic form possesses none of them.

Mention should be also made here of Tornquist's forms (Wold, 1953, pp.98-110). Separate forms have been suggested for necessary, "relative luxury", luxury and inferior items of consumption and these often give satisfactory fit to observed data. However, these forms pose considerable estimational problems and are somewhat intractable in subsequent analyses.

The two-parameter forms mentioned above, though useful for explaining variation in expenditures on many individual items, sometimes prove to be inadequate as judged by their goodness of fit. In this context, it is worthwhile to refer to the log-log-inverse form $\log y = \alpha + \beta \log x + \frac{\gamma}{x}$ introduced by Goreux (1964) that has proven capacity of showing sensible variation in engel elasticity along the engel curve and of ensuring satisfactory fit for all types of items. In some studies other forms viz., the semilog-inverse $y = \alpha + \beta \log x + \frac{\gamma}{x}$ the parabola $y = \alpha + \beta x + \gamma x^2$, and the log-parabola, $\log y = \alpha + \beta \log x + \gamma (\log x)^2$ have also been used (vide, Singh, 1968).

Other forms of engel curve emerged out of the analyst's concern over specific properties of engel curves. Thus Houthakker's addilog systems of engel curves were derived in such a manner that they satisfy the adding up criterion while maintaining the desired non-linearity of the engel curve. In fact, despite Nicholson's theorem on the adding up criterion (Nicholson, 1957), the restriction is rarely stressed in empirical engel curve analyses since among the common algebraic forms only the linear and the parabolic could be forced to satisfy this restriction. Houthakker's addilog systems provide functional forms that yield more or less reasonable patterns of engel elasticity while satisfying the budget constraint. Algebraically, those systems are :

$$\log y_i = \alpha_{ij} + \beta_{ij} \log y_j \text{ (direct addilog system)}$$

and

$$y_i = \frac{a_i x^{b_i + 1}}{\Sigma_j a_j x^{b_j}} \text{ (indirect addilog system)}$$

where i and j are commodity suffixes. Thus, for the direct addilog system, every item expenditure is a double-logarithmic function of every other item expenditure, i.e., the ratios of engel elasticities are constant. For the indirect addilog system, on the other hand, differences of engel elasticities are constant. In view of the complicated inter-relationships among different item expenditures implied in these systems the estimation procedures are necessarily complicated. Further, these systems emerged as a result of imposing the somewhat restrictive assumption of additivity of the utility function, and this may limit the scope for these forms in empirical studies.

Finally, Leser (1963) stressed the observed phenomenon that the conditional variances of item expenditures are often roughly proportional to x^2. This heteroseedasticity of item expenditures representing variation in individual preferences led Leser to specify the engel relation as $\frac{y}{x} = \alpha + \beta \log x + \frac{\gamma}{x}$, a form which by construction eliminates the problem of heteroscedasticity and offers on balance a flexible function that may be forced to satisfy the adding-up criterion as well.

1.3.4 Some problems of estimation :

Usually engel curves, if they can be linearized by suitable transformations, are estimated by single equation least squares procedure[7]. Estimation of engel curves from empirical data requires a suitable stochastic specification. For a linearized engel curve $y_i' = \alpha + \beta x_i'$ (y_i' and x_i' being either the original variables or some transformations of them) an additive disturbance (ε_i) is often introduced with the assumptions $E(\varepsilon_i) = 0$, $E(\varepsilon_i \varepsilon_j) = \sigma^2 \delta_{ij}$ where δ_{ij} is Kronecker's delta and ε's are completely independent of the x_i's . In case of ungrouped data satisfying these assumptions Ordinary Least Squares method suffices for the efficient estimation of engel parameters. For

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[7] For some non-linear forms the maximum likelihood method is sometimes applied; e.g., Fisk (1959) has provided the MLE for Tornquist's forms.

grouped data $(\bar{y}_i, \bar{x}_i, p_i)$[8], i = 1, 2, ..., the assumption of homoscedasticity is usually untenable and it is often assumed instead that $V(\bar{\varepsilon}_i/\bar{x}_i) = \sigma^2 / p_i$ (where $\bar{\varepsilon}_i$ is the mean disturbance for the i-th x-class); thus generalized (weighted) least squares procedure is adopted in these cases. For data based on samples drawn by complicated methods of sampling, the above assumption regarding $V(\bar{\varepsilon}_i / \bar{x}_i)$ can only be regarded as a rough approximation.

The criteria for judging the goodness of fit of the fitted engel curves are two-fold : (i) the extent of variation of the dependent variable of the engel curve explained by the regression, and (ii) the degree of randomness of the residuals around the fitted regression. As regards (i) the coefficient of determination (R^2) is used frequently. Comparison of goodness of fit of alternative forms of engel curve for a single item is also done on the basis of the adjusted coefficient of determination $(\bar{R}^2)$ and the squared correlation coefficient between observed and expected item expenditures (R_y^2). $\bar{R}^2$ is suitable for comparing competing forms in which the dependent variable is the same (i.e., either y or the same transformation of y) but the number of parameters are different for the different form.[9] R_y^2 is needed in cases in which some of the competing forms have y itself as the regressand while other forms use some transformation of y.

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[8] Here $\bar{y}_i$ and $\bar{x}_i$ denote the average per capita item expenditure and total expenditure respectively, for the ith size class of x and p_i is the corresponding estimated population or proportion of population.

[9] Theoretically, however, $\bar{R}^2$ cannot be justified, vide Theil (1971) and Koerts and Abrahamese (1970).

So far as the randomness of residuals is concerned, it may be noted that any mis-specification of the engel curve generally leads to a systematic pattern in the regression residuals and thus results in a positive autocorrelation of the residuals. For examining the extent of such autocorrelation the Durbin-Watson statistics or other non-parametric tests are used very often (vide Prais and Houthakker, 1955, pp.53-54).

With the single equation least squares technique of estimation of engel curves in view, some observations may be usefully made at this stage. First, the way in which the stochastic specification of an engel curve is made may raise certain problems of estimation. For instance, for the constant elasticity form $y = ax^b$ it has been shown that the maximum likelihood estimates of a and b for the multiplicative error specification, i.e., $y = ax^b\varepsilon$ (where ε is the random disturbance), and the corresponding ordinary least squares estimates based on the additive error-specification, $\log y = \log a + b \log x + \varepsilon$, often differ considerably (Teekens and Koerts, 1972; Mazumdar, 1972). This suggests that the properties of the estimated engel parameters may not be clear in the absence of any prior knowledge about the correct error-specification. Next, in view of the fact that the sampling designs of household budget surveys are often complicated (multi-stage, stratified, etc.) the usual least squares procedure of estimating the sampling variances may be unsatisfactory. However, in the Indian National Sample Surveys the estimates are provided for two (or more) independent and interpenetrating halfsample (subsamples). In such cases, the divergence between the subsamplewise estimates may provide a better idea of sampling errors of the combined sample estimates.

Another subtle problem is often overlooked in the literature on cross-section studies (Bhattacharya, 1967). Usually budget data relate to a moving reference period so that households interviewed on different dates furnish accounts for different reference periods of a fixed length. As the interviews are spread over the entire survey period, of a few months or one year, seasonal variation is superimposed on the true variation between different households. The size distribution of per capita total expenditure (x) exaggerates the true extent of inequality. What is more important, the engel curves are possibly distorted by seasonal variation in x and y. We are actually interested in the engel curve that would obtain if all the households furnished information for the same annual reference period, and there is no rigorous means of estimating this from the data based on a moving reference period. The classificatory variable x is not permanent consumption, since seasonal (transitory) elements are by no means negligible. But the real trouble is that the transitory elements in x and y are likely to be correlated. In fact, the elasticities for the necessaries may be underestimated while those of luxuries overestimated through usual procedure. Liviatan (1961) had considered a similar problem and had suggested the use of the instrumental variable technique of estimation using recorded income as the instrument. Of course, one can fall back upon enquiries employing an annual reference period. But such enquiries are not easy to carry out, in view of high resistance from the respondents. One may also utilize the data on the 'normal' level of per capita expenditure that is sometimes available in budget surveys, or at least use a better classificatory variate by excluding unusual item expenditures (that are subject to seasonal or short-run fluctuations) from the recorded total consumer expenditure.

1.4 Effects of household characteristics on consumption pattern :

The micro-economic theory of consumer behaviour sets out the analytical basis of the individual consumer's allocation problem and works out the reactions of the consumer to changes in prices and income when the individual preference pattern is assumed fixed. In reality, the decision-making unit is often the household, composed of a group of individuals. A household may be characterized in terms of its demographic characteristics (viz., the size and age-sex composition of the household, marital status and inter-relationships among individual members; age, level of education and occupation of the principal earner(s) and soon), the social class of the household, religion, regional particulars etc. The preference pattern of the household emerges through an interaction of these diverse factors characterising the household. It is thus clear that a change in any of these characteristics alters the preference pattern of the household and thus leads to a different pattern of consumption even when household income and prices do not change.

In fact, one can differentiate between the separate and the total effects of a change in any of these characteristics on the pattern of household consumption. The separate effect relates to the change in the consumption pattern when a particular characteristic is varied keeping all others fixed. The total effect, on the other hand, makes allowances for changes occurring in all the other factors in response to a change in the particular characteristic.

Cross-sectional studies may be designed to examine the effects of different household characteristics on household consumption pattern, which may be interesting in themselves. Also, the introduction of these so-called extra-economic factors into engel curve analysis leads to a more accurate measurement of the pure income effect (by more nearly eliminating the influences of all variables other than income on consumption).

Coming to the problem of incorporating the variables related to household characteristics in empirical engel curve analyses it is convenient to differentiate between two broad categories of these characteristics. While such variables as household size and composition (being easily quantifiable) may be introduced explicitly into the engel function itself, others like occupation, region, race etc., present complications in view of their qualitative nature. To study the effects of these latter type of variables it is necessary to cross-classify the households by these characteristics (in case sample size is large enough) or to use suitable dummy variable approach.

1.4.1 Effects of household size and composition :

Household composition is described by such variables as the number of persons in the household and their distribution over age, sex categories. All these factors as also the interrelationships among the members are accepted as important in the decision-making process within the household[10/]. For a single household a change in composition influences not only its aggregate consumer expenditure but also the whole structure of demand. Since household composition constitutes a fundamental dimension of any society, whenever such composition changes rapidly and radically in response to changes in socio-economic institutions, such changes induce considerable changes in aggregate consumption pattern.

[10/] Morgan (1960), Sharp and Mott (1956), Wilkening (1958) and Wolgast (1957) presented a variety of theoretical framework for studying a household's decision-making process.

Briefly, decision-making in the household is largely affected (i) by culturally defined needs that cause a larger household to substitute necessary goods for luxuries when the income level is fixed, (ii) by such time-dependent processes as learning and aging that are implicit in the habit formation aspects of household behaviour and (iii) plans and expectations of the households. All these are intimately related to household composition and its changes over time.

Cross-sectional studies of the effects of household size and composition based on household budget data do not throw direct light on the process of decision-making of the households. However, such studies are valuable in several ways. The knowledge of the relationship between household size/composition and expenditure pattern eventually leads to more accurate estimates of the (pure) income elasticities for various items. Considerable importance may also be attached to the estimation of 'unit consumer scales', seeking to assess individuals of different age-sex categories in terms of their relative consumption of different items (and also with respect to income/total expenditure). Knowledge about such scales helps to a great extent in comparing the levels of living of households of varying composition. In the formulation of income tax policies, and policies for consumption reallocation and rationing appropriately calibrated unit consumer scales may serve very important purposes (Prais and Houthakker, 1955, pp. 125-45; Forsyth, 1960; Nicholson, 1949, 1964; Friedman, 1952). Finally, such scales are useful in correcting for the effects of possible changes in the age-structure of population in time series based studies of consumption pattern.

Technically, it is necessary to introduce household size explicitly even in the simplest studies based on household budget data. This is because the sample households vary considerably in respect of size and further, for most items of consumption, the level of household expenditure depends both on household size and household income/total expenditure. Engel curves estimated from household level expenditure data are liable to yield biased and inconsistent estimates of the true engel parameters. The easiest approach to incorporate household size into the engel curve is to use the 'homogeneity postulate' i.e., to specify that the engel function $y = f(x, n)$ is homegeneous of degree one, where x and y are the household's total and item expenditures, respectively, and n is household size. This at once leads to the usual 'per capita formulation' of the engel curve

$$\frac{y}{n} = f\left(\frac{x}{n}\right)$$

Clearly, the homogeneity postulate over-simplifies reality on two counts : (i) the way household size is measured (by the total number of persons of different age-sex categories present in the household) does not pay due consideration to the varying needs and capacities of consumption of different types of persons, and (ii) even when the households contain a single type of individual, variation in household size may give rise to significant economies/diseconomies of scale that cannot be accommodated in the usual per capita formulation.

The technique of measuring household size as a weighted sum that discriminates between the needs of adults and children and also of males and females has a long history that goes back to Quetelet and Engel. Following this approach a set of weights g_d, known as the equivalent adult scale (with $g_d = 1$ for adult male, d indicating age-sex category) is used to standardize household size which is measured as $n^* = \Sigma_d \, g_d \, n_d$, where n_d is the number of members of d-th category present in the household. Thus, $\frac{y}{n^*} = f(\frac{x}{n^*})$ provides an improvement in so far as it attempts to neutralize inter-household variation in composition. Even this formulation is of limited significance, especially if the g_d's are calculated on the basis of normative nutritional needs of different categories of individuals. This is undesirable for the purpose of demand analysis where it is necessary to have scales for standardization based on actual patterns of purchase and consumption reflecting the household's belief about the nature of adult-equivalence. This apart, the practice of using a single scale for all items of consumption seems totally unjustifiable. In fact, it is essential to have specific scales of equivalence separately for each item as also for income/total expenditure.

These considerations led Sydensticker and King (1921) to formulate the engel relation as

$$\frac{y_i}{n_i^*} = f_i\left(\frac{x}{n_o^*}\right);$$

where

$$n_i^* = \Sigma_d \; g_{id} \, n_d; \quad n_o^* = \Sigma_d \, g_{od} \, n_d \qquad \ldots (1.4.1)$$

the g_{id}'s being the coefficients of the specific equivalent-adult scale for the i-th item and the g_{od}'s the corresponding coefficients of the overall/income scale[11].

Following (1.4.1) it is easily shown that the effect of adding person of a particular type to a household has a negative income effect and a positive specific effect on the level of household consumption of any specific commodity. The income effect results from the lowering of the standard of living of the household as a result of an increase in household size with unchanged income, and the positive specific effect reflects the need of the additional member for the specific commodity. Algebraically

$$\frac{\delta y_i}{\delta n_d} = g_{id} f_i - x\, g_{od} \frac{n_i^*}{n_o^*} f_i' \qquad \ldots (1.4.2)$$

where $f_i' = \delta \left(\frac{y_i}{n_i^*}\right) / \delta \left(\frac{x}{n_o}\right)$. In terms of elasticities

$$f_{id} = g_{id} - \pi_i g_{od} \qquad \ldots (1.4.3)$$

where f_{id} is the partial elasticity of y_i with respect to n_d and π_i is the engel elasticity for commodity i. Now, since $\Sigma_i y_i = x$, $\Sigma_i w_i f_{id} = 0$ and $\Sigma_i w_i \pi_i = 1$, we get

$$g_{od} = \Sigma_i w_i g_{id} \qquad \ldots (1.4.4)$$

where $w_i = \frac{y_i}{x} \frac{n_o^*}{n_i^*}$. Thus, the overall (income) coefficient, g_{od}, for a specific type of person is the weighted sum of the corresponding specific coefficients g_{id}.

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[11] The same formulation was independently rediscovered by Prais and Houthakker (1955, **Chap.** 9).

It is interesting to note that an investigation by Barten (1964) throws light on the above formulation from the point of view of utility theory. Barten (1964) has shown the equivalence of a change in household composition with market prices held constant and that of a change in all the market prices with household composition fixed. That is, the effect of adding (say) a child to a household would first be to cause an adverse income effect and thereafter a complex of substitution effects. Formally, the problem is to maximize the household utility function

$$\text{maximise} \quad u\,(y_1^*, y_2^*, \ldots\ldots \quad) \qquad \ldots (1.4.5)$$

subject to $\Sigma_i \, p_i^* \, y_i^* = x$ where $y_i^* = y_i/n_i^*$

y_i being household purchase of commodity i, n_i^* is a prior normative measure of household size for item i decided upon by the household, x is the household's income, and $p_i^* = p_i \, n_i^*$, the price of commodity i adjusted for household size. This formulation is formally equivalent to the usual static model of a single consumer's utility maximization with p_i^* replacing p_i. It is clear that the resulting demand functions are

$$y_i^* = \frac{y_i}{n_i^*} = f_i\,(p_1^*, p_2^*, \ldots, x\,) \qquad \ldots (1.4.6)$$

Assuming further that all cross-price elasticities are independent of real income

$$\frac{y_i}{n_i^*} = f_{1i}\,(\frac{x}{\pi})\; f_{2i}\,(\,\frac{p_1^*}{\pi}\,,\,\frac{p_2^*}{\pi}\;\ldots. \quad) \qquad \ldots (1.4.7)$$

i.e., $$\frac{y_i}{n_i^* \, f_{2i}} = f_{1i}\,(\,\frac{x}{\pi}\,) \qquad \ldots (1.4.8)$$

where π is an appropriate index of the average price. The formal equivalence of (1.4.1) and (1.4.8) may be noted; $n_i^* f_{2i}$ may be identified as the specific size of the household and π as the overall size. In fact, (1.4.8) provides a deeper insight into the problem of adult-equivalence in so far as it takes into consideration the complicated substitution effects in consumption in response to a change in composition, through f_{2i}. The model suggests that even for commodities not consumed by children at all, addition of a child to a household may increase the specific size of the household as a result of possible substitutions in favour of these commodities[12].

Another problem involved in tackling household size and composition in the context of engel curve analysis arises because of the existence of economies/diseconomies of scale in consumption. A change in household size usually enables a household to enjoy some economies of scale and thus to attain a relatively higher/lower level of living at the same levels of per capita income. Such economies for individual items of consumption result from the concessions for bulk purchases, convenience in within-household preparations resulting out of the division of labour and substitution of self-service for purchased domestic services, and even in consumption itself through reduction of wastage. This is true of many items of consumption, although it is

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[12] This is one of the principal arguments against the usual methods of evaluating cost of children (vide Brown and Deaton, 1972).

intuitively obvious that non-food items frequently offer greater scope of economization than food items.

Formally, the simplest approach for examining the existence of economies of scale in household consumption of any specific item is to specify a constant elasticity engel function $y = ax^{\beta} n^{\gamma}$. Here economies (diseconomies) of scale are indicated by $\beta + \gamma < 1$ (or > 1) (Houthakker, 1957; Crockett, 1960). This approach, although convenient for testing the 'homogeneity postulate', does not help in identifying the sources of economies (diseconomies), if any. In this context, Prais and Houthakker (1955) provide an improvised formulation, viz.,

$$\frac{y_i}{n^{\theta_i}} = f_i \left(\frac{x}{n^{\theta_o}} \right). \qquad \ldots (1.4.9)$$

where $(1 - \theta_i)$ and $(1 - \theta_o)$ indicate specific and overall economies (diseconomies) of scale respectively. (1.4.9) is analogous to (1.4.1) and it can be shown that $\theta_o = \Sigma w_i \theta_i$ where $w_i = \frac{y_i}{x}$, the engel ratio for the i-th item.

Coming to the problems of fitting the models (1.4.1) and (1.4.9) to budget data, it may be mentioned that while these formulations are elegant and provide reasonable explanations of household consumption behaviour when household size and composition vary, they pose a number of problems of estimation. First, these formulations lead to engel function essentially nonlinear in the different parameters. Thus in most cases simple least squares technique cannot be applied to yield estimates of the engel parameters. This apart, Forsyth (1960) pointed out that these formulations are such that it would not be possible even in principle to separate the specific and the overall effects of changes in composition/size purely from empirical data, i.e., without having prior knowledge about any of these effects[13]. Objections can also be levelled against the formulations (1.4.1) and (1.4.9) on the ground that they mingle up the pure effects of changes in household size and composition with those due to shifts in preferences resulting from changing household structure. This suggests that the relationship between household composition/size and consumption might be more satisfactorily examined through studies based on analysis of variance and covariance and through the use of dummy variable regression technique (David, 1962). The approach of studying the consumption behaviour of households of each particular composition type separately, however, may be a 'daunting' prospect and from a pragmatic point of view the traditional formulations (1.4.1) and (1.4.9) are 'good working ones for most items of personal consumption such as food and clothing' (Brown and Deaton, 1972).

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[13] Fortunately, this does not seem to be the case and it has been shown in Chapter II of this thesis that even staying within this traditional framework one can identify all the specific effects as also the overall effect uniquely.

1.5 Time series studies of complete (static) demand systems :

Time series data on movements of quantity purchased in response to variation in income and prices provide the information suitable for estimating the commodity demand functions. In many empirical studies, simple demand functions of the type

$$q = q\left(\frac{x}{\pi}, \frac{p}{\pi}, t\right)$$

(where q is per capita quantity purchased of the commodity, $\frac{x}{\pi}$ is per capita real income, $\frac{p}{\pi}$ is the vector of relative prices (π being the overall price level) and t is time variable introduced to account for trends in tastes and preferences) are estimated through single equation least squares technique. This pragmatic approach, however, poses serious methodological difficulties. Apart from the well-known problems of aggregation and of identification of the demand function, besides least squares bias there are difficult operational problems of specification of the demand functions.

Conceptually, demand for any commodity depends upon all the prices and income. But lack of independent movements of prices and income in time series data and also shortness of time series prevents the precise estimation of a demand equation including all the prices. This leads the analyst to seek meaningful restrictions on the parameters of the demand function from economic theory in order to develop a consistent *a priori* specification of the system of demand functions. As the theory is sufficiently developed, demand equations embodying restrictions from theory may be so formulated as to guard the analyst against absurdities and inconsistencies that might arise in case of a 'pragmatic' model. However, it must be remembered that the restrictions of the theory refer to the behaviour of an individual consumer while the data actually used in empirical studies often relate to the average consumer. Thus there arises a problem of consistent aggregation of the individual demand functions (Theil, 1965; Pearce, 1964). In actual practice, the problem of aggregation is tacitly ignored in the hope that the constraints of economic theory hold good, approximately, for the average consumer.

Let us briefly consider some of the well-known systems of demand functions that have been applied in empirical studies.

The Rotterdam model of differential demand equations (Theil, 1967) may be considered as the pioneer among the models testing simultaneously the empirical validity of the restrictions that follow from the static theory of consumer behaviour. This starts from the real demand equations

$$dq = q_x\,(dx - q'\;d_p) + S\;\;dp \qquad \ldots\;(1.5.1)$$

where dq and dp are the vector of total derivative of quantities and prices, q_x is the vector of partial derivatives of quantities with respect to income x, and S is the substitution matrix. This decomposes the observed demand changes into the real income effect and the substitution effect. Eqn. (1.5.1) may be alternatively written, being approximately equivalent to

$$\hat{w}\ d\log q = b\ d\log \bar{x} + c\ d\log p \qquad \ldots (1.5.2)$$

where $d\log \bar{x} \simeq d\log x - w'\ d\log p$ and $\hat{w}$ is the diagonal matrix of engel ratios. Since $dw \equiv \hat{w}\ d\log q + \hat{w}\ d\log p - w'\ d\log x$, $\hat{w}\ d\log q$ is the only component of the total change in budget allocation (dw) that depends upon behavioural factors and is hence attractive to the researcher. In (1.5.2) b is the vector of marginal budget shares and c is related to the substitution matrix S through $c = x^{-1}\hat{p}\ S\ \hat{p}$, where $\hat{p}$ is the diagonal matrix of prices. In this model the aggregation restrictions (1.2.6) imply $e'b = e'c = 0$ (e being the sum vector); the symmetry of S implies $c = c'$; negativity of S implies $Z'\ C\ Z \leq 0$ for any Z (< 0 if $Z \neq \alpha C$); and finally the homogeneity restriction means $ce = 0$. This set up facilitates a systematic testing of all the theoretical postulates in actual data. However, a serious limitation of the model is that it does not generally satisfy the integrability condition, a requirement so crucial for a model in first difference form. There is also a relative price variant of the Rotterdam model where behavioural changes in value shares are sought to be explained by changes in real income and relative prices (Theil, 1970, 1971; Barten, 1968).

The Linear Expenditure System (LES) of Klein and Rubin (1947-48) which finds extensive application in works of Stone and others has the following system of expenditure equations :

$$\hat{p}\, q = \hat{p}\, c + b\,(x - p'c) \qquad \ldots (1.5.3)$$

where c is the vector of 'committed' quantities and b is the vector of marginal propensities. (1.5.3) is associated with the well-known Stone-Geary preference function (Geary, 1950-51).

$$V(q_1, \ldots, q_n) = \prod_{i=1}^{n} (q_i - c_i)^{b_i} \qquad \ldots (1.5.3a)$$

(1.5.3) satisfy the aggregation, symmetry and homogeneity restrictions. For ensuring the negativity of the substitution matrix, it is necessary that all elements of b are positive and $x > p'c$, which in turn rules out the existence of inferior and complementary commodities in the LES set up.

The LES, in spite of its limitations viz., linearity of the engel curves, inelasticity of price-quantity demand curves, and incapability of incorporating complementary and inferior commodities, has found extensive empirical application (Stone, 1954, 1964; Parks, 1969; Paelinck, 1964; Pollack and Wales, 1969; Yosihara, 1969; Leoni, 1967; Dahlman and Klevmarken, 1971). This is due essentially to its relative simplicity from the point of view of interpretation. There have also been a number of international comparison of demand structures based on this model (Baschet and Debreu, 1971; Goldberger and Gamaletos, 1970; Theil, 1971; Barten and Parks, 1973). In some applications, the LES has been extended by making the vector c dependent on prices (Stone, 1964; Nasse, 1970), by introducing habit formation aspects through replacing the vector c by some functions of lagged values of consumption (Pollack and Wales, 1969; Deaton and Wigley, 1971; Dahlman and Klermarken, 1971) and also by introducing elements of changing preference through time trends in the parameters of the model (Stone, Brown and Rowe, 1964; Pollack and Wales, 1969).

As regards the estimation of LES, the most straightforward procedure is to minimize the sum of squared residuals over all expenditure equations and time periods. This procedure is appealing for its simplicity and is a straightforward generalization of single equation ordinary least squares, but it is devoid of any <u>a priori</u> specification of the error structure and hence does not indicate the sampling properties of the estimators. Parks (1968) modified this procedure in such a way that the resulting estimators coincided with the corresponding maximum likelihood estimators and also provided asymptotic variance covariances of the estimators. Similar maximum likelihood estimators have also been derived for some of the variants of LES (Pollack and Wales, 1969).

Houthakker (1960) introduced the systems of addilog demand equations based on specific forms of additive utility functions. Corresponding to the indirect utility function

$$\psi = \Sigma_i \frac{\alpha_i}{\beta_i} \left(\frac{x}{p_i} \right)^{\beta_i}, \quad (\beta_i > -1) \qquad \ldots (1.5.4)$$

the indirect addilog system of demand equations were obtained as

$$q_i = \frac{\alpha_i \left(\frac{x}{p_i} \right)^{\beta_i +1}}{\Sigma \alpha_j \left(\frac{x}{p_j} \right)^{\beta_j}} \qquad \ldots (1.5.5)$$

where α_i and β_i are structural parameters. This system leads to a set of non-linear engel curves which satisfy the adding-up criterion. Moreover, unlike the LES, this system is capable of incorporating inferior and complementary commodities. In the direct addilog system of demand equations the demand interrelationships are given by

$$q_i = \left\{ \left(\frac{\alpha_i}{\alpha_j} \right) \left(\frac{p_i}{p_j} \right) q_j^{\beta_j - 1} \right\}^{\frac{1}{\beta_i - 1}} \qquad \ldots (1.5.6)$$

This follows from the direct additive preference function

$$V (q_1, \ldots, q_n) = \Sigma_i \frac{\alpha_i}{\beta_i} q_i^{\beta_i} \qquad \ldots (1.5.7)$$

or a monotone nondecreasing function of V, where α_i's and β_i's are the parameters. A comparison of (1.5.5) and (1.5.6) shows that in the direct addilog system the ratio of engel elasticities of any two commodities is constant while in the indirect addilog system their differences are constant.

Of the two addilog systems, the indirect one has been used in many applications. In many cases the indirect model has been compared with the LES, (e.g., Parks, 1969; Yosihara, 1969). The results of comparison, however, have not always led to the same conclusion. So far as the analytical aspects of the two models are concerned, the assumption of want independence implicit in LES appears to be less restrictive than the assumption of additivity of the indirect utility function. Computationally also, the LES appears to be more straight forward and offers fewer complications.

Another system of demand equations which finds frequent application is the constant elasticity system

$$\log q = \alpha + \beta \log x + \Gamma \log p \qquad \ldots (1.5.8)$$

where α is the vector of intercepts, β is the vector of income elasticities and Γ is the matrix of price elasticities. This model, with its constant income and price elasticities, often oversimplifies reality to a great extent. Actually, the assumption that all the elasticities are constant is inconsistent with the theory of consumer behaviour. However, this model may be accepted as holding approximately over the observed range of income and prices.

The systems mentioned above are the most popular ones. There are also other models that have been applied in certain empirical studies. Here, mention must be made of the Australian models due to

Leser (1958, 1960) and Powell (1966a). These models have been developed by imposing various restrictions on the linear or log-linear expenditure systems. By and large, these models sought to force the theoretical restrictions at means of the observations. As regards the performances there has not been any attempt to compare the other standard models with these Australian models, and thus their relative efficiencies are not yet quite clear.

Finally, we may mention an interesting tool devised by Theil (1965) based on information theoretic ideas. Theil, concerned about measuring the change in budget allocation between two situations, regarded the sets of engel ratios $w^{(1)}$ and $w^{(2)}$ corresponding to the two situations as the a priori and a posterori probabilities and defined the information content of the message of the change in demand pattern as

$$I(w^{(2)}, w^{(1)}) = \Sigma_i \; w_i^{(2)} \; \log \left(\frac{w_i^{(1)}}{w_i^{(2)}} \right)$$

This measures the discrepancy between the allocations $w^{(1)}$ and $w^{(2)}$ and can be used for comparing alternative budget allocations. This measure can also be used for comparing the predictive accuracies of different empirical demand systems. For the latter purpose actual engel ratios are compared with those predicted by the different demand systems (Theil, 1965; Theil and Mnookin, 1966; Parks, 1969; Goldberger and Ganaletos, 1970). Although this information measure conveniently summarises the differences in two allocation patterns through a unidimensional index, the possibility that for some i $\log\left(\frac{w_i^{(1)}}{w_i^{(2)}}\right)$ may be negative and this in turn may lead to a non-positive value of the index seems to have been overlooked. Operationally the method seems to favour systems that use the engel ratios rather than the quantities, since the former models are estimated by maximizing the predictive capacity with respect to engel ratios while the latter models aim at predicting the quantities instead.

1.6 Dynamic Demand Functions :

A principal limitation of the demand systems mentioned in Section 1.5 is their static nature. This static nature is not essentially lost even if the parameters be treated as functions of time, or if time is introduced as an explicit explanatory variable. In reality, current purchases of commodities depend not only on current income and prices, but also on the income-profile, the level of stocks held, the pattern of past purchases and consumption, income expectations and so on. These factors introduce elements of dynamism in the consumer's decision-making process. However, since some of the factors responsible for this dynamism are not directly observable, it is difficult to specify and estimate a demand model incorporating all the dynamic elements. Attempts have therefore been made to evolve dynamic analytical models that are relatively simple and can be conveniently tested against data.

There have been two approaches to the investigation of the dynamics of consumer behaviour. The first approach starts from a utility function dependent upon the stocks and current purchases of different commodities and maximizes this utility function subject to the budget constraint and depreciation rules (Boulding, 1950 ; Cramer, 1957 ; Phlips, 1973 ; Mettei, 1971 ; Houthakker and Taylor, 1970). The other approach directly specifies the demand functions wherein stocks are paid due consideration (Stone and Rowe, 1957 ; Houthakker and Taylor, 1970, Chap. 5).

The Boulding-Cramer model maximizes the utility function $v(s)$ dependent on the vector of stocks, s, (which includes assets and liabilities) subject to a net worth constraint $w = p's$ in which the prices p and net worth w are assumed to be exogeneously fixed. It further assumes a linear depreciation rule and defines an accumulation process as $\dot{s} = q - \hat{a}\, s$ where $\dot{s}$ is the vector of time rates of change of s, q is the vector of current purchases and $\hat{a}$ is the diagonal matrix of linear depreciation rates. In equilibrium $\dot{s} = 0$ and for maintaining an equilibrium level of stocks it is necessary to have new purchases $q = \hat{a}\, s$. The cost of replacement is given by $x = p'q$. That is, if the consumer is provided with an income x each period, he may be satisfied with the equilibrium level of stocks. However, if the actual income is larger than x, there is accumulation leading to a rise in net worth. This calls for adjustment of the old equilibrium levels of stocks towards new stable ones. The process of adjustment is such that the consumer moves optimally to new levels of equilibrium stocks where the new level of income exactly matches depreciation requirements. The model actually leads to a fairly simple relationship between change in current purchases and change in income.

Cremer (1957) used the above model to examine Dutch data on ownership of individual durables and found satisfactory conformity of the ownership elasticities estimated from this model with the corresponding income elasticities estimated from cross-section data. The model however fails to consider the effect of price change in a satisfactory manner : any price change pushes the consumer from the initial equilibrium to a suboptimal position and there is nothing in the model that may indicate an optimal path from a suboptimal to an optimal position.

A more straightforward procedure has been adopted by Houthakker and Taylor (1970) and Phillips (1970) who maximize a quadratic utility function dependent upon stocks or state variables and current purchases subject to the budget constraint which equates the value of current purchases to current income. The elements of dynamism are introduced through the accumulation function $\dot{s} = q - \hat{a} s$. The empirical results based on these models indicate that the associated short-run and long-run income elasticities do differ appreciably. This fact alone is a sufficient justification for introducing dynamic elements in empirical demand analysis.

The other approach where dynamic considerations are introduced in the demand function without any reference to the utility function is based on the belief that current purchase decisions are largely influenced by stocks held and hence by past behaviour. Thus in Stone and Rowe's (1957) model current consumption, u, is assumed to be made not only out of current purchases, q, but also from stocks, s, held at the beginning of the period. Algebraically, $u = \frac{s}{n} + \frac{q}{m}$, where n and m $(\geq n)$ are reducing balance depreciation rates. Elements of dynamism are introduced through the accumulation equation $\Delta s \equiv v = q - u$, i.e., any purchase in excess of current depreciation is added to the existing stock. These two relations imply that the opening stock, s, for any period is related to all past purchases through a distributed lag relationship. Now, in any period the decision to purchase is governed by the notion of an equilibrium stock, s^*, that depends on exogenous factors such as income and prices. The consumer is assumed to partially close the gap between s and s^* through purchases in order to move towards the equilibrium position. The demand function relates current purchases q_t to the previous purchases q_{t-1} and the equilibrium stocks s^*_t and s^*_{t-1}. Since s^* depends upon income and prices, q_t may be finally expressed explicitly in terms of incomes, prices and q_{t-1}. The relevant elasticities and the depreciation rates may then be estimated from actual time series data.

A similar argument is implicit in Houthakker and Taylor's State-Adjustment Model (Houthakker and Taylor, 1970, Chap. 1). There are two structural equations in this model : There is, first, the depreciation equation $\dot{s} = q - \delta s$. Here, s is the state variable representing either physical stock of a durable or psychological stock of non-durables and services arising out of the habit-forming property of these items of consumption; q, as before, is the purchase and δ is the depreciation rate for stocks. This model does not specify anything like a stock-adjustment mechanism. The reason is simple. The state variable s is assumed to depend on non-controllable factors and thus direct stock-adjustment would not be meaningful. Houthakker and Taylor postulate a direct relationship between q, s and other exogenous variables (z) such as income and prices, viz., $q = \alpha + \beta s + \gamma f(z)$. Each commodity in this model is characterised by two parameters β and δ. If β [illegible] for any commodity this implies that the higher the existing stock the higher is the level of current purchases and the commodity is habit-forming in nature. If $\delta > 0$, stocks exert a downward pressure on q and thus the commodity is subject to inventory effects. The structural equations of the model lead to a differential equation

$$\dot{q} = (\beta - \delta) q + \gamma \left\{ \dot{f}(z) + \delta f(z) \right\}$$

Here the change in current purchases is related to the level of current purchases and the level of exogenous variables and their chan-

The discrete version of this is a linear function which links up q_t to q_{t-1}, z_t's and z_{t-1}'s. Formally, this function is indistinguishable from the corresponding relationship in Stone and Rowe's Model.

Empirical results based on the dynamic models mentioned above indicate the need for introducing dynamic elements in empirical demand analysis. Specifically, both Stone and Rowe's and Houthakker and Taylor's results indicate that the short-run and long-run elasticities for various items of expenditure are often different. As regards the speed of adjustment, estimates based on Stone and Rowe's model suggest that this is relatively slow for durables and faster for perishables. The estimates of depreciation rates from this model appear to be implausibly high, probably because consumers seemed to attach too much importance to the 'newness' of goods. The estimates of depreciation rates from Houthakker and Taylor model, on the other hand, are usually low. So far as this model is concerned the estimated low depreciation rates may be explained by noting that depreciation in this model does not relate merely to the physical stock but also to the psychological stock, if any. Houthakker and Taylor interpreted this phenomenon through the following argument : As income rises the consumer becomes relatively insensitive to economic forces and habit-formation becomes dominant, so stocks in the U.S. depend more on habits than on physical stock. The rate of depreciation therefore may well be expected to be low since habits wear out at a relatively slow rate.

1.7 Recent studies on consumer behaviour in India :

Empirical studies on consumer behaviour started in India in the fifties in connection with the formulation of India's Second Five Year Plan. Since then a large number of studies have been carried out mostly on the basis of National Sample Survey (NSS) budget data. Initially, demand projections for individual items of consumption were carried out on the basis of engel curves, making many simplified assumptions, and with the availability of more and more extensive budget data from the NSS the researchers were induced to study the effect of the total consumer expenditure (proxy for income) on consumption patterns. Gradually, methodological questions that arose in the context of demand projections from engel curves attracted interest and studies were made to examine the effects of factors other than total consumer expenditure on household consumption pattern. In contrast, the inadequacies of time series data especially .. consumer prices have discouraged the estimation of demand equations from time series data, and very few definitive results on price responses have so far been obtained. In this section we attempt to give a brief account of the Indian studies, stressing the contributions.

1.7.1 Engel curve fitting :

In the absence of satisfactory income data per capita total consumer expenditure (x) is used as the explanatory variable of the engel curves. In most cases, grouped data have been used for fitting the engel curves, and the engel curves have been estimated through appropriate weighted least squares procedures. In some cases fractile groupwise averages of per capita item and total consumer expenditures are available, and ordinary least squares method is followed, since the weights in this case are same for all fractile groups. In a number of studies attempts have been made to use ungrouped data pertaining to individual household. While this is advantageous in many respects a problem arises when logarithm of per capita item expenditure is used as the regressand, since for many items of expenditure an appreciabl proportion of households report zero consumption. Omission of these households may lead to serious bias in the estimated elasticities (Iyengar, Jain and Srinivasan, 1969).

In a large number of studies the suitability of alternative forms of engel curve for different items of consumption has been examined. These studies considered such forms as linear (L), parabola (P), hyperbola (HYP), semilog (SL), double-log (DL), log-inverse (LI), exponential (E), log-log-inverse (LLI), semilog inverse (SLI), and log-quadratic (LP). The choice of the algebraic form is crucial in so far as the estimated engel elasticity and the marginal propensity to consume for any item often vary considerably from one engel curve form to another. The criterion employed for choosing the best-filling form have generally been the coefficient of determination (R^2), the adjusted coefficient of determination ($\bar{R}^2$), the squared correlation coefficient between observed and predicted item expenditures (R_y^2) or other distance measures (but the randomness of the regression residuals are often left unexamined).

Among the studies examining the suitability of alternative forms of engel curve for individual items mention may be made of these by Sinha (1966), Maitra (1969), Bhattacharya and Maitra (1970), Singh (1968), Gupta (1968), Jain and Tendulkar (1973) and Jain (1972). Sinha's study, based on extensive NSS budget data for rural and urban India, revealed the overall superiority of log-log-inverse form over other forms viz., semi-log, double-log, log-inverse and hyperbola when judged by $\bar{R}^2$ and the Durbin-Watson statistics for the residuals. This superiority of LLI was also observed by Maitra, Bhattacharya and Maitra, and Singh. Maitra analysed the state-level NSS data on the consumption of foodgrains items in rural areas. A comparison of HYP, SL, DL, LI and LLI suggested that

SL and LLI, particularly the latter, gave the most satisfactory results. Bhattacharya and Maitra carried out an extensive analysis using grouped NSS data for rural and urban India for a number of item groups. In this analysis data from 14 rounds of NSS (from 7th (October 1953 - March 1954) to the 22nd (July 1967 - June 1968), except the 20th and 21st rounds) were covered and four forms viz., HYP, SL, DL and LLI were compared for each item sector round combination on the basis of R^2, R_y^2 and the Durbin-Watson statistic. The results showed that LLI was most satisfactory in majority of cases. For this form the regression residuals were nearly random unlike those from the other three form, thus indicating the absence of significant misspecification. Singh compared $\bar{R}^2$ for ten algebraic forms in course of an investigation of the effects of household composition on consumption pattern. The three-parameter forms viz., P, LLI, SLI and LP were generally seen to perform satisfactorily. It should, however, be mentioned that the sample sizes were quite small in this study. Jain and Tendulkar tried five two-parameter forms viz., L, SL, DL, LI and HYP, in a study of occupational differences in consumption based on 19th round NSS data for rural and urban India. They used the distance criterion, i.e., for any item they calculated the formwise sum of squares of deviations of observed and predicted item expenditures, weighted by estimated population in different levels of per capita total expenditure, and choose that form for which the distance measure turned out to be smallest. Their results indicated that

SL appeared to be the best for many necessary items while DL proved best for luxuries. Finally, Jain showed that the indirect addilog system of engel curve gave better predictions on the whole than those given by DL, SL, HYP, E, LI or L.

A methodological question naturally arises in the context of usual procedure of estimation of engel curves from budget data like those from the NSS. The NSS, like many other budget enquiries covers a probability sample of households drawn according to a complicated sample design. This makes it difficult to calculate standard errors etc., of the estimated engel curve parameters through the usual least squares procedure. More generally, the standard techniques of statistical inference cannot be employed to such data. Frequently, such complications are overlooked and one proceed as though the samples were simple random. Thus for a double-log engel curve (say) one starts with a model of the following nature :

$$\log \bar{y}_i = \alpha + \beta \ \log \bar{x}_i + \varepsilon_i$$

with $E(\ \varepsilon_i) = 0$ and $\mathrm{Var}\ (\varepsilon_i) = \frac{\sigma^2}{p_i}$ where $\bar{y}_i$, $\bar{x}_i$ are the average per capita item expenditure and total expenditure respectively in the i-th class of x and p_i is the proportion of estimated population in that class. In some cases, however, the engel parameters are estimated from each of the indepedent and interpenetrating half-samples comprising the NSS sample as also from the combined sample, and the divergence between half-sample estimates is taken as a measure of uncertainty associated with the combined sample estimate. While the validity of the first approach for obtaining the standard errors of the estimated engel parameters is not clear enough, the latter approach lacks a satisfactory theory of statistical inference. In actual practice, these two alternative methods may lead to quite different estimates of sampling variance for the same engel parameter and thus the suitability of these approaches in case of sample data like that from NSS needs further investigation.[14/]

Before concluding, mention may be made of the notion of average elasticity of a variable elasticity engel curve introduced by Bhattacharya (1972). He drew upon the formula expressing the market income elasticity as the weighted average of the individual income elasticities. Expressions for the average elasticity were derived for some common forms of engel curve. For some of the forms the average elasticity actually coincides with the elasticity at particular values of per capita income/total expenditure, such as the arithmetic, the geometric or the harmonic mean. However, there is no general result and the average elasticity can only approximately be obtained for a number of common forms. Such average elasticities have been computed in some recent studies (Jain, 1972).

[14/] vide Appendix D infra for a comparison of sampling variances of engel parameters estimate by these two alternative approaches.

1.7.2 Demand projections from engel curves :

As stated earlier, it was the need for demand projections in the context of national planning that stimulated initial empirical research on consumer behaviour in India. Since then, considerable amount of work, has been done by Indian researchers in this direction and some of these have methodological significance (e.g., Ganguly et.al, 1960; NCAER, 1959)

The problem of demand projection is a familiar one, and econometric literature contains numerous examples of this (vide Wold and Jureen, 1953; Sandee, 1964). For a country like India which has adopted the policy of planned development the need for demand projections arises in the following way : with the rise in real income and population, the demand for individual consumer goods is expected to change in a definite way depending upon the nature of the goods. Unless adequate provision is made for increased demand, i.e., unless the balance between supply and demand for various consumer goods is ensured, prices will soar and create difficulties. Forecasts of consumer demand are therefore an essential ingredient of economic planning.

The demand projection exercises are usually carried out with the supposition that relative prices and preferences would remain unchanged during the forecast period. Thus only changes in population and income distribution are taken into consideration. The assumption of the constancy of relative prices and preferences over the period of projection implies that the market composition of goods is not disturbed by the introduction of new commodities and there is no trend in tastes and needs over time. Further, usually engel curves relating per capita item consumption to per capita consumer expenditure are used and these take no account of the economies of scale in household consumption or of the effects of age-sex composition of the households on consumption pattern. Finally, projections are frequently done at all-India level, taking all regional and socio-occupational classes together, only the rural and urban sectors are kept separate. The projections, therefore, tacitly assume that the structure of population in terms of household size and composition and also in terms of socio-occupational and regional classifications remains unchanged during the period of projection. These assumptions are not unrealistic for projections for 5 to 10 years except for novel items showing steep trend in tastes[15].

NSS budget data have been used for all these projection exercises. As mentioned earlier, these data furnish information about total consumer expenditure which is used as proxy for income in the absence of satisfactory income data. For projection purposes the postulated changes in income distributions have to be translated into corresponding changes in the distribution of (per capita) total consumer expenditure making adjustments for the plan target of savings and growth of populatio

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[15] It may be pointed out that projections starting from regional and other categories pose some operational problems, since projections of region-wise population and the corresponding plan targets for increase in total consumption expenditure are not readily available. Even for the rural-urban breakdown used, the researchers have to assume the same rate of growth of per capita consumption for both the sectors of the country.

We may now present a simple mathematical formulation of the problem of demand projection. Suppose that during the base period, $g(x)$ is the marginal p.d.f. of per capita total consumer expenditure (x), and $E(y/x) = f(x)$ is the engel curve for the commodity under consideration; the consumption of this is denoted by y. The average per capita consumption of the commodity during the base period is then $E(y) = \int_0^\infty f(x) g(x) dx$. If now $g(x)$ changes to $g^*(x)$ at a future date while the engel curve remains invariant over time, the new level of per capita demand would be $E^*(y) = \int_0^\infty f(x)\, g^*(x)\, dx$. Given $f(x)$ and $g(x)$, estimated from household budget, the task of demand projection is then to estimate $E^*(y)$ on the basis of information about the anticipated shift from $g(x)$ to $g^*(x)$. Once $E^*(y)$ is obtained, expected future aggregate consumption of the specific commodity may be obtained by multiplying $E^*(y)$ by expected future population.

If, in the above model, $f(x) = ax^b$ and $g^*(x) = g(\frac{x}{1+\alpha}) \frac{1}{1+\alpha}$, i.e., the x-distribution shifts proportionately, then $E^*(y)/E(y) = (1+\alpha)^b \simeq 1 + g b$, whatever be the form of $g(x)$ [*vide* Roy and Laha, 1960]. If, further, it is assumed that population increases to $(1+r)$ times the original size, the aggregate demand increases to $(1+r)(1+\alpha)^b \simeq (1+r+\alpha b)$ times the original size.

The formulation mentioned above has been frequently used in India. However, the assumption regarding the nature of shift in $g(x)$ may seem to be oversimplified. In fact, the assumption of proportionate shift in $g(x)$ — that is, of a change in the scale parameter of the x-distribution means that the inequality in the x-distribution remains unaltered. While the average level changes over time, reduction of inequality was actually anticipated in view of the declared policy of the Government of India of moving towards a socialistic pattern of society. It was thus felt that the projections should allow for possible reduction in concentration of the x-distribution and this led to some contributions to the methodology of demand projection. For example, Roy and Laha (1960) derived the necessary formula for projection assuming both $g(x)$ and $g^*(x)$ to be of the Pareto form and $f(x)$ to be of the constant elasticity form. The formula gave $E^*(y)/E(y)$ for a situation where the mean and the Lorenz ratio of the x-distribution are expected to change by specified percentage. However, in view of the fact that in India the distribution of per capita consumer expenditure (x) is seen to be approximately of the Log-normal form and not of the Pareto form (Roy and Dhar, 1960; Bhattacharya and Iyengar, 1961; Iyengar, 1960a, 1967), Iyengar derived the projection formula under the assumptions of lognormality of x and constant elasticity engel curves. Iyengar made some interesting comparison of this formula with the more simple ones stated above. He also examined the consequences of changes in concentration alone while $E(x)$ remains unchanged over time. It was shown that a reduction in inequality of the x-distribution would lead to an increase (decrease) in the aggregate consumption of essential (luxury) commodities, even when $E(x)$ remained unchanged.

Iyengar and Jain (1969) made extensive use of the above approach and obtained projections of consumption, for rural and urban India during 1970-71 and 1975-76, for nearly 60 times of consumption. Separate projections were made for different plausible assumptions regarding the changes in the mean and the concentration of the x-distribution.

Bhattacharya (1963) extended Iyengar's formula for projection to cases where the engel curve is allowed to assume various alternative algebraic forms. Iyengar and Rao (1968) gave yet another formula for demand projection starting from indirect addilog engel curves. These studies overcome the limitation of using constant elasticity engel

1.7.3 Use of specific concentration curves :

A valuable tool of demand analysis was introduced by Professor Mahalanobis in connection with his researches in consumption in India. This is the specific concentration curve (SCC) reflecting the disparity in the consumption of a specific commodity (y) among persons in different brackets of per capita income/expenditure (x). This is an obvious generalization of the Lorenz curve representing the inequality in the distribution of x.

The formal definition of the SCC is as follows (vide Roy, Chakravorty and Laha, 1960) : Let x, y, g(x), E(x), E(y) and E(y/x) be the same as defined in the earlier section; $P(x) = \int_0^x g(u)\,du$ is the proportion of persons having per capita/total consumer expenditure $\leq x$;

$Q_y(x) = \int_0^x E(y/u)g(u)\, du/E(y)$ is the proportionate share of these persons in the total consumption of the specific commodity; and $Q(x) = \int_0^x u\, g(u)\, du/E(x)$ is the proportionate share of the same persons in aggregate x. While the Lorenz curve is parametrically represented by the equations for P(x) and Q(x), the SCC is represented by the equation for P(x) and $Q_y(x)$. Just as the Lorenz ratio $L = 1 - 2\int_0^1 Q\, dP$ measures the overall disparity in the x-distribution, the specific concentration ratio is given by $L_y = 1 - 2\int_0^1 Q_y\, dP$, which measures the overall disparity in the consumption of y between persons in different interva of x.

Roy, Chakravorty and Laha (1960) examined the properties of the SCC in the general case assuming nothing about the forms of g(x) and E(y/x). They obtained the following formula giving the (variable) elasticity $\pi(x)$ in terms of the characteristics of the SCC :

$$\pi(x) = \frac{d^2 Q_y / dP^2}{d Q_y / dP} \cdot \frac{x\, dP}{dx}$$

which shows that the SCC for an inferior good lies above the egalitarian line.

Iyengar (1960) made an interesting application of the SCC. Assuming g(x) to be the lognormal density and the engel curve to be of constant elasticity form he showed that the constant elasticity (π) is $\pi = \left.\frac{tQ_y}{tQ}\right|_{P=0.5}$, where $tQ_y = \phi^{-1}(Q_y)$ and $tQ = \phi^{-1}(Q)$

are the normits of cummulative proportions Q_y and Q respectively, corresponding to P = 0.5. Another formula that may be used for estimating π is

$$\pi = \frac{t\left(\frac{1 + L_y}{2}\right)}{t\left(\frac{1 + L}{2}\right)} .$$

Iyengar also derived the formula for estimating the constant elasticity when x follows the log-logistic distribution. In this case we simply have $\pi = \frac{L_y}{L}$. Similar results are also available for estimating the variable elasticity $\pi(x)$ for a number of engel cur forms such as the semi-log, assuming log-normality of x (Bhattacharya, 1963; Iyengar, 1964). These formulas have been extensively used by Iyengar (1964) and Saha (1973).

The above technique of estimating engel elasticity from SCC and Lorenz curves, apart from simplicity of computations and elegance, has some advantages over the standard weighted least squares method of estimation applied to grouped household budget data. It has been shown (Iyengar, 1964) that the standard least squares procedure gives inconsistent estimates of engel elasticities, essentially because it uses the logarithms of the group means of x and y and not the group means of the logarithms. The approach based on concentration curves, in contrast, gives consistent estimates of the elasticity if the formula $\pi = \frac{t\,Q_y}{tQ}\Big|_{P=0.5}$ is used. Strictly speaking the other two formulas do not yield consistent estimate if L_y and L are estimated by trapezoidal rule of quadrature from grouped data.

1.7.4 Effects of household size and composition on household consumption :

In most of the engel curve analyses carried out on Indian data, per capita consumption of a specified commodity $(\frac{Y}{n})$ has been related to per capita household income/total consumer expenditure $(\frac{X}{n})$. Such a formulation tacitly assumes away the existence of economies (diseconomies) of scale in household consumption. Obviously for many items such as fuel and light, rent, durables and so on, the economies of scale are expected to be substantial. In such cases the 'per capita formulation' of the engel curves leads to considerable bias in the estimates of engel parameters.

Iyengar, Jain and Srinivasan (1969) fitted the constant elasticity function, log $y = \alpha + \beta$ log x, to ungrouped NSS 17th round (September 1961 - July 1962) budget data for the rural and urban sectors of the two states, Madras and Uttar Pradesh. In their analysis of the consumption pattern of total cereals, milk and milk products, fuel and light, and clothing it was found that economies of scale were clear in case of cereals and fuel and light in U.P. as well as in Madras, but the economies were not so clear for milk and milk products and clothing. (These two items are considered to be luxuries in India.)

Apart from the limitation that the effects of age-sex composition of households were ignored and the constant elasticity form of engel curve was chosen uncritically, this study suffered from an important drawback, viz., the households reporting zero specific expenditure were omitted. To the extent that the proportion of such zero cases was correlated with the level of living, this biased the estimates of the engel elasticities. In spite of these limitations, this pioneering study indicated the inadequacies of the "homogeneity postulate" for some important items of consumption.

Chaudhuri (1970) followed the approach of Crockett (1960) and carefully established the form $\log y = \alpha + \beta \log x + \gamma \log n$, as a rough approximation, using the extensive budget data from NSS 18th round (February 1963 - January 1964) covering the whole of rural and urban India. She considered (i) cereals and cereals substitutes, (ii) milk products (excluding liquid milk), (iii) meat, fish and egg, and (iv) fuel and light, and used per capita expenditure estimates cross-classified by per capita total consumer expenditure and household size. Her results indicated large economies of scale for fuel and light and some diseconomies for milk products. Furthermore, it was shown that for those items for which the economies (diseconomies) of scale were large the weighted average of household-size-wise engel elasticities differed considerably from the corresponding estimate of engel elasticity estimated in the usual manner employing the per capita formulation.

Gupta (1968) examined the effect of household size on consumer behaviour using ungrouped NSS 17th round data for rural and urban households in UP and Madras. Ten major commodity groups and eleven other detailed items were taken up, though some were eventually dropped when the number of reporting households was found to be small. Engel curves of the form $\log y = \alpha + \beta \log x + \gamma \log n$ were fitted by weighted least squares method using the probability weights or 'multipliers' for the sample households as weights. The elasticities β and γ were found to move in opposite directions. It was shown that $\beta + \gamma$ was often significantly below unity for essential items, but close to 1 or above it for the less essential and luxury items. A comparison of the results for the two states indicated considerable regional variation in the effect of household size on consumption pattern. In a study of some methodological interest Singh (1972) proposed an iterative procedure for estimating the overall and the specific economies of scale in the well-known framework of Prais and Houthakker (1955, Chapter 10) and applied this to the consumer expenditure data for rural and urban households in West UP obtained in the NSS 15th Round.[16]

Coming to studies dealing with the effect of household composition on consumption pattern, mention must be made of a study by Chaudhury (1967), who obtained surprisingly reasonable estimates of the specific unit consumer scale for cereals through a crude approach. He assumed the engel elasticity for cereals to be zero and thus expressed

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[16] *vide* Chapter 4, Section 1 *infra*.

total household consumption of cereals as a homogeneous linear function of the household composition vector (the elements being the numbers of persons in six different age-sex groups). The relative magnitudes of the estimated regression coefficients gave the estimate of the specific unit consumer scale for cereals. NSS 4th round data for each of the six population zones of rural India were used in this investigation.

An important contribution was made by Singh (1968; see also Singh and Nagar, 1973)where he made an interesting extension of Prais and Houthakker's (1955) well-known procedure of estimating unit consumer scales. This procedure was actually applied to NSS 15th round data for 381 sample households in rural West UP. Separate estimates of unit consumer scales were obtained for four occupational groups. Household members were classified into four groups:(i) males above 14 years, (ii) females above 13 years, (iii) boys between 4 and 14 years and girls between 4 and 13 years, and (iv) children below 4 years. Twelve food and eight nonfood items were considered. The estimated scales were not entirely satisfactory, but Singh could explain some of the anomalous results.

1.7.5 Regional variation in consumer expenditure pattern :

In most of the cross-sectional studies based on NSS data consumption patterns of the rural and urban sectors of the country have been separately examined. These studies reveal marked differences in consumption habits in the two sectors of the country (Rudra and Roy, 1960; Sinha, 1966; Gupta, 1968; Mahajan, 1971). In fact, several items appear to be luxuries in the rural sector while they are necessaries in the urban sector. For foodgrains, the engel curve quickly reaches a satiety level in the urban sector, while the curve for the rural sector shows very little of any such tendency. The factors responsible for such differences seem to be numerous, the principal ones being the differences in the standard of living between the two sectors, the differences in relative prices and in the extent of monetization prevailing in the two sectors, variation in the occupational pattern of the populations, and so on.

Apart from the broad inter-sectoral differences in consumption pattern, considerable inter-regional differences in household consumption exist within each sector. Natural resource endowments, physical and climatic conditions, economic factors like opportunities for employment and income, prices and extent of monetization, demographic factors like the structure of households and the degree of urbanisation, and cultural factors vary widely across regions and result in considerable variation in the pattern and level of consumption. All these call for region-wise studies of consumption patterns and region-wise demand projections therefrom.

Several studies were carried out for comparing the expenditure patterns of the six zones of the country (separately for the two sectors) based on the relevant NSS estimates of consumer expenditure. For example, Varma (1959) fitted constant elasticity engel curves to region-wise NSS data on foodgrains, and observed appreciable regional variation in the elasticities. Sinha (1966) also discussed the inter-zonal differences in consumption patterns. Studies by Radhakrishna and Misra (1970) and Mahajan (1971) also revealed interesting inter-regional differences in consumption patterns. Gupta (1968) compared the patterns of consumption of foodgrains and clothing across different regions, separately for rural and urban India. He applied the analysis of covariance technique and found considerable regional differences in the consumption pattern of both the items in either sector.

In another study, Gupta (1968) compared the consumption patterns in UP and Madras separately for the two sectors. Using NSS 17th round ungrouped data on some broad item-groups as well as on some detailed items, Gupta examined the homogeneity of the state-wise regression equations $\log y = \alpha + \beta \log x + \gamma \log n$. The between state variation turned out to be significant for many items in either sector. (Significant rural-urban differences were also observed within each state.) This study, however, ignored sample households reporting zero item expenditures. The regression results, therefore, are biased for many items.

Finally, Maitra (1969) examined the grouped state-wise estimates for (i) cereals and cereal substitutes for rural India obtained from

NSS rounds numbered 13, 15, 16, 17 and 18, and also (ii) estimates of quantitative consumption of rice, wheat and total cereals from the 17th round of the NSS. The LLI and SL forms of engel curve, especially the former, were found to provide best fit to the data. Analysis of covariance showed considerable inter-state variation of the engel elasticity within each round. However, inter-temporal variation of the elasticity appeared to be less pronounced. It was also shown that the estimates of elasticities based on aggregated data for rural India as a whole differed significantly from the corresponding weighted average of the state-wise elasticities, a result that has obvious implications for demand projections.

1.7.6 Other studies based on cross-section data :

There have been quite a few studies which examined the effect of occupational factors on consumer expenditure pattern (Ganguly, 1960; Singh, 1968; Jain and Tendulkar, 1973), effects of monetization on consumption pattern (Mukherjee, 1967; Mukherjee and Rao, 1972), derivation of indifference surfaces from estimated engel curves (Radhakrishna, 1967) and attempt to form clusters of regions on the basis of household consumption patterns (Mukherjee and Lahiri, 1967; Mahajan, 1971; Radhakrishna and Misra, 1970).

Jain and Tendulkar's study of occupational differences in consumer expenditure pattern in rural and urban India compared the expenditure patterns of households belonging to five broad occupational groups through the analysis of covariance technique. The results indicated that while in the rural sector households having agricultural occupation have a clearly distinct consumption pattern, in the urban sector the group of households having professional, technical and related occupations are the distinct group. The principal limitation, however, of this study is that the occupational classifications adopted are much too broad and lumped together different types of agricultural occupations such as cultivator, share-cropper, agricultural labourer and so on.

The importance of the occupational factor has also been established through the studies by Ganguly (1960) and Singh (1968). Ganguly (1960) compared the expenditure patterns of farmers and cultivators, agricultural labourers and other households of rural UP utilising NSS 7th round data. Graphical comparisons revealed considerable inter-occupational variation of the engel curves for each of the five items considered in the study. Singh also found appreciable differences between the consumption patterns of four occupational groups of households in rural and urban areas of Western UP.

Gupta (1968) examined the influence of the age of head of the household on household consumption. The study was carried out separately for the rural and urban sectors of UP and Madras using 17th round NSS data. For each region, the consumption patterns of three categories of households were examined, viz., households with head below 30 years, those with head between 30 and 49 years, and those with head above 49 years. On the average, the middle age-group tended to have larger households. As regards the expenditure pattern, the lower age-group tended to spend relatively more on non-food items. However, the results of analysis of covariance indicated that, on the whole, age of head was not an important determinant of consumption pattern of these households.

Most Indian studies based on NSS data use the figures for total household expenditure on all items composed of expenditures in cash and imputed values of consumption in kind (either out of home-grown stock or obtained through barter exchange). However, such a practice of pooling cash and kind expenditures fails to take account of the role of monetization in the determination of consumer expenditure patterns. It is well-known that as an economy develops through industrialization the market structure alters gradually and the degree of monetization rises. If cash and kind components of item expenditures have different income elasticities, then for purposes of demand forecasting these two components have to be studied separately. Going further, the two components of the expenditure on any item would depend in characteristic ways on the level of income received in cash and in kind. Mukherjee (1967), concerned with this phenomenon, estimated the elasticities of (i) total item expenditure (e) with respect to total consumer expenditure (E), (ii) item expenditure in cash (e_m) with respect to total cash expenditure (E_m), (iii) item expenditure in kind (e_k) with respect to total kind expenditure (E_k), and finally (iv) E_m and E_k with respect to E. Such elasticities were computed for three item-groups viz., cereals, food and non-food, using 13th round NSS data grouped by levels of total household expenditure (E). The results indicated that (i) the share of E_k would fall with rise in E, especially in urban areas, (ii) the relation between e_k and E_k was roughly one of proportionality, and (iii) the elasticity of e_m with respect to E_m was much smaller than that of e with respect to E for cereals and total food in the rural sector, while for the nonfood group the difference between the two elasticities was rather small. It may be mentioned that earlier Sinha (1966) had showed that for many food items the elasticity of e_m with respect to E was less than that of e_k with respect to E. Mukherjee suggested that the elasticity of e with respect to E should be calculated by using the detailed relation (i) between e_m and E_m, (ii) between e_k and E_k and (iii) between E_m or E_k on the one hand and E on the other. Mukherjee and Rao (1972) went more carefully into the same question, using data classified by per capita household expenditure. The estimates of the above-mentioned elasticities obtained from the per capita and the per household classifications were seen to be fairly close.

Radhakrishna (1967) modified Wald's method of deriving the indifference map from linear engel curves and applied this to NSS data on household budgets. Precisely, the modifications included (i) estimating the indifference map from the knowledge of fewer than $\frac{n+1}{2}$ engel curves (while Wald's method required the knowledge of $\frac{n+1}{2}$ engel curves corresponding to different price structures), and (ii) extending the method to the case of a log-quadratic preference function. Some dynamic versions of Wald's method were also suggested by Radhakrishna.

Finally, Mukherjee et.al. (1967), Mahajan (1971) and Radhakrishna and Misra (1970) applied various techniques of clustering to group the regions of the country into a smaller number of clusters characterised by homogeneity of consumption patterns. Distance measures were employed to assess the divergence between each pair of regions in respect of (i) the vector of levels of per capita item expenditures, (ii) the vector of engel ratios for different items, or (iii) the vector of engel elasticities for different items.

1.7.7 Studies based on time series data and on time series of cross-section data :

It has been already mentioned that non-availability of satisfactory time series of consumer prices has discouraged researches on complete demand functions. In some applications, however, attempts were made to fit the LES and the Indirect addilog system to empirical data. Other studies include attempts to estimate demand functions for specific items through single equation approach, investigations regarding the intertemporal stability of consumer expenditure patterns, and an attempt to construct a dynamic model of consumer behaviour of households in the semi-monetized rural economy of India.

Rudra (1964) fitted the LES to NSS consumption data from the 8th through 14th rounds for six commodity groups — foodgrains, milk and products, other food, clothing, fuel and light, and other nonfood. As regards prices, they constructed index series for each commodity group by averaging the official monthly indices of wholesale prices of constituent items over the months covered by different NSS rounds. The LES fitted the data fairly satisfactorily, but the expenditure elasticities obtained therefrom were at variance with the usually accepted cross-sectional estimates obtained from different NSS rounds. This led the authors to raise serious doubts about the validity of the cross-sectional elasticities for purposes of demand projections.

Bhattacharya (1967) re-examined the Paul-Rudra computations, analysing separately the rural and urban expenditure estimates besides the pooled rural-plus-urban data. In each case, the halfsample-wise estimates and the corresponding combined sample estimates of expenditures were analysed separately. The price series, however, were the same in each case. It was shown that while using Stone's two-stage iterative procedure for estimating the parameters of the LES Paul and Rudra had been misled by the agreement between the results of consecutive cycles and had stopped after a few cycles. Bhattacharya continued the iteration longer and obtained better estimates of the parameters. It was also verified that fairly similar final estimates were obtained starting from very different initial estimates. Bhattacharya also considered a three commodity-group classification with foodgrains, other food and nonfood items and used price indices for foodgrains derived from NSS budget data instead of the indices based on official wholesale prices mentioned above. The results indicated wide halfsampl divergences of the estimates and also the extreme sensitivity of the estimates to changes in the price data. This suggests that owing to limitations of data the estimates of the parameters of the LES were associated with wide margins of uncertainty. Anyway, while the Paul-Rudra estimates of engel elasticities could not be completely ruled out, the most plausible point estimates were comparable with the corresponding cross-sectional estimates.

Joseph (1968) made interesting comparisons of demand projections based on the constant elasticity engel curve with those based on the (simple) LES. The former takes no account of the shifts in the engel curve resulting from changes in relative prices over time. Also, projections from engel curves were shown to vary with the choice of the base period and also of the period to which the cross-section elasticity referred. In fact, for some items the estimated constant elasticity varied markedly over NSS rounds. It was suggested that unless the interval between the base period and the forcast period is very short, the projections from LES would be superior to those based on constant elasticity engel curves. Joseph (1968) also carried out other interesting exercises such as fitting the LES to data relating to sections of the population in specific size-classes of per capita total consumer expenditure, and also fitting generalized forms of the LES in which the parameters are assumed to be linear functions of time.

Radhakrishna and Murthy (1972) fitted the LES to data on nine commodity groups from NSS rounds 8 through 14. The model was fitted separately for households in three ranges of per capita expenditures and also for the overall averages of each round. It was found that while the "committed quantities" increased with rising levels of per capita expenditure, the marginal budget shares of most of the food items declined particularly in the rural sector.

Krishnan (1964) made an attempt to estimate income and price elasticities of demand separately for rural and urban India by using NSS estimates of expenditures from a number of rounds. For any item, he brought together the estimates of per capita item expenditure for each of the per capita total expenditure classes and for several NSS rounds and regressed this on the corresponding estimate of per capita total consumer expenditure and the price index of the particular item after deflating both the regressors by an all-commodity price index. The price indices used were based on official wholesale price data and the same index was used for all the per capita expenditure classes. In spite of this limitation, Krishnan obtained very reasonable estimates of income and (own) price elasticities for different item-groups. Iyengar and Jain (1969) also obtained sensible estimates of price and income elasticities using NSS data for two time periods and two broad commodity groups, food and nonfood, assuming the indirect addilog model. They applied this to the fractile groupwise expenditure estimates for rural West Bengal during 1952-53 and 1957-58 along with the corresponding prices estimated from the NSS budget surveys.

Bhattacharya and Maitra (1969) examined the inter-temporal shifts of the LLI engel curves fitted for various items[17/]. After an examination of the shifts in parameters of the LLI curves, they tried alternative forms of empirical demand functions some of which yielded more or less satisfactory results[18/].

In some studies attempts have been made to estimate demand functions for specific commodities. Thus, in a study of the relationship between industry and agriculture, Krishnan (1964b) analysed aggregate demand for mill-made cloth in India using average cloth price, average foodgrains price and national income as explanatory variables and annual sales of mill-made cloth as the dependent variable. The results indicated a negative cross-price elasticity between mill-made cloth and foodgrains. However, Krishnan was able to explain such a phenomenon. More recently, Murthy and Desai (1972) studied the demand function for sugar in a constant elasticity set-up using per capita

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[17/] vide Chapter VI, Section 6 infra.

[18/] vide Sinha (1966), Maitra (1969) and Roy and Dhar (1960) for other studies dealing with inter-temporal shifts in engel curves and engel elasticities.

total expenditure and wholesale price of sugar (both variables deflated by the overall price index) as the independent variables.

Tendulkar (1969) made an important attempt to construct a theoretical model of consumer behaviour for rural households in a semi-monetized economy where the typical household has a stock of agricultural commodities and has to decide how much to sell and how much to retain for self-consumption. Applying Houthakker and Taylor's (1966) state-adjustment model to cash and kind components of consumption of food articles, it was found that cash outlays acted as inventory adjustment mechanism while kind expenditures indicated a habit formation process. The estimates of short and long-run elasticities of cash and kind expenditures with respect to total expenditure and prices turned out to be reasonable and, in fact, the estimated long-run expenditure elasticities showed satisfactory conformity with the estimates of expenditure elasticities from budget data obtained by Sinha (1966).

Finally, mention must be made of an important but relatively unnoticed study based on continuous cross-sectional data (Mathur, 1961). In this study the short-and log-run effects of change in (per capita) total expenditure on (per capita) consumption of foodgrains was analysed on the basis continuous cross-sectional budget data for a sample of Vidarbha farmers relating to the years 1955-56 and 1956-57. Expenditure elasticities for foodgrains were estimated (i) by the usual method separately from each year's data, and (ii) by regressing changes in consumption of foodgrains between the two years on the corresponding changes in total consumer expenditure (making due adjustments for price changes). It is generally recognized that (i) measures the long-term effects of total expenditure on consumption of foodgrains while (ii) measures the corresponding short-run effects. Interestingly all the elasticities were found to be close. This perhaps indicates the stability of the engel relationship over time. At least in this case the cross section data give a correct indication of inter-temporal variations in consumption in response to changes in per capita total consumer expenditure. The importance of this type of studies is obvious, for in their absence demand projections based on cross-sectional engel curves can never be used with complete confidence.

Chapter II

Effect of Household Consumption on Household Consumption Pattern

2.1 Introduction

In many practical applications engel curves of the form

$$\frac{y_i}{n} = f_i\left(\frac{x}{n}\right) \qquad \ldots \quad (2.1.1)$$

are used. Here y_i is household expenditure on the ith commodity, x is the household total consumer expenditure/income and n is household size. Household size, in this specification, ignores the differences in age-sex and other particulars between individual members of the household. Since different types of household members have varying needs and ability to consume, the actual decisions regarding expenditure by a household are considerably influenced by the composition of the household in terms of age, sex etc. This gives rise to the need for devising proper scales of measurement that would show the equivalence of different types of household members to one of the standard type, and thus enable the researcher to measure household size more accurately.

Attempts to incorporate age-sex composition of the household in (2.1.1) date back to the days of Ernst Engel, who used the new-born baby as the standard for measuring the equivalence of individuals of different age-sex categories. However, Sydenstricker and King's (1921) formulation has been widely accepted as a more reasonable specification of engel curves. This formulation, independently arrived at at a much later date by Prain and Houthakker (1955, Chap.9), recognizes the need for introducin two types of unit consumer scales, viz., those for the expenditure on different items and that for the income/total expenditure of the househol The specific scales measure the equivalence of different types of perso in respect of the consumption of different items of household budget, while the income or overall scale is used to work out the number of consumers in respect of income/total expenditure. In symbols, this formulation is[1/]

$$\frac{y_i}{\Sigma_d \, g_{id} \, n_d} = f_i \left[\frac{x}{\Sigma_d \, g_{od} \, n_d} \right] \qquad \ldots (2.1.2)$$

where

g_{id} : value for the dth (d = 1, 2, ..., k) type of person on the specific unit consumer scale for the ith item (i = 1, 2, ..., m);

g_{od} : value for the dth type of person on the income/overall unit consumer scale;

and n_d : number of persons of type d present in the household.

Thus $\Sigma_d \, g_{id} \, n_d$ and $\Sigma_d \, g_{od} \, n_d$ measure the household size in terms of number of unit consumers (or in terms of equivalent adults when the male is taken as the *numeraire*) measured on the specific and the overal scale, respectively.

[1/] This formulation ignores the possibility of economies of scale in household consumption. However, (2.1.2) could be reformulated to include possibilities of such economies. *Vide* Prais and Houthakker (1955, Chap. 10).

In (2.1.2) the unknowns to be estimated are the g_{id}'s, the g_{od}'s and the structural parameters of $f_i(\cdot)$. As Prais and Houthakker demonstrated, for every d, the g_{od}'s are related to the corresponding g_{id}'s through the restriction

$$g_{od} = \Sigma_i \frac{y_i}{x} \frac{\Sigma_d g_{od} n_d}{\Sigma_d g_{id} n_d} g_{id} \qquad \ldots (2.1.3)$$

which follows from the budget constraint $\Sigma_i y_i = x$.

The formulation (2.1.2) constitutes the basis for many empirical studies on the effect of household composition on household consumption pattern. However, Forsyth (1960) pointed out that it is not possible, in general, to estimate the specific and overall scales uniquely from actual household budget data. The purpose of the present chapter is first to show that Forsyth's conclusion need not be true in general and, finally to illustrate our arguments both analytically and numerically.

The organisation of the present chapter is as follows : Section 2.2 presents a review of the existing methods of estimation of unit consumer scales. In Section 2.3 we have discussed Forsyth's problem of separating the specific and overall effects of a change in household composition on consumption pattern. In Section 2.4 we have examined Barten's solution to Forsyth's problem and have demonstrated that Barten's approach does not solve the problem. A general solution to Forsyth's problem has been presented in Section 2.5. Section 2.6 illustrates a specific situation where the g_{id} and g_{od} coefficients can be estimated through imposing restrictions on the parameters of specific engel curve forms. Finally, in Section 2.7 we have offered a numerical illustration of how the specific and overall coefficients of composition effects could be calculated uniquely. This illustration is based on the consumer expenditure data of UK households used by Forsyth.

2.2 A review of methods of estimating unit consumer scales :

The methods of estimation of unit consumer scales are largely based on the formulation (2.1.2) which ignores economies of scale. Moreover, most of these methods are based on drastic assumptions.

Nicholson's method (Nicholson, 1949; Henderson, 1949) attempts to estimate the income/overall coefficient for a child. This method, known as that of measuring the cost of a child, selects a 'standard' commodity, such as tobacco, for which a child's specific coefficient is assumed to be zero. Given this, two households are considered which differ in composition by the presence of an additional child in one of them. It is clear that, since the child's specific coefficient for tobacco is zero, the specific sizes of the two households are equal. Now, the household containing an additional child would require a higher level of household income/total expenditure for attaining the same level of tobacco consumption as done by the smaller household. Thus the difference in household income/total expenditure corresponding to a fixed level of tobacco consumption would be a function of the child's overall coefficient. The cost of a child, therefore, can be calculated from this difference in household

The limitation of the Nicholson approach lies essentially in the assumption that a child's specific coefficient for the 'standard' commodity is exactly zero. This assumption is an oversimplification of reality, since the addition of a child to a household generally leads to a complicated string of substitutions in the household budget allocation and thus in spit of the fact that a child does not consume a 'standard' commodity it may hav a non-zero specific coefficient for the commodity reflecting ancillary consumption by other members of the household (Prais and Houthakker, 1955, Chap. 9; Barten, 1964).

The second method of estimating the unit consumer scales is based on the assumption that the specific and overall coefficients are all identical (Friedman, 1952). This assumption is clearly not true for many items of consumption. If for any particular item of consumption the specific coefficients are different from the overall coefficients, the estimates of scales obtained by forcing the two types of coefficients to equality would be biased estimates of the true scales.

For commodities with engel elasticity close to zero, one may estimat the specific scale by ignoring the influence of income altogether. This is possible, since in this case consumption does not depend upon household income/total expenditure, and is largely determined by household size/ composition. In these cases, the specific coefficients are easily obtained by relating item consumption to the number of members falling in different age-sex categories. This method is known to give satisfactory results for absolute necessaries only. In other cases, this will lead to underestimates of the true specific coefficients (Prais and Houthakker, 1955, Chap. 9).[2]

Wold (1953, Chap. 14) used an interesting method for eliminating the bias in the estimated constant income elasticity resulting from the neglect of household composition. An alternative procedure of estimation of the unit consumer scale is implicit in this method. Here, sample households are classified into relatively homogeneous groups, each group having broadly the same age-sex composition. Income elasticity for any item is then calculated by two alternative methods. First of all, separate estimates of income elasticity are obtained for each group and a weighted average of these group-wise income elasticities is taken as the overall elasticity (the weights being aggregate expenditures on the item concerned incurred by different groups of households). An alternative estimate of the overall income elasticity is also obtained by pooling all groups of households together and using a tentative specific unit consumer scale for calculating item expenditure per unit consumer. Income/total expenditure per unit consumer is found through an overall scale assumed to be known *apriori*. Finally, these two estimates of income elasticity are compared. The agreement between them indicates the appropriateness of the tentative specific scale used. If the estimated elasticities differ appreciably the tentative scale is revised on the basis of the following principle : "If the scale adopted gives too much weight to children's consumption, small elasticities will be overestimated by direct pooling, and large elasticities

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[2] Vide Chowdhury (1967) and Roy and Dhar (1960).

will be underestimated; and conversely, if the scale gives too little weight to the children's consumption". The whole process is repeated until the two elasticities are similar. As regards the estimate of the overall scale (which is assumed to be known at the time of estimating the specific scales), Wold considered the consumption function relating total expenditure to income (which presupposes the existence of reliable income data). It is assumed that the scale for total expenditure and income are the same and the elasticity of total expenditure with respect to income estimated from pooled data is compared with the corresponding weighted average of the group-wise elasticities. If these elasticities differ the underlying scale is revised and the process is continued until the elasticities agree.

Brown (1954) in a study of food expenditure behaviour of British households, worked with semi-log and double-log engel curves. In the semi-log case, we write

$$\frac{y_i}{\Sigma_d\, g_{id}\, n_d} = \alpha_i + \beta_i \log \frac{x}{\Sigma_d\, g_{od}\, n_d} \qquad \ldots.\ (2.2.1)$$

i.e.,

$$y_i = \Sigma_d\, g_{id}\, n_d \left[\alpha_i - \beta_i \log\ \Sigma_d g_{od}\, n_d\right] + \beta_i \left[\Sigma_d g_{id}\, n_d\right] \log x \qquad \ldots\ (2.2.2)$$

the estimates of the slopes for a homogeneous group of households would be linearly related to the composition vector $(n_1, \ldots, n_k)$. Thus the specific scale, as Brown suggested, could be obtained by regressing the

~~estimated composition-wise slopes on the composition vector.~~ In the double-log case

$$\frac{y_i}{\Sigma_d\, g_{id}\, n_d} = a_i \left[\frac{x}{\Sigma_d\, g_{od}\, n_d}\right]^{b_i} \qquad \ldots(2.2.3)$$

i.e.,

$$y_i = a_i \frac{\Sigma_d\, g_{id}\, n_d}{(\Sigma_d\, g_{od}\, n_d)^{b_i}}\; x^{b_i} \qquad \ldots\ (2.2.4)$$

the engel elasticity, b_i, is constant and same for all types of composition. Now, assuming $g_{od} = 1$ for all d and using a common estimate of b_i (i.e., a weighted average of composition-wise b_i's) the specific scale may be estimated through

$$\frac{y_i}{\left[\frac{x}{\Sigma_d\, g_{od}\, n_d}\right]^{b_i}} = a_i\, \Sigma_d\, g_{id}\, n_d = \Sigma\, g^{*}_{id}\ \ n_d \text{ (say)}, \qquad \ldots\ (2.2.5)$$

a regression having no intercept term. These estimated coefficients (g^{*}_{id}), however, depend upon the presumed values of the overall scale coefficients (g_{od}). Brown experimented with alternative sets of values of g_{od}'s and observed that the changes in the estimated specific coefficients in response to a change in the income coefficients is given approximately by the formula $\delta\, g_{id} = b_i\, \delta\, g_{od}$.

Prais-Houthakker's iterative scheme for estimation of g_{id}'s from semi-log and double-log formulation of engel curves is also based on the assumption that the g_{od}'s are known apriori. In the semi-log case, they used

$$\frac{y_i}{(\gamma_i+\mu)} = \beta_i \Sigma_d g_{id} n_d = \Sigma g^*_{id} n_d \qquad \ldots (2.2.6)$$

where $\gamma_i = \frac{\alpha_i}{\beta_i}$ and $\mu = \log \frac{x}{\Sigma_d g_{od} n_d}$. Similarly, for the double-log case (2.2.5) is used. If γ_i in (2.2.6) and b_i in (2.2.5) are known, g^*_{id}'s can be estimated through least squares method. Prais and Houthakker suggested a search procedure through which the g_{id}'s (or equivalently g^*_{id}'s) could be estimated for a specific value of γ_i(or b_i) that would maximize the multiple correlation coefficient for the equation (2.2.6) (or (2.2.5)). Thus if a good guess can be made for the g_{od}'s it should be possible to obtain satisfactory estimates of the g_{id}'s. The guess need not be an ultimate restriction on the method since, in principle, one can work out a new set of g_{od}'s through (2.1.3) and use it to repeat the whole process. In actual practice, however, the specific scales were estimated by Prais and Houthakker with the supposition that g_{od}'s were all equal to unity. Actual empirical results suggested that this procedure could, in fact, lead to unique set of g_{id}'s (for each i) for which the multiple correlation coefficient of (2.2.5) or (2.2.6) reached the maximum.[3]

Singh (1968) (also Singh and Nagar, 1974) adopted an elegant iterative procedure for estimating g_{id}'s and g_{od}'s from the formulation (2.1.2). Initially, they started with $g^{(o)}_{id} = g^{(o)}_{od} = 1$ for all d and i, and

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[3] For working out the g_{od}'s Prais and Houthakker suggested an alternative procedure in which the quality equation, $p = \alpha + \beta \log\left[\Sigma_d \frac{x}{g_{od} n_d}\right]$, relating the quality index of food items consumed to the per capita total expenditure per unit consumer can be used to estimate the g_{od}'s. This method, however, turned out to be less satisfactory. *Vide* Prais and Houthakker, (1955, pp. 138).

fitted different functional forms of (2.1.2) for each i. The expected values of f_i are then calculated from the best-fitting form of engel curve for each i. Next $g_{id}^{(1)}$'s are estimated through the relation

$$\frac{y_i}{f_i} = \sum_d g_{id}^{(1)} n_d \qquad \forall\ i \qquad \ldots (2.2.7)$$

The overall coefficients, the g_{od}'s, are then calculated through

$$g_{od}^{(1)} = \sum w_i^{(1)} \; g_{id}^{(1)} \qquad \ldots (2.2.8)$$

where

$$w_i^{(1)} = \frac{y_i}{x} \; \frac{\sum_d g_{od}^{(o)} n_d}{\sum_d g_{id}^{(o)} n_d}$$

is estimated from averages over all the sample households. The estimates of $g_{id}^{(1)}$ and $g_{od}^{(1)}$ are then used to repeat the whole process. The iteration is continued until convergence of the estimates of g_{id}'s and g_{od}'s is evident. The methodological advantages of this elegant procedure lie in the facts that (i) at each stage of iteration different forms of engel curves are compared and the best form is chosen for each item (thus the statistical criterion of goodness of fit is dealt with more objectively) and (ii) both the specific and overall scales are estimated simultaneously. The empirical results, however, were in many cases unsatisfactory. The estimated g_{id}'s often proved to be absurd in the sense that the estimated $\sum_d g_{id} n_d$'s turned out to be negative. To guard against such absurdities, Singh attempted to improve upon the results by incorporating the apriori restrictions $0 \leq g_{id} \leq 1$ and $\sum_d g_{id} = 1$ in the restricted least squares set-up considered by Kakwani (1967). Even after incorporating these restrictions some of the estimated g_{id}'s turned out to be negative. Since the sample sizes were small, it is possible that the remaining absurdities were due to sampling fluctuations.

A general remark may now be made regarding the nature of specific scale coefficients estimated from constant elasticity engel curves. Brown's (1954) experiments suggested that for any marginal change in the overall/income scale coefficient the corresponding specific coefficient is changed by a magnitude equal to engel elasticity times the change in the income scale coefficient. What is more important is that the estimated engel elasticity remain more or less same when the income scale is altered marginally. This fact may lead to the apprehension that while the compound effect ($g_{id} - b_i g_{od}$) of a change in household size (through the addition of member of category d) is estimable, it is not possible to separate out the specific and the overall effects, viz., g_{id} and g_{od}, on the basis of actual data. In fact, this problem of impossibility of estimating g_{id}'s and g_{od}'s uniquely is wellknown as Forsyth's problem. In the next section we deal with this problem in somewhat details.

2.3 Forsyth's Problem :

Forsyth (1960) examined the relationship between household size and composition and household consumer expenditure pattern using UK budget data. In the theoretical part of the paper Forsyth stressed the analytical impossibility of separating the specific and the overall effects of a change in household size/composition on consumption pattern as actually carried out by Prais and Houthakker. Precisely, he 'discovered' that the specific and the overall scale coefficients are not identified when the engel curves meet the adding-up criterion.

Forsyth's objection to Prais and Houthakker's approach is summed up in the following general argument : If the engel curves (for each of the m commodities) of two types of households, differing in composition by a single individual of a particular age-sex type, be compared at a fixed level of household income/total expenditure, the observed differences in consumption pattern would be dependent upon the m specific coefficients and the income coefficient pertaining to the particular type of individual. Now, the adding-up criterion implies that there are only (m-1) independent comparisons of expenditure functions. Even if we obtain the income coefficient as the weighted average of the specific coefficients, there are m independent specific coefficients to be estimated from the data. Thus it appears that it would not be possible to estimate these m coefficients uniquely from m-1 independent comparisons of the observed engel curves.

Forsyth made the problem more clear in a particular framework in the following manner. Assume the engel curves to be of constant elasticity form, i.e.,

$$\frac{y_{it}}{(c + z_t)^{d_i}} = a_i \left[\frac{x_t}{(c + z_t)^{d_o}} \right]^{b_i} \qquad \ldots (2.3.1)$$

where y_{it} is the expenditure on the ith commodity by a household composed of a couple and z_t children, x_t is the corresponding total consumer expenditure/income. $(c+z_t)^{d_i}$ and $(c+z_t)^{d_o}$ measure the effective household size for the ith commodity and for total expenditure respectively[4]. Finally, a_i and b_i are the parameters of the engel curve for the ith commodity. Now, if w_i's are the average engel ratios for different items, from the budget constraint it follows that $\Sigma_i\ w_i b_i = 1$ and $\Sigma_i\ w_i d_i = d_o$, approximately[5]. Given these restrictions Forsyth showed that even though $(d_i - b_i d_o)$ is uniquely estimable for each i, it is not possible to estimate d_i and d_o separately from actual sample observations.

2.4 Barten's solution of Forsyth's problem :

Barten (1964) examined the unit consumer scale hypothesis in a general framework starting from engel curves of the form

$$\frac{y_i}{s_i} = f_i\left(\frac{x}{s_o}\right), \qquad i = 1, 2, \ldots, m \qquad \ldots (2.4.1)$$

Here

$$s_i = s_i(n_1, n_2, \ldots, n_k), \qquad i = 0, 1, \ldots, m \quad \ldots (2.4.2)$$

measure the household size in respect of total expenditure/income (s) and the specific item expenditures (s_i, $i \neq 0$) respectively, and n_d ($d=1,\ldots,k$) is the number of persons of the dth age-sex category present in the household.

4/ The exponential formulation $(c+z_t)^{d_i}$ and $(c+z_t)^{d_o}$ seeks to capture the differential impact of the marginal child on the specific and overall household size.

5/ Here it is assumed that for (2.3.1) the restrictions resulting from the budget constraint are satisfied at least at the average level.

The effect of a change in n_d on y_i is given by

$$\frac{\delta y_i}{\delta n_d} = \frac{y_i}{s_i}\left(\frac{\delta s_i}{\delta n_d}\right) - \pi_i \frac{y_i}{s_o}\left(\frac{\delta s_o}{\delta n_d}\right) \qquad \ldots (2.4.3)$$

where π_i is the (partial) income elasticity of y_i. Equation (2.4.3) may be written in terms of elasticities as

$$f_{id} = G_{id} - \pi_i G_{od} \qquad i = 1, 2, \ldots, m \quad d = 1, 2, \ldots, k \qquad \ldots (2.4.4)$$

where f_{id}, G_{id} and G_{od} are respectively the (partial) elasticities of y_i, s_i and s_o with respect to n_d. Now, the adding-up criterion $\Sigma_i y_i \equiv x$ implies

$$\Sigma_i w_i f_{id} = 0 \qquad \forall \quad d \qquad \ldots (2.4.5)$$

and

$$\Sigma_i w_i \pi_i = 1 \qquad \ldots (2.4.6)$$

where $w_i = \frac{y_i}{x}$ is the engel ratio for the ith item. Thus from (2.4.4) one gets, using (2.4.5) and (2.4.6).

$$G_{od} = \Sigma_i w_i G_{id} \qquad \forall \quad d \qquad \ldots (2.4.7)$$

i.e., the income coefficient, G_{od}, is a weighted average of the corresponding specific coefficients, G_{id}, for all d. The system of equations (2.4.4) involving the G_{id}'s as the unknowns can now be written as

$$F = (I - \pi w') G \qquad \ldots (2.4.8)$$

where $F = \left[f_{id}\right]$ and $G = \left[G_{id}\right]$ are m x k matrices, $\pi = (\pi_i)$ and $w = (w_i)$ are m x 1 vectors and I is the m x m identity matrix. In view of (2.4.6) it is clear that $(I - \pi w')$ is singular. Thus, given

F, π and w G cannot be solved uniquely from (2.4.8). This is essentially the difficulty pointed out by Forsyth.

At this point Barten suggests that although it is not possible to use (2.4.8) in its present form for obtaining G_{id}'s from a set of estimates of F and π, "one can derive an estimate of G from such a set of values of F and π by deleting a row of F, the corresponding row and column of $(I - \pi w')$ and the corresponding row of G". In this way the matrix $(I - \pi w')$ would be reduced to a matrix of full rank, barring other linear dependences. The deleted row of G could be reconstructed from the results of other rows and restrictions. Barten does not give the details of the procedure, but merely outlines it as stated above.

This method of solution proposed by Barten, however, appears to be dubious. If the r-th row of G is deleted, the solution of the (m-1) remaining elements of any column vector of G from the truncated system of equations is identical to the solution that would be obtained from (2.4.8) by setting $G_{rd} = 0$ for all d. That is, Barten essentially assumes G_{rd} to be zero for all d (for some particular r). Clearly, the solution of G_{id} $(i \neq r)$ and $G_{rd} = 0$ satisfy the r-th equation as well. This is so because, from (2.4.5) we have

$$f_{rd} = -\frac{1}{w_r} \Sigma_{i \neq r} w_i f_{id} \qquad \forall \quad d \qquad \dots (2.4.9)$$

Further

$$f_{id} = G^*_{id} - \pi_i \Sigma_j G^*_{jd} w_j , \qquad i \neq r \qquad \dots (2.4.10)$$

where G^*_{id}'s are the solutions obtained from the truncated system (where one takes $G_{rd} = 0$ apriori). Substituting (2.4.10) in the right hand side of (2.4.9)

$$f_{rd} = - \frac{1}{w_r} \left[\sum_{i \neq r} w_i G^*_{id} - \sum_{i \neq r} w_i \pi_i \sum_{j \neq r} w_j G^*_{jd} \right] \qquad \ldots (2.4.11)$$

On simplification (2.4.11) leads to

$$f_{rd} = - \pi_r G_{od} \qquad \forall \ d.$$

Thus G^*_{id} $(i \neq r)$ and $G_{rd} = 0$ satisfy the r-th equation as well (for all d). That is, Barten inadvertently suggested a procedure by which all the equations in (2.4.8) are satisfied but one row of G becomes null.

Further, if any set of values are assumed for G_{rd} (for all d), the solution for the G_{id} $(i \neq r)$ would be linear functions of the assumed values of G_{rd}. Once a row vector of G is assumed to be null there is no way of revising the values of its elements, as Barten suggested, as this would also change the values of the rest of the G_{id}'s.

It thus appears that Barten arrived at essentially the same position as Forsyth : his analysis showed that only $(G_{id} - \pi_i G_{od})$'s are identified and that all the G_{id}'s and G_{od}'s cannot be uniquely estimated from data.

2.5 A solution of the Forsyth problem :

We now extend Barten's analysis to provide a solution to Forsyth's problem. It is clear that any such solution must center around finding an additional restriction on the G_{id}'s for each d. Fortunately, in the system developed above in Section 2.4, there do exist additional meaningful restrictions on these coefficients.

The only restriction stressed so far has been (2.4.7). This suggests that although the G_{id}'s do not change in response to partial changes in x, G_{od}'s may change as a result of budget reallocations arising from any partial change in x[6]. But from (2.4.2) we have

$$\frac{\delta G_{id}}{\delta x} = 0 \qquad \forall \quad i = 0, 1, \ldots, m$$

i.e., all the G_{id}'s are invariant with respect to changes in x. In order that (2.4.2) and (2.4.7) may be consistent

$$\sum_i \frac{\delta y_i}{\delta x} G_{id} = G_{od} \qquad \ldots (2.5.1)$$

must be true. (2.5.1) is obtained by differentiating G_{od} in (2.4.7) with respect to x and setting it equal to zero. Equation (2.5.1) may be alternatively written as

$$\sum_i w_i \, \pi_i \, G_{id} = G_{od} \qquad \forall \quad d \qquad \ldots (2.5.2)$$

In vector-matrix notation this is

$$w'\hat{\pi} G = G_{od} \qquad \ldots (2.5.3)$$

where $\hat{\pi}$ is the diagonal matrix with π_i as the i-th diagonal element[7].

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[6] Usually it is assumed that the G_{id}'s and the G_{od}'s are constant, independent of x. This assumption of constancy of the G_{id}'s and the G_{od}'s should not be discarded until empirical exercises reveal that such an assumption is inadequate. In fact, here we have offered a solution to Forsyth's problem by stressing the need for keeping G_{od}'s constant.

[7] (2.5.3) together with (2.4.7) imply $\Sigma_i \, w_i(\pi_i - 1)G_{id} = 0$ for each d. Thus in situations where $w_i \, \pi_i \neq w_i$ for at least one i, we have an additional independent restriction on the G_{id}'s in (2.5.3).

It may be noted that this restriction is unique in the sense that for the constancy of G_{id} $(i = 0, 1, \ldots, n)$, this is the only restriction that need be enforced.

Let us now consider equations (2.4.4) and (2.5.2) together. This may be written as

$$\begin{bmatrix} F \\ 0 \end{bmatrix} = \begin{bmatrix} I & -\pi \\ -w'\hat{\pi} & 1 \end{bmatrix} \begin{bmatrix} G \\ G_{od} \end{bmatrix} = A \begin{bmatrix} G \\ G_{od} \end{bmatrix} \text{ (say)} \qquad \ldots (2.5.4)$$

or, alternatively as

$$F = (I - \pi w'\hat{\pi})G \qquad \ldots (2.5.5)$$

Now, since A is normally non-singular, G and G_{od} can be uniquely solved from (2.5.4)[8]. Finally, it has to be shown that the solution of G and G_o from (2.5.4) satisfies (2.4.7). This is straight forward since premultiplication of (2.5.5) by w' leads to

$$w'F = w'G - w'\pi w'\hat{\pi} G \qquad \ldots (2.5.8)$$

By (2.4.5) $w'F = 0$ and by (2.4.6) $w'\pi = 1$.

Hence

$$w'G = w'\hat{\pi} G = G_{od}$$

by (2.5.3).

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[8] The non-singularity of A requires

$$|A| = |I|\,|I - \pi w'\hat{\pi}| \neq 0 \qquad \ldots (2.5.6)$$

or, equivalently

$$|A| = |1|\,|1 - w'\hat{\pi}\pi| \neq 0 \qquad \ldots (2.5.7)$$

Now, from (2.5.7)

$$|A| = 1 - \sum_i w_i \pi_i^2$$

Thus the necessary and sufficient condition for the non-singularity of A is $\sum_i w_i \pi_i^2 \neq 1$. This seems to be quite reasonable. From (2.5.6) it is evident that if A is non-singular so will be $(I - \pi w'\hat{\pi})$ and hence (2.5.5) will have a unique solution.

2.6 An estimable case based on Working's form of engel curve :

It has been shown that the overall coefficients, G_{od}, are related to the specific coefficients, G_{id}, through two relations (vide equations (2.4.7) and (2.5.3)). It is this fact that we exploited for demonstrating the general theoretical possibility of estimating the G_{od}'s and the G_{id}'s uniquely. In this section we consider a concrete situation and the solution of the Forsyth problem, by way of illustration. Our purpose here is to show that even in Prais-Houthakker's formulation (2.1.2) if the form of $f_i(.)$ satisfies the adding-up criterion, the g_{id}'s and the g_{od}'s can, in principle, be (consistently) estimated uniquely from observed data on household expenditure.

Let the form of engel curve be

$$\frac{y_i}{s_i} = \beta_i \left(\frac{x}{s_o}\right) + \gamma_i \quad \phi\left(\frac{x}{s_o}\right), \quad i = 1,2,\ldots, m \qquad \ldots (2.6.1)$$

where $s_i = \Sigma_d \, g_{id} \, n_d$, $s_o = \Sigma_i \, g_{od} \, n_d$, $\phi\left(\frac{x}{s_o}\right)$ is some arbitrary function of $\frac{x}{s_o}$ and β_i and γ_i are parameters of the engel curve.

Rewriting (2.6.1) as

$$y_i = \beta_i \left(\frac{s_i}{s_o}\right) x + \gamma_i \, s_i \quad \phi\left(\frac{x}{s_o}\right) \qquad \ldots (2.6.2)$$

Here $\Sigma_i \, y_i = x$ and $\sum_i \frac{\delta y_i}{\delta n_d} = 0$ imply $\sum_i s_i \, \beta_i = s_o$ and $\sum_i \gamma_i s_i = 0$ i.

$$\left.\begin{array}{lll} \Sigma_i \; \beta_i g_{id} = g_{od} & \forall & d \\ \Sigma_i \; \gamma_i g_{id} = 0 & \forall & d \end{array}\right\} \qquad \ldots (2.6.3)$$

Now, the difficulty pointed out by Forsyth can be overcome in the following way : Given (2.6.2) and (2.6.3) if comparisons of consumer expenditure of households of different composition-type are made, we have for each d a determinate system of equations involving g_{id}'s and g_{od}. This is so because now for any d we have exactly (m-1) (and not m) independent g_i (the remaining g_{id} and g_{od} being determined by (2.6.3)) and exactly (m-1) independent comparisons of engel curves.

As a concrete illustration of the above method, we consider here the form of engel curve suggested by Working (1927) and employed by Leser (1963) and show how the g_{id}'s and the g_{od}'s can be consistently estimated without making unwarranted assumptions.

The form of engel curve proposed by Working is

$$\frac{y_i}{x} = \alpha_i + \beta_i \log x, \qquad i = 1, 2, \ldots, m \qquad \ldots (2.6.4)$$

For our purpose we extend this to

$$\frac{y_i/s_i}{x/s_o} = \alpha_i + \beta_i \log (\frac{x}{s_o}), \quad i = 1, 2, \ldots, m \qquad \ldots (2.$$

i.e.,

$$y_i = \alpha_i^* x + \beta_i^* x \log x \qquad \ldots. (2.6.6)$$

where

$$\alpha_i^* = \frac{s_i}{s_o} \left[\alpha_i - \beta_i \log s_o\right] \qquad \ldots (2.6.7)$$

and

$$\beta_i^* = \frac{s_i}{s_o} \beta_i \qquad \ldots (2.6.8)$$

(2.6.5) represents a possible world. The right hand side of (2.6.6) may give the actual values of y_i for every household or its expectati a given x and a given composition vector. We merely assume that over the observed range of x, the y_i's are non-negative for every i and every co position-vector. The adding up criterion is met if $\Sigma_i \alpha_i^* = 1$ and $\Sigma_i \beta_i^* =$ for every composition-vector. These lead to the constraints

$$\left.\begin{array}{l} \Sigma_i \beta_i g_{id} = o \\ \Sigma_i \alpha_i g_{id} = g_{od} \end{array} \quad \text{for all } d \right| \qquad \ldots (2.6.9)$$

Now, suppose we have infinitely large samples of household budgets fo each of a number of household composition types. We would then know th exact values of α_i^* and β_i^* for all i and for each of the different c position types represented in the sample. We may first utilize the val of α_i^* and β_i^* for the single-adult households. For these househol

$$\frac{\alpha_i^*}{\beta_i^*} = \frac{\alpha_i}{\beta_i} \qquad \ldots (2.6.10)$$

since s_o is unity for these households. Comparing $\frac{\alpha_i^*}{\beta_i^*}$ for oth of households with that of the single-adult ones we have the corresp values of log s_o and hence of s_o, from which g_{od}'s can be obtained thro appropriate differencing. Once the s_o's are known the values of $\beta_i^* s_o = \beta_i s_i$ are known for all types of households. Thus $\beta_i g_{id}$'s be obtained by differencing and finally

$$g_{id} = \frac{\beta_i g_{id}}{\max_d (\beta_i g_{id})} \quad \text{for all } d \qquad \ldots (2.6.11)$$

yields the specific coefficients. Obviously, $\beta_i = \max_d (\beta_i g_{id})$.

Let us now consider a situation where there is a finite sample of budgets and suppose that the above process is used for estimating the parameters. Least squares regression would give unbiased and consistent estimates of α_i^* and β_i^* of equation (2.6.6) for different i and also for different composition types. By Nicholson's theorem (Nicholson, 1957), these estimates would satisfy $\sum_i \hat{\alpha}_i^* = 1$, $\sum_i \hat{\beta}_i^* = 0$ for every composition vector.[9] Now, since $\frac{\hat{\alpha}_i^*}{\hat{\beta}_i^*}$, $i = 1, 2, \ldots, m$ for the single-adult households yield consistent estimates of $\frac{\alpha_i}{\beta_i}$, the estimates of $\log s_o$ and hence of s_o for the different types of households would also be consistent. Next, $\hat{\beta}_i^* \hat{s}_o$ would be a consistent estimate of $\beta_i s_o$, hence the estimated $\widehat{\beta_i g_{id}}$'s would be consistent. Thus $\hat{g}_{id}$'s estimated through (2.6.11) would also be consistent (since both the numerator and denominator of (2.6.11) are consistent estimates). Finally, consistent estimates of α_i and β_i are obtained from $(\hat{\alpha}_{iM}^* / \hat{g}_{i1})$ and $(\hat{\beta}_{iM}^* / \hat{g}_{i1})$ where $\hat{\alpha}_{iM}^*$ and $\hat{\beta}_{iM}^*$ are parameters estimated for the single-adult male households and $\hat{g}_{i1}$ is the estimated specific coefficient for commodity i of the adult male. We have done nothing to guarantee that the estimates thus obtained satisfy the constraints (2.6.9), but since the estimates are consistent the constraints will be approximately satisfied in large samples.

The estimation procedure outlined above neglects a large bulk of data. Below we suggest a reasonable iterative procedure for exploiting the entire material which may lead to more efficient estimates. It is, of course, necessary to examine the question of convergence of this procedure

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[9] $\wedge$ indicates least squares estimates.

and to put the ideas to test with empirical data. We may, however, add that the suggested procedure is parallel to that of Prais and Houthakker (1955) used in their pioneering work and they also could not tackle the question of convergence in a theoretical manner.

We may write (2.6.5) as

$$\frac{y_i}{\mu(1+\gamma_i \log \mu)} = \sum_d g^*_{id} \; n_d \qquad \ldots (2.6.12)$$

where $\mu = \frac{x}{S_o}$, $\gamma_i = \frac{\beta_i}{\alpha_i}$ and $g^*_{id} = \alpha_i \, g_{id}$. We may start with a given set of values of g_{od}, say $g_{od} = 1$ for all d, so that μ is known for each household. We then try different values of γ_i and for every trial value regress the variable on the left hand side of (2.6.12) on $(n_1, n_2, \ldots, n_k)$ (the regression has no intercept term). We find out that value of γ_i, denoted $\hat{\gamma}_i$, for which the correlation between the left hand side variable of (2.6.12) and n_d's is the highest. Using the corresponding estimated g^*_{id}'s obtain

$$\hat{\alpha}_i = \max_d \left(\hat{g}^*_{id} \right) \text{ and } \hat{g}_{id} = \frac{\hat{g}^*_{id}}{\hat{\alpha}_i} . \text{ Then } \hat{\beta}_i = \hat{\gamma}_i \, \hat{\alpha}_i .$$

After this has been done for each i, the $\hat{g}_{od}$'s are calculated from the relation $\hat{g}_{od} = \sum_i \hat{\alpha}_i \, \hat{g}_{id}$ for all d. The cycle is repeated with revised values of μ until convergence is evident.

2.7 A Numerical Illustration :

We have made an attempt to put to an empirical test the technique proposed in Section 2.5 for separate estimation of the specific and overall effects of compositional variation on household expenditure pattern. This empirical exercise is based on the material examined by Forsyth; indeed, we make use of Forsyth's estimates of household compositionwise constant elasticity engel curves for British households surveyed by the U.K. Ministry of Labour in 1953-54.

Forsyth considered four family types, viz., families consisting of a couple (C), a couple and a child (C + 1), a couple and two children (C + 2) and a couple and three children (C + 3). Forsyth's constant elasticity engel curve (2.3.1) can be written as

$$y_{it} = a_i \, (C + Z_t)^{\gamma_i} \, x_t^{b_i} \qquad \ldots \quad (2.7.1)$$[10]

where y_{it}, x_t, a_i and b_i are as already defined in Section 2.3 above and

$$\gamma_i = d_i - b_i \, d_o \qquad \ldots \quad (2.7.2)$$

where d_i and d_o are the specific and overall composition coefficients respectively. It has been argued by Forsyth that for (2.7.1) the adding up criterion would be approximately satisfied by the estimated values of y_{it}. Thus the restrictions (2.4.7) and (2.5.2) may also be expected to be satisfied approximately. For (2.7.1), (2.4.7) implies the restriction

$$\sum_i w_i \, d_i = d_o \qquad \ldots . \quad (2.7.3)$$

while (2.5.2) implies

$$\sum_i w_i \, b_i \, d_i = d_o \qquad \ldots . \quad (2.7.4)$$

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[10] To be precise, $(C + Z_t)$ measures the physical size of a family with a couple and t children ($t = 1,2,3$), C being a constant measuring the size of a couple family and Z_t measuring the physical size of t children.

Combining (2.7.3) and (2.7.4) we have

$$\sum_i w_i(b_i - 1)\, d_i = 0 \qquad \ldots (2.7.5)$$

Thus, we have the following system of linear equations for solving d_i and d_o.

$$\begin{bmatrix} I & -b \\ (w'\hat{b} - w) & 0 \end{bmatrix} \begin{bmatrix} d \\ d_o \end{bmatrix} = \begin{bmatrix} \gamma \\ 0 \end{bmatrix} \qquad \ldots (2.7.6)$$

where I is m x m identity matrix (m being the number of commodities),

b is m x 1 column vector of engel elasticities, b_i,

w is m x 1 column vector of engel ratios,

$\hat{b}$ is m x m diagonal matrix with b_i as the ith diagonal element,

d is m x 1 column vector of unknown specific coefficients, d_j,

and γ is m x 1 column vector of known γ_i's.

(2.7.6) describes a system of (m+1) equations involving m unknown d_i's and d_o. Obviously, one can estimate b_i's and γ_i's from data. Since the inverse of the partitioned matrix on the left hand side of (2.7.6) usually exists, the solution for the system is

$$\begin{bmatrix} d \\ d_o \end{bmatrix} = \begin{bmatrix} I - bD^{-1}(w'\hat{b} - w) & bD^{-1} \\ -D^{-1}(w'\hat{b} - w) & D^{-1} \end{bmatrix} \begin{bmatrix} \gamma \\ 0 \end{bmatrix} \quad ..(2.7.7)$$

where $D = (w'\hat{b} - w)\, b$.

Thus if $D \neq 0$, i.e.,

$$\sum_i w_i\, b_i^2 \neq \sum_i w_i\, b_i$$

we have unique solutions of d_i's and d_o from (2.7.6).

In the empirical exercise reported here, the values of w_i, b_i and γ_i for different items of expenditure have been adopted from Forsyth's results (Forsyth, 1960). On the basis of these values we have estimated d_i's and d_o and constructed family equivalence scales for different items of expenditure as also for total expenditure. Finally, a comparison of these equivalence scales is made with those obtained by setting $d_o = 1$.

Table 2.1 gives the average expenditures on twelve groups of commodities by family type at the geometric mean level of total expenditure over all sample families of each type estimated from the constant elasticity engel curves fitted by Forsyth. The average w_i's have been estimated as follows : (i) for each item the average level of expenditure over all family types has been calculated by weighting the family type-wise average experditures by corresponding number of families, and (ii) the average engel ratios w_i have been taken as the ratio of average item expenditure and the corresponding total expenditure (obtained as the sum of average item-wise expenditures).

Forsyth's estimates of family-type-wise constant engel elasticity b_i for different items have been reproduced in Table 2.2. The average elasticities over all family-types for different items have been obtained as weighted averages of the family-type -wise elasticities where aggrega item expenditure by different types of families havve been taken as w Table 2.2 also gives Forsyth's estimates of the common constant elasticity for different items for all types of families when the elasticities were forced to be equal for different types of families. These two sets of elasticities compare favourably except for fuel and light for which

Table 2.1 : Average expenditure on twelve commodity-groups by family type estimated from the constant elasticity engel curves at the geometric mean level of total expenditure over all families, U. K., 1953-54.

family type	commodity expenditure (pence per week)						
	housing	fuel, light and power	total food*	alcoholic drink	tobacco	clothing and footwear	household durables**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
C	210.7	135.7	777.7	95.9	167.7	248.9	269.1
C + 1	190.4	138.3	891.0	73.0	182.0	258.8	211.3
C + 2	189.6	150.0	977.0	61.4	164.6	266.6	212.1
C + 3	188.2	156.4	1046.6	66.2	182.9	246.6	166.4
all	199.2	141.2	871.9	80.2	171.9	255.0	233.6

Table 2.1 (contd.)

family type	commodity expenditure (pence per week)						
	other goods	trans-port	enter-tainment	essential *** services	other services	total expenditure@	no. of families
(1)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
C	176.9	166.0	42.0	103.8	87.5	2481.9	3011
C + 1	190.8	166.7	44.2	81.5	81.2	2509.2	1665
C + 2	189.5	124.8	34.2	76.9	67.4	2514.1	1447
C + 3	185.0	114.9	32.7	66.8	70.1	2522.8	571
all	183.8	152.9	40.1	89.3	80.1	2499.2	6694

* includes meals bought away from home.

** includes furniture and furnishings, radio and T.V., gas and electric appliances, china, glass and hardware.

*** includes postage, telephone, telegraph, hairdressing, laundry, cleaning and domestic help etc.

@ obtained by summing columns (2) - (13).

Table 2.2 : Forsyth's estimates of engel elasticities from constant elasticity engel curves — by commodity and family type

srl. no.	commodity	family type					
		C	C+1	C+2	C+3	all* (Forsyth)	all**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	housing	0.76	0.91	0.88	0.54	0.79	0.81
2.	fuel, light & power	0.35	0.45	0.52	0.40	0.33	0.42
3.	total food	0.53	0.53	0.47	0.58	0.52	0.53
4.	drink	1.23	1.48	1.09	2.06	1.30	1.33
5.	tobacco	0.86	0.54	0.38	0.48	0.71	0.65
6.	clothing & footwear	1.30	1.43	1.30	1.79	1.35	1.38
7.	household durables	1.61	1.34	1.70	1.43	1.57	1.56
8.	other goods	0.99	0.99	0.91	0.98	0.98	0.97
9.	transport	1.91	1.75	1.71	1.43	1.83	1.80
10.	entertainment	1.65	1.22	1.11	1.24	1.47	1.41
11.	essential services	1.47	1.95	1.92	2.15	1.66	1.71
12.	other services	2.12	2.20	2.68	2.68	2.24	2.28

* The common slope estimates from the constant elasticity engel curve.

** Weighted average of family type-wise elasticities with share of aggregate commodity expenditure for each family type as weight.

Forsyth's estimate of common elasticity seems to be wrong, since it falls outside the range of family type-wise elasticities.

Finally, the estimates of γ_i have been obtained from Forsyth's estimates of family equivalences for different items based on total effects γ_i. To be precise Forsyth reports the values of $(1 + \frac{z_t}{2})^{\gamma_i}$ for different values of z_t in Table 4 of his paper. We have computed the γ_i's from these figures. In Table 2.3 we present the values of γ_i along with those of w_i and b_i for different items.[11]

The estimates of d_i's for different items and that for d_o from (2.7.7) appear to be sensible (vide Table 2.3). As for example, large cific economies of scale are observed for items such as housing, fuel, lig and power, durables, and essential services. On the other hand, for items such as other services and clothing the magnitude of specific economies ar relatively small. The figures for food, transport, entertainment and total expenditure hold intermediate positions.

Table 2.4 presents the family equivalence scales for different ite based on the specific economies d_i and also on d_o estimated from (2.7.7) The estimates of $(1 + \frac{z_t}{2})^{d_i}$ for different types of families (with $z_t = 0, 1, 2,$ and 3) and for different items seem to provide sensible scales of itemwise family equivalences. As the results suggest, these scales are clearly more reasonable than those obtained by setting d_o equa to 1 (which yields rather unrealistic estimates of equivalences for mo of the luxury items).

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[11] It may be mentioned that for the estimated w_i, b_i and γ_i for different items reported in Table 2.3 $\Sigma w_i b_i = 0.9840$ and $\Sigma w_i \gamma_i = 0.01$ i.e., the underlying restriction. $\Sigma w_i b_i = 1$ and $\Sigma w_i \gamma_i = 0$ are approximately satisfied by these estimates.

Table 2.3 : Estimated w_i, b_i, γ_i, and d_i by commodity-groups

srl. no.	commodity	w_i	b_i	γ_i	d_i
(1)	(2)	(3)	(4)	(5)	(6)
1.	housing	0.080	0.81	-0.152	0.255
2.	fuel, light and power	0.057	0.42	0.130	0.324
3.	total food	0.349	0.53	0.324	0.591
4.	drink	0.032	1.33	-0.555	0.114
5.	tobacco	0.069	0.65	0.056	0.383
6.	clothing and footwear	0.102	1.38	0.056	0.750
7.	household durables	0.094	1.56	-0.456	0.328
8.	other goods	0.074	0.97	-0.096	0.584
9.	transport	0.060	1.80	-0.342	0.563
10.	entertainment	0.015	1.41	-0.227	0.482
11.	essential services	0.036	1.71	-0.478	0.381
12.	other services	0.032	2.28	-0.286	0.860
13.	total expenditure	-	-	-	0.506 $_0$

Table 2.4 : Specific and overall effective family sizes in terms of number of couples.

srl. no.	commodity group	effective size of family type							
		assuming $d_o = 1$				using $d_o = 0.503$			
		C	C+1	C+2	C+3	C	C+1	C+2	C+3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	housing	1.00	1.29	1.55	1.79	1.000	1.108	1.193	1.262
2.	fuel, light and power	1.00	1.21	1.38	1.53	1.000	1.140	1.251	1.345
3.	total food	1.00	1.41	1.80	2.17	1.000	1.271	1.506	1.718
4.	alcoholic drink	1.00	1.35	1.68	1.98	1.000	1.047	1.081	1.109
5.	tobacco	1.00	1.37	1.70	2.02	1.000	1.168	1.303	1.420
6.	clothing & footwear	1.00	1.77	2.65	3.63	1.000	1.355	1.683	1.988
7.	household durables	1.00	1.57	2.16	2.76	1.000	1.143	1.256	1.351
8.	other goods	1.00	1.55	2.10	2.67	1.000	1.266	1.500	1.706
9.	transport	1.00	1.83	2.81	3.92	1.000	1.256	1.476	1.675
10.	entertainment	1.00	1.66	2.37	3.13	1.000	1.215	1.396	1.554
11.	essential services	1.00	1.62	2.27	2.96	1.000	1.167	1.302	1.418
12.	other services	1.00	2.20	3.86	5.97	1.000	1.417	1.815	2.198
13.	total expenditure	1.00	1.50	2.00	2.50	1.000	1.226	1.417	1.585

Chapter III

Effect of Household Size On Household Consumption in India - I

3.1 Introduction:

Frequently in analyses of consumer behaviour it is postulated that a household's consumption of a specific commodity (y) is a linear homogeneous function of its income/total expenditure (x) and its size (n). This 'homogeneity hypothesis' (Prais and Houthakker, 1955, Chap. 10) may prove to be inadequate in situations where the households investigated show wide variation in respect of size. It is generally believed that there exist economies of scale in household consumption that enable a larger household to maintain a given standard of living with a relatively low per capita total consumer expenditure. This may be possible due to economies in purchase, storage, preparation and consumption (*vide* Prais and Houthakker, op. cit). This suggests that the usual 'per capita formulation'

$$\frac{y}{n} = f\left(\frac{x}{n}\right) \qquad \ldots \qquad (3.1.1)$$

that follows from the 'homogeneity hypothesis' would no longer be appropriate. In fact, the engel elasticity estimated from such a specification would in general be biased if there are appreciable economies of scale in household consumption. Hence the need for bringing in household size as an explicit factor for explaining variation in household consumption pattern.

The simplest approach towards studying the effect of household size on consumption and for examining the existence of economies of scale is to specify a constant elasticity engel curve

$$y = \alpha x^{\beta} n^{\gamma}$$

i.e., $\log y = \alpha' + \beta \log x + \gamma \log n$ ... (3.1.2)

where $\alpha' = \log \alpha$. An alternative formulation which is equivalent to the above is

$$\log (\frac{y}{n}) = \alpha + \beta \log (\frac{x}{n}) + \gamma \log n \quad \text{... (3.1.3)}$$

Here α, β and γ are the behavioural parameters in different functions (Houthakker, 1957; Crockett, 1960; Crockett and Friend, 1960)[1]. In (3.1.2) $\beta + \gamma < 1$ indicates existence of economies of scale. Similarly, in (3.1.3), such economies are indicated by $\gamma < 0$. The constant elasticity form (3.1.2), though convenient due to its simplicity, may prove to be unrealistic. This is so because for many necessary items, such as cereals, the constant elasticity specification may be worse than alternative forms like the semilogarithmic, i.e., $y = \alpha + \beta \log x + \gamma \log n$ (*vide* Landsberger, 1965). The former would also be relatively difficult to handle in case there are zero observations on y in the sample.

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[1] Crockett (1960), in a study of food expenditure pattern based on U.S. data, arrived at (3.1.2) by first setting up $\log y = \alpha_n + \beta_n \log$ separately for each n, then demonstrating the homogeneity of β_n's for different values of n, and finally, showing the linearity of α_n and log n. Frequently, however, form (3.1.2) or (3.1.3) is used without such careful examination.

In most engel curve analyses carried out on Indian data the per capita formulation' (3.1.1) has been used. Only a few attempts have been made to incorporate household size explicitly in the engel curve.

Iyengar, Jain and Srinivasan (1969) fitted (3.1.2) to ungrouped budget data from the NSS 17th Round (Sept. 1961 - July 1962) for two states, Madras and Uttar Pradesh (*vide* Chap. 1, Sec. 7.4 *supra*). It was seen that for both the states economies of scale were appreciable for such items as cereals and fuel and light. Gupta (1968, 1969) also used the NSS 17th Round budget data for the states of Madras and Uttar Pradesh to examine the nature of economies of scale in household consumption of ten commodity-groups (besides a number of individual items). Fitting (3.1.2) to ungrouped data on each of the items/itemgroups, he observed that the estimated $\beta + \gamma$ was often significantly below unity for essential items (*vide* Chap. 1 Sec.7.4 *supra*). Finally, Singh (1968, 1972) examined the extent of economies of scale present in the household consumption pattern of rural and urban Western Uttar Pradesh. In this study, based on ungrouped NSS 15th Round (July 1959 - June 1960) budget data, Singh employed an iterative procedure of estimating economies of scale (*vide* Chap. 4 *infra*). However, the results were in most cases not satisfactory probably due to the small size of the samples.

The empirical studies mentioned above relate to particular regions (and groups of households) and in all the cases sample sizes were quite small. Furthermore, everywhere the constant elasticity form was used irrespective of the nature of the item. Another important limitation of these studies based on ungrouped data is the omission of sample households reporting zero item expenditure. Insofar as the proportion of such zero cases was correlated to the level of living, the estimated elasticities were biased for items for which zero specific expenditure was quite frequent.

The present study attempts to examine the effect of household size on consumer expenditure pattern of Indian households. As yet no attempt has been made to examine the nature of economies of scale at the national level, and the 'per capita formulation' is used for estimating the item-wise engel elasticities at the national level. We have used the all-India estimates of expenditure on (i) cereals and cereal products, (ii) meat, fish and egg, (iii) milk products[2/], and (iv) fuel and light obtained from the 18th Round NSS (Feb. 1963 - Jan. 1964), and tried to estimate the underlying scale effects (for the rural and urban sectors separately) by different methods.

The present chapter, apart from describing the consumer expenditure data used, sets out the preliminary empirical results. Section 3 compares some alternative forms of engel curves, viz., double-logarithmic (DL), semilogarithmic (SL), log-inverse (LI) and log-log-inverse (LLI), fitted for each item separately for households of different size in the

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[2/] Liquid milk had been excluded owing to inadvertence at the stage of tabulation (*vide* Goel, 1968).

rural and the urban sector of the country as a whole. In Sections 4-6 we report some results based on the fitted DL curves[3]. First, in Section 4, an examination is made of the relationship between the engel-elasticities for different items and household size. Some preliminary results are then given (in Section 5) on the extent of economies of scale for different items. Finally, in Section 6 we make a comparison of the DL engel elasticities for different items estimated from the usual 'per capita formulation', those estimated from the specification (3.1.3) and lastly those estimated as weighted averages of household-sizewise elasticities.

In Chapter 4, first of all, we have reviewed breifly the methods of estimation of economies of scale due to Prais and Houthakker (195 Chap. 10) and Singh (1968, 1972). Next, we have set out two methods of estimating the scale coefficients (based on Prais and Houthakker's formulation). Finally, these methods are applied to Indian budget data from the NSS.

Precisely, our first method is based on the following formulation of the engel curves

$$\frac{y_i}{n^{\theta_i}} = f_i\left(\frac{x}{n^{\theta_o}}\right), \quad \theta_i, \theta_o \neq 1 \text{ necessarily} \qquad (3.1.4)$$

where y_i is household expenditure on commodity i and x is household total expenditure/income. Here $(1 - \theta_i)$ and $(1 - \theta_o)$ represents the

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[3] Chaudhuri (1970) analysed household size-wise DL curves using these data. In fact, we have extended her results and these may be treated as introductory to the next chapter.

specific effect for each commodity and the overall/income effect of economies of scale respectively. It is shown that if the algebraic form of (3.1.4) is SL, LI, LLI, linear or hyperbolic, then θ_i and θ_o can, in principle, be estimated by studying the shifts in the parameters of the engel curves for different household sizes. The essential idea is to fit engel curves of the same form separately for each household size and then to estimate θ_i and θ_o by relating the shifts in the parameters of the engel curve to changes in household size. Actually, the empirical results reported in Chapter 4 are based on SL, LI and LLI engel curves.

The second method is essentially due to Nicholson (1964), but a careful application of the basic idea has been made is Chapter 4. Taking the engel ratio for food as a perfect indicator of the standard of living of a household[4], Nicholson estimated a family equivalence scale by comparing the levels of income required by households of different sizes for attaining a given standard of living. We have used this idea to estimate the scale coefficient θ_o, which, however, is assumed to equal θ_i for all food.

3.2 Material analysed:

As mentioned earlier, the present analysis is based on budget data from the 18th Round of the NSS (Feb. 1963 - Jan. 1964) covering the whole of rural and urban India. The budgets were collected by

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[4] This implies that the specific scale coefficient (θ_i) for food equals the overall scale coefficient (θ_o).

interview method from a probability sample of households over the whole country. For each sector, the sample design was stratified, multistage, with provision of four independent interpenetrating subsamples, which were grouped into two independent and interpenetrating half-samples.

Data on household consumption expenditures on (i) cereals and cereal substitutes, (ii) meat, fish and egg, (iii) milk products – liquid milk had been left out by inadvertence — and (iv) fuel and light, were cross-classified by household size and level of per capita monthly total expenditure (Goel, 1968). The tables used show average per capita expenditure on each of these four items (as well as on all items of the household budget) along with estimated population, separately for 12 intervals of per capita monthly total expenditure and separately for household sizes n = 1, 2, ..., 10 and 11 and above.[5/] All these estimates were available for each of the two half-samples of the NSS sample as also for the combined sample.

The size distribution of sample households was as follows :

sector	household size (n)											
	1	2	3	4	5	6	7	8	9	10	≥11	all
rural	1436	2039	2608	3389	3459	2848	2114	1391	811	478	1283	21776
urban	766	406	409	590	501	512	361	259	172	105	166	4337

Households with 11 or more members have been left out because of the opendedness of this class. In terms of estimated population, this

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[5/] In the NSS household budget enquiries household size is defined as the number of persons who stayed in the household and participated in the common kitchen for a period of 16 days or more during the reference period of last 30 days preceding the date of enquiry.

excludes about 11 and 9.5 per cent, respectively of the rural and urban population of the country.

Nicholson's method was applied to the household-sizewise food expenditure data available from NSS 19th Round (July 1964 - June 1965). Combined sample estimates of average per capita monthly food expenditure and total consumer expenditure, cross-classified by level of per capita total consumer expenditure and household size, are available separately for rural and urban households in India (vide, NSS Report No.20, 1969)[6]. The available tables use nine size classes of households, viz., households with 1, 2, ..., 8 members and those with 9 or more members. For our analysis, seven of these classes were chosen; single-member households as well as those with $n \geq 9$ were left out. The former households were omitted in view of the peculiar behavioural patterns of single-member households, and the latter, because of the openendedness of the size class. The relevant distributions of sample households by size were as follows :

sector	household size (n)									
	1	2	3	4	5	6	7	8	9	all
rural	446	705	569	1163	1185	1071	745	531	788	9503
urban	945	449	528	609	619	591	442	298	537	5018

In this case 27 and 30 per cent, respectively, of the estimated population of rural and urban sector of India are left out as a result of omitting the two extreme classes of household size.

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[6] Since household-sizewise data on food expenditure could not be obtained from NSS 18th Round, we have utilized this NSS 19th Round material. However, even for this half-samplewise estimates were not available. That is why Nicholson's method is applied only to the combined sample estimates of food expenditure.

Finally, it should be mentioned that the NSS 19th Round estimates of food expenditure used in this application of Nicholson's idea were built up from estimates of expenditure on such food items as cereals, cereals substitutes, and pulses and their products, milk and milk products, meat, fish and egg, sugar, salt etc. The items that were left out include fruits and vegetables, spices, cooked meals etc., as information about these items were not readily available from the existing tabulations.

3.3 Itemwise engel curves by household size :

Using NSS 18th Round data for each item (viz., cereals and cereal substitutes, meat, fish and egg, milk products and fuel and light) four forms of engel curve, viz., SL, DL, LI and LLI, were fitted separately for each household size, each sector, and each sample (half-sample or combined). In each case, the weighted least squares method was followed for estimating the parameters, taking as weights the estimated population in different intervals of per capita total expenditure.

The adjusted coefficient of determination ($\bar{R}^2$) was used for comparing the goodness of fit of alternative forms of the engel curve.[1] Table 3.1 presents the values of $\bar{R}^2$ for the curves fitted for different items separately by household size and for the rural and urban sectors. These values relate to the fits obtained for combined sample data. Comparison of $\bar{R}^2$'s for different forms suggests that, in general, LLI gives the best fit for all the items in both the sectors. For the rural sector, for cereals and cereal substitutes, the SL appears to be as

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[1] It is clear that a straightforward application of $\bar{R}^2$ is not useful for comparing the SL with other forms since in SL the regressand is while in other forms it is log y_i. Goldberger's technique of comparing the correlation between the observed and expected y_i from different forms would have been much more pertinent here.

food as LLI, followed by LI and DL. Again, while expenditures on fuel and light and milk products are best explained by LLI, DL seems to be a close contender. Interestingly, SL gives satisfactory fit for the smaller households sizes but not for the larger ones. On the whole, LI proves to be least satisfactory. However, for meat, fish and egg, DL, SL and LI all prove to be equally good.

Table 3.1 : Adjusted coefficients of determination ($\bar{R}^2$) for different forms of engel curve fitted to NSS 18th Round data, separately by household size : all-India rural and all-India urban, combined sample.

household size	rural India				urban India			
	DL	SL	LI	LLI	DL	SL	LI	LLI
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(a) cereals and cereal substitutes				
1	0.786	0.979	0.984	0.989	0.013	0.010	0.509	0.685
2	0.935	0.984	0.910	0.966	0.792	0.866	0.797	0.855
3	0.871	0.949	0.976	0.984	0.665	0.866	0.926	0.966
4	0.971	0.970	0.914	0.989	0.674	0.680	0.879	0.868
5	0.943	0.989	0.974	0.993	0.707	0.812	0.962	0.957
6	0.948	0.982	0.956	0.985	0.452	0.456	0.777	0.848
7	0.956	0.970	0.935	0.979	0.615	0.740	0.963	0.969
8	0.959	0.938	0.915	0.976	0.962	0.970	0.894	0.969
9	0.905	0.943	0.941	0.954	0.571	0.600	0.735	0.710
10	0.940	0.929	0.801	0.936	0.815	0.940	0.908	0.979

contd....

Table 3.1 (contd.)

household size	rural India				urban India			
	DL	SL	LI	LLI	DL	SL	LI	LLI
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(b) meat, fish and egg				
1	0.941	0.888	0.893	0.955	0.800	0.920	0.800	0.818
2	0.913	0.900	0.907	0.951	0.843	0.834	0.962	0.972
3	0.886	0.923	0.826	0.895	0.867	0.861	0.633	0.844
4	0.940	0.907	0.876	0.950	0.839	0.793	0.559	0.856
5	0.931	0.925	0.924	0.956	0.842	0.905	0.938	0.966
6	0.900	0.913	0.955	0.962	0.756	0.790	0.907	0.896
7	0.916	0.809	0.925	0.950	0.504	0.548	0.592	0.548
8	0.907	0.809	0.855	0.912	0.723	0.866	0.898	0.890
9	0.864	0.613	0.812	0.861	0.803	0.849	0.883	0.873
10	0.925	0.843	0.937	0.978	0.859	0.706	0.535	0.846
				(c) milk products				
1	0.865	0.837	0.566	0.855	0.899	0.956	0.515	0.929
2	0.773	0.711	0.427	0.855	0.729	0.849	0.632	0.710
3	0.891	0.832	0.732	0.879	0.804	0.698	0.126	0.883
4	0.716	0.682	0.525	0.697	0.819	0.748	0.615	0.804
5	0.859	0.738	0.655	0.867	0.737	0.677	0.313	0.807
6	0.946	0.794	0.835	0.940	0.749	0.806	0.782	0.776
7	0.915	0.671	0.700	0.927	0.808	0.806	0.973	0.969
8	0.926	0.777	0.725	0.928	0.867	0.726	0.773	0.856
9	0.931	0.866	0.882	0.938	0.760	0.721	0.590	0.738
10	0.790	0.680	0.533	0.793	0.326	0.531	0.325	0.277

contd......

Table 3.1 (contd.)

household size	rural India				urban India			
	DL	SL	LI	LLI	DL	SL	LI	LLI
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(d) fuel and light				
1	0.911	0.960	0.864	0.956	0.780	0.770	0.240	0.779
2	0.937	0.899	0.805	0.934	0.912	0.903	0.772	0.929
3	0.949	0.956	0.844	0.952	0.948	0.850	0.415	0.944
4	0.988	0.957	0.854	0.989	0.943	0.943	0.750	0.936
5	0.969	0.707	0.802	0.971	0.954	0.866	0.658	0.950
6	0.985	0.934	0.875	0.984	0.940	0.927	0.819	0.925
7	0.898	0.432	0.644	0.932	0.898	0.585	0.463	0.950
8	0.930	0.610	0.646	0.976	0.885	0.885	0.857	0.896
9	0.958	0.886	0.808	0.954	0.855	0.793	0.667	0.844
10	0.979	0.856	0.739	0.982	0.740	0.804	0.915	0.951

For the urban sector, expenditure on cereals and cereal substitutes by different household sizes are best explained by LLI, and LI is closest to LLI. DL and SL are clearly worse in this case. For fuel and light and milk products DL and LLI appear to be about equally good, while SL is less satisfactory and LI is the worst. For meat, fish and egg, however, LI comes closest to LLI and SL and DL are less satisfactory.

3.4 Results based on DL form[8]:

Table 3.2 shows the combined sample estimates of elasticities by household size and item based on DL curves (along with the corresponding elasticities obtained from LLI curves at the mean level of per capita total expenditure for each household size).

The elasticities based on DL curve suggest that for cereals and cereal substitutes in rural India the elasticity rises with household size upto n=4 and then falls gradually for larger n. In no other case, such a tendency for the engel elasticity to vary systematically with n is evident.

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[8] We wish to acknowledge Chaudhuri (1970) who obtained the results reported in this section using the same set of NSS 18th Round estimates. The results discussed in Sections 3.5 and 3.6 are also extensions of Chaudhuri's study. These discussions based on DL forms are worthwhile since for most of the items considered in the present study the DL form performed quite satisfactorily.

Table 3.2 : Engel elasticities estimated from LLI and DL engel curves separately by each household size, based on NSS 18th Round data : all-India rural and all-India urban, combined sample*.

house-hold size	cereals & substitutes		meat & fish and egg		milk products		fuel and light		average total consumer expenditure/ person/30 da (Rs.)
	LLI	DL	LLI	DL	LLI	DL	LLI	DL	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(1
				(a) rural India					
1	0.331	0.475	1.347	1.489	2.010	1.926	0.483	0.588	38.84
2	0.481	0.533	1.351	1.520	2.145	1.824	0.602	0.620	29.35
3	0.440	0.504	1.082	1.138	1.822	1.829	0.545	0.562	26.01
4	0.447	0.591	1.113	1.181	1.812	1.719	0.625	0.637	22.59
5	0.532	0.590	1.151	1.251	2.056	1.918	0.740	0.719	20.52
6	0.539	0.551	1.108	1.242	2.044	2.064	0.629	0.637	19.92
7	0.495	0.537	1.171	1.296	1.946	1.822	0.827	0.752	19.61
8	0.535	0.569	1.073	1.134	1.728	1.659	0.734	0.688	20.47
9	0.476	0.531	1.090	1.143	1.731	1.823	0.609	0.601	21.00
10	0.477	0.491	1.262	1.404	1.483	1.386	0.702	0.682	20.35
				(b) urban India					
1		0.120	1.220	1.523	2.014	1.714	0.401	0.357	63.05
2	0.305	0.394	1.280	1.856	2.081	2.280	0.660	0.750	45.25
3	0.235	0.425	1.110	1.127	2.055	1.680	0.698	0.684	38.19
4	0.223	0.302	1.616	1.479	1.671	1.612	0.587	0.583	29.49
5	0.188	0.329	1.814	1.132	1.687	1.350	0.714	0.696	32.19
6	0.153	0.210	0.854	0.991	1.515	1.628	0.666	0.678	28.37
7	0.224	0.494	0.642	1.213	1.566	2.194	1.002	0.846	27.27
8	0.357	0.377	1.004	1.319	2.068	2.126	0.589	0.639	25.00
9	0.242	0.326	1.174	1.379	1.637	1.577	0.769	0.743	26.05
10	0.339	0.514	1.106	1.147	0.782	0.909	0.506	0.852	29.37

* For the LLI curves, the elasticities were computed at the average of per capita total consumer expenditure presented in col. (10).

Chaudhuri (1970) examined the significance of such trends in detail through ANOVA and also through Spearman's rank correlation coefficient between the combined sample estimate of elasticity based on DL curve, on the one hand, and household size n, on the other, separately for each item and each sector.

As graphical examination revealed some peculiarities of the engel curves for single-member households, both the significance-tests were carried out once including household size 1 and again excluding this particular size class of households. Table 3.3 reproduces Chaudhuri's results based on the Spearman rank correlation coefficient. It must be mentioned that this test based on rank correlation indicates whether there is any monotonic relationship between the two variables and it fails to detect other types of pattern.

Table 3.3 : Spearman's rank correlation coefficient between the combined sample estimate elasticity based on DL engel curve and household size*.

item	including household size 1		excluding household size 1	
	rural India	urban India	rural India	urban India
(1)	(2)	(3)	(4)	(5)
1. cereals and cereal substitutes	0.079 (0.838)	0.394 (0.264)	-0267 (0.494)	0.167 (0.678)
2. meat, fish and egg	-0.333 (0.348)	-0.345 (0.330)	-0.100 (0.810)	-0.117 (0.776)
3. milk products	-0.600 (0.074)	-0.455 (0.192)	-0.533 (0.148)	-0.483 (0.197)
4. fuel and light	0.539 (0.114)	0.503 (0.144)	0.400 (0.292)	0.317 (0.410)

* Figures in parentheses are the probabilities of deviations from zero numerically greater than or equal to those observed.

The only result which approaches significance at 5 per cent level is the negative rank correlation for milk products in rural India when single-member households are included. This indicates that the elasticities do not show any monotonically rising or monotonically falling trend as n increases for any of the item in either sector.

Chaudhuri (1970) also applied the ANOVA to test, for each item, the homogeneity of the household-sizewise estimates of elasticities based on DL curves. For the purpose of carrying out this test, the half-samplewise elasticities for different household size were used as the primary observations, and 'half-sample' was treated as another factor contributing to the variation of the elasticities.

Table 3.4 : Values of F for anova tests applied to half-samplewise and household sizewise estimates of engel elasticities based on DL curves, for examining the significance of between household size and between halfsample variations of engel elasticity : NSS 18th Round, all-India rural and urban.

item	including household size 1				excluding household size 1			
	rural		urban		rural		urban	
	hh size (9,9)@	half-sample (1,9)	hh size (9,9)	half-sample (1,9)	hh size (8,9)	half-sample (1,9)	hh size (8,9)	half-sample (1,9)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. cereals and cereal substitute	5.81*	16.55*	0.94	1.45	4.81*	12.83*	1.00	1.89
2. meat, fish and egg	2.55+	7.21*	3.49*	2.74	3.72*	6.69*	1.17	4.78*
3. milk products	1.23	1.96	2.97+	1.51	1.15	1.72	2.79+	0.74
4. fuel & light	1.14	5.11*	0.34	0.49	1.30	6.85*	0.34	0.43

@ indicates degree of freedom.

* denotes significance at 5 per cent level.

\+ denotes significance at 10 per cent level.

Table 3.4 presents the results of ANOVA (vide Chaudhuri, 1970). It is interesting to note that for household size F is significant at 5 per cent level for cereals and cereal substitutes in rural India and for meat, fish and egg in both the sectors. For meat, fish and egg in the urban sector the elasticity of single member households is solely responsible for the significant result. The only other case where F exceeds the 10 per cent level is for milk products in the urban sector. It must be noted here that the ANOVA ignores the ordering of the n-values and may give significant result even when the graph does not show any trend. This seems to have happened for meat, fish and egg in the rural sector and for milk products in the urban. For half-sample variations, the corresponding F's are often clearly significant pointing to the significant differences between the two half-samples of the NSS sample.

3.5 Examination of the economies of scale based on DL engel curves :

For a preliminary investigation of the economies of scale. we tried for each item and sector the formulation (3.1.3). In this formulation $\gamma < 0$ indicates the existence of economies of scale for the particular item. For each item the equation (3.1.3) was estimated through the weighted least squares method, i.e., by minimising

$$\sum_{i,n} p_{in}\left\{\log\left(\frac{y}{n}\right)_{in} - \alpha - \beta \log\left(\frac{x}{n}\right)_{in} - \gamma \log n\right\}^{2} \quad \ldots (3.5.1)$$

with respect to α, β and γ. Here p_{in} is the estimated population in the i-th class of per capita total expenditure for household size n. Table 3.5 presents the itemwise estimates of γ for the households in rural and urban India.

Table 3.5 : Estimate of γ of equation (3.1.4) for different items by half-samples based on NSS 18th Round data : All-India, rural and urban.

item	rural India			urban India		
	h.s.1	h.s.2	comb.	h.s.1	h.s.2	comb.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. cereals and cereal substitutes	-0.048	-0.04	-0.046	0.088	0.033	0.053
2. meat, fish and egg	0.031	0.118	0.037	0.498	0.167	0.267
3. milk products	0.449	0.514	0.424	0.166	0.397	0.291
4. fuel and light	-0.301	-0.317	-0.299	-0.121	-0.009	-0.054

It is clear that for rural households there are economies of scale for cereals and cereal substitutes and fuel and light. However. γ for cereals and cereal substitutes is close to zero indicating that the extent of economies is small. For urban households, only fuel and light indicate slight economies of scale. For milk products in both sector γ is positive and quite large in magnitude indicating diseconomies of scale for this item (such results were also found by Prais and Houthakker and explained by shifts in preferences with increasing n). This is true for meat, fish and egg in the urban sector, and to a very slight extent for cereals and cereal substitutes.

3.6 A comparison of engel elasticity estimated from alternative DL specifications :

In view of the fact that for some of the items considered in the present analysis economies/diseconomies of scale are seen to be quite large, it is of interest to examine the elasticities estimated from the usual per capita DL formulation.

If (3.1.3) is the correct specification the per capita formulation (3.1.1) (with the constant elasticity assumption) is a misspecification insofar as the term $\gamma \log n$ is omitted (where $\gamma \neq 0$) and subsumed in the disturbance term. The least squares estimate of the elasticity, $\hat{\beta}$, from the misspecified equation has, in fact, the expected value

$$E(\hat{\beta}) = \beta + \gamma \frac{\mathrm{Cov}(\log \frac{x}{n}, \log n)}{\mathrm{Var}(\log \frac{x}{n})} \qquad \ldots (3.6.1)$$

Since $\mathrm{Cov}(\log \frac{x}{n}, \log n) < 0$ for commodities with $\gamma < 0$, the 'per capita formulation' would overestimate the true engel elasticity, while the opposite would be true for commodities with $\gamma > 0$.

To examine this phenomenaon in actual data, we compared the estimates of constant elasticity for different items computed through three alternative routes. First of all, we estimated the elasticity from the formulation (3.1.3). The fit by weighted least squares method (vide *supra*) has already been used for examining the γ's. We then fitted the DL form of (3.1.1) again by weighted least squares method. Finally, we considered the DL formulation

$$\log (\frac{y}{n}) = \alpha_n + \beta_n \log (\frac{x}{n})$$

separately for each n, and computed the weighted average of the estimated household-sizewise constant elasticities $(\hat{\beta}_r)$, the weights being the estimated aggregate expenditures on the item by households of different sizes. Table 3.6 shows the three alternative estimates of the engel elasticity. For each item, half-samplewise and combined estimates are presented separately for the rural and urban sectors of the country.

Table 3.6 : Alternative estimates of engel elasticity for different items by half-sample based on NSS 18th Round data : all-India, rural and urban

item	type*	rural India			urban India		
		h.s.1	h.s.2	comb.	h.s.1	h.s.2	comb.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. cereals and cereal substitutes	$\hat{\beta}_1$	0.525	0.572	0.550	0.413	0.296	0.349
	$\hat{\beta}_2$	0.533	0.580	0.558	0.369	0.287	0.325
	$\hat{\beta}_3$	0.528	0.577	0.553	0.385	0.323	0.348
2. meat, fish & egg	$\hat{\beta}_1$	1.177	1.328	1.230	1.446	1.101	1.240
	$\hat{\beta}_2$	1.188	1.266	1.227	1.338	1.082	1.183
	$\hat{\beta}_3$	1.203	1.340	1.247	1.527	1.189	1.280
3. milk products	$\hat{\beta}_1$	1.830	2.012	1.836	1.448	1.725	1.699
	$\hat{\beta}_2$	1.720	1.864	1.770	1.384	1.581	1.479
	$\hat{\beta}_3$	1.920	1.984	1.824	1.576	1.825	1.743
4. fuel and light	β_1	0.665	0.607	0.660	0.706	0.661	0.685
	β_2	0.769	0.664	0.720	0.725	0.665	0.699
	β_3	0.669	0.605	0.659	0.702	0.766	0.696

* $\hat{\beta}_1$ denotes the estimate of engel elasticity based on the formulation (3.1.4), $\hat{\beta}_2$, that from the 'per capita formulation' (3.1.1) with the constant elasticity assumption, and $\hat{\beta}_3$, the weighted average of the household-sizewise estimates of constant engel elasticities.

The results confirm the conjecture made above. It can be seen that for cereals and cereal substitutes in the rural sector and for fuel and light in both the sectors the 'per capita formulation' yields elasticities which exceed the elasticities obtained from the formulation (3.1.3). (In all these cases the estimated γ are negative, indicating existence of some economies of scale.) On the other hand, for milk products in both the sectors and for meat, fish and egg in the urban sector an opposite tendency is evident. This is only to be expected since for these items the estimates of γ show some diseconomies of scale.

As regards the weighted average of the household-sizewise elasticities, it is clear that for most items the weighted average provides a good approximation to the engel elasticity based on the formulation (3.1.3).

The conclusion that emerges from the above results is essentially that if constant elasticity specification is used for matters of convenience the weighted averages of the household-sizewise engel elasticities are the best estimates and give satisfactory estimates of the engel elasticities that would be available from the specification (3.1.3).

Chapter IV

Effect of Household Size on Household Consumption in India-II

4.1 Prais-Houthakker formulation :

Prais and Houthakker (1955, Chap. 10) considered an elaborate formulation of engel curve incorporating household size (n) explicitly, viz.,

$$\frac{y_i}{n^{\theta_i}} = f_i\left(\frac{x}{n^{\theta_o}}\right),\ \theta_i,\ \theta_o \neq 1 \text{ necessarily} \qquad (4.1.1)$$

where y_i and x household expenditures on the i-th commodity and on all commodities respectively, In this form, they envisaged a specific scale effect for each individual commodity, and an overall/income effect of the economies of scale; these are measured by $(1 - \theta_i)$ and $(1 - \theta_o)$ respectively.

Two consequences of (4.1.1) are noteworthy. First, this formulation decomposes the total effect of an increase in household size on the consumption of any particular commodity into a positive specific effect and a negative income effect. In terms of elasticities, $\pi_{in} = \theta_i - \theta_o \pi_{ix}$ where π_{in} is the (partial) elasticity of y_i with respect to n and π_{ix}, the corresponding engel elasticity. Second, it may be demonstrated that θ_o is an weighted average of all the commodity-specific θ_i's where the weights are the respective engel ratios for the commodities[1].

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[1] This is easily demonstrated. The budget constraint $\sum_i y_i = x$ implies
(i) $\sum_i w_i \pi_{in} = 0$ where $w_i = \frac{y_i}{x}$ are the engel ratios, and
(ii) $\sum_i w_i \pi_{ix} = 1$. Thus from $\pi_{in} = \theta_i - \theta_o \pi_{ix}$ it follows
$0 = \sum_i w_i \pi_{in}$ which in turn implies $\theta_o = \sum_i w_i \theta_i$.

For the estimation of θ_i and θ_o from household expenditure data, Prais and Houthakker specified a DL form for (4.1.1) which then can be rewritten as

$$\frac{y_i}{n} = \alpha_i \left(\frac{x}{n}\right)^{\beta_i} n^{\gamma_i} \qquad \ldots (4.1.2)$$

where $\gamma_i = \beta_i(1 - \theta_o) - (1 - \theta_i)$ ... (4.1.3)

β_i being the constant engel elasticity in (4.1.2). Now (4.1.2) can be fitted by least squares method to obtain estimates of β_i and γ_i. Then, if θ_o is known, θ_i can be obtained from (4.1.3). Prais and Houthakker estimated θ_o by estimating the following 'quality equation'

$$P_n = C_1 + C_2 \log \left(\frac{x}{n^{\theta_o}}\right) \qquad \ldots (4.1.4)$$

Here, P_n, an index of the quality of all foodstuff consumed by a household of size n, is assumed to be influenced by the overall economies of scale and not by the specific economies. The quality variable P_n was calculated for each household as a Laspeyre's index number of the form

$$P_n = \frac{\Sigma q_o p_j}{\Sigma q_o p_o}$$

where p and q indicate, respectively, the prices and quantities of individual food items consumed and the summation extends over all food items. The suffix '0' indicates the mean value for all households and the suffix 'j', the value for a particular (the j-th) household.

The success of this method of estimation rests heavily upon the reliability of the estimates of the parameters of (4.1.4) which presupposes considerable variation of prices in the data. It may also be argued that since the 'quality equation' is developed on the basis of prices, it reflects only that part of the income economies which arise in purchases and perhaps ignores such phenomena as division of labour in household activities, substitution of domestic services for market services and so on.

Singh (1968, 1972) considered the following engel curve of constant elasticity form[2]

$$\log\left(\frac{y_i}{S_i^{\theta_i}}\right) = \alpha_i + \beta_i \log\left(\frac{x}{S_o^{\theta_o}}\right) \qquad \ldots (4.1.5)$$

where $S_i = \sum_d g_{id} n_d$ and $S_o = \sum_d g_{od} n_d$ are the adjusted household sizes measured on the specific and the overall unit consumer scales respectively (g_{id} and g_{od} being the specific and overall unit consumer coefficients for the d-th type of household member and n_d, the number of such members in the household).

If g_{id}'s and g_{od}'s are known a priori, estimation of (4.1.5) presents no difficulty. Singh, using a priori values of g_{id}'s and g_{od}'s, adopted the following iterative procedure for the estimation of θ_i and θ_o from (4.1.5). Rewriting (4.1.5) as

$$\log\left(\frac{y_i}{S_i}\right) = \alpha_i + \beta_i \log\left(\frac{x}{S_o^{\theta_o}}\right) - (1 - \theta_i) \log S_i \qquad \ldots (4.1.7)$$

it is seen that if θ_o is known, all the variables on the right hand side of (4.1.7) become measurable. The iterative method starts with an initial

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[2] This is the DL form of

$$\frac{y_i}{S_i^{\theta_i}} = f_i\left(\frac{x}{S_o^{\theta_o}}\right) \qquad \ldots (4.1.6)$$

also due to Prais and Houthakker (1955, *vide* Chap. 10). However, they did not consider this for estimation of economies of scale from household budget data.

θ_o and estimates θ_i from (4.1.7) for each i. The θ_o for the next iteration is obtained through

$$\hat{\theta}_o = \sum_i w_i \hat{\theta}_i \qquad \ldots (4.1.8)$$

where
$$w_i = \frac{\bar{g}_i \, y_i/S_i}{\sum_i \bar{g}_i \, y_i/S_i}$$

$$\bar{g}_i = \frac{1}{k} \sum_i g_{id}$$

k being the number of age-sex types[3]. The iterative process is continued until convergence is evident. Empirical results obtained through this procedure were in most of the cases quite unsatisfactory. However, this may be due to the smallness of the sample sizes to which Sinch applied this procedure.

4.2 A method of estimating economies of scale from variable elasticity engel curves :

In empirical studies of economies of scale in household consumption the use of the constant elasticity specification (4.1.2) is very common. This form, apart from being an unsuitable specification in

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[3] The restriction (4.1.8) is derived as follows : For (4.1.6) the adding-up criterion leads to

$$\theta_o = \sum_i \left[\frac{g_{id}}{g_{od}} \, \frac{y_i}{x} \, \frac{S_o}{S_i} \right] \theta_i \qquad \ldots (4.1.9)$$

Singh further asserts that for (4.1.6)

$$g_{od} = \sum_i \frac{y_i}{x} \, \frac{S_o}{S_i} \, g_{id} \qquad \ldots (4.1.10)$$

will also be true.(This, however, is not true for (4.1.6)). Combining (4.1.9) and (4.1.10)

$$\theta_o = \sum_i g_{id} \, \frac{y_i}{S_i} \theta_i \Big/ \sum g_{id} \frac{y_i}{S_i} \qquad \ldots (4.1.11)$$

Since (4.1.11) implies k restrictions on θ_o and θ_i, Singh assumes that (4.1.11) would be true for the averages, $\bar{g}_i$, as well.

many cases entails the problem of separating the specific and overall scale effects in the formulation (4.1.1). Here we propose a method of estimating the scale coefficients assuming a number of variable elasticity forms of the engel curve (4.1.1). Precisely, the essential idea is to fit engel curves of the same form for each household size and then to estimate θ_i and θ_o by relating the shifts in the parameters of the engel curve to changes in household size. However, the present method ignores the effect of variation in household composition on household consumption patterns and this leads to some relatively unsatisfactory results in the empirical applications reported in Section 4.4.

If for any commodity the engel curve specification is SL, LI, LLI, hyperbolic (HYP) or linear (L), both θ_i and θ_o of the formulation (4.1.1) can, in principle, be estimated without making any special effort like establishing a 'quality equation' as done by Prais and Houthakker (1955). The present method has the additional advantage that by examining expenditure data for a single item one would obtain estimates of θ_i and θ_o. The method in no way guarantees that the θ_o's estimated from data for different items would be the same apart from sampling errors. But if the engel curve (4.1.1) is correctly specified for each item, the θ_o's estimated for different items may be expected to be close to one another.

4.2.1 Semilogarithmic (SL) engel curves :

If the SL form be assumed in formulation (4.1.1), the engel curve is

$$\left[\frac{y_{ijn}}{n^{\theta_i}}\right] = \alpha_i + \beta_i \log \left[\frac{x_{jn}}{n^{\theta_o}}\right] + \varepsilon_{ijn} \qquad \ldots (4.2.1)$$

where y_{ijn} : expenditure on the i-th commodity by the j-th household of size n,

x_{jn} : income/total consumer expenditure of the j-th household of size n,

and ε_{ijn} : the random disturbance term.

Equation (4.2.1) may be rearranged as

$$y_{ijn} = \alpha_{in} + \beta_{in} \log x_{jn} + \varepsilon_{ijn} \qquad \ldots (4.2.2)$$

where

$$\alpha_{in} = (\alpha_i - \beta_i \theta_o \log n)\, n^{\theta_i} \qquad \ldots (4.2.3)$$

$$\beta_{in} = \beta_i \; n^{\theta_i} \qquad \ldots (4.2.4)$$

and

$$\varepsilon_{ijn} = \varepsilon_{ijn}\, n^{\theta_i} \qquad \ldots (4.2.5)$$

We make all the standard assumptions about ε_{ijn} necessary for single equation weighted least squares estimation of (4.2.2) separately for each n.

Once the estimates $\hat{\alpha}_{in}$ and $\hat{\beta}_{in}$ for different n are obtained from (4.2.2), θ_i (besides β_i) can be estimated through (4.2.4) by regressing log $\hat{\beta}_{in}$ on log n by the weighted least squares procedure[4]. The weights in this case should ideally be reciprocals of the estimated variances of log $\hat{\beta}_{in}$[5]. The estimate of θ_o is then obtained from the

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[4] Here as elsewhere $\wedge$ on a specific parameter indicates the corresponding least squares estimate.

[5] In the empirical illustrations we have approximated the variance of of log $\hat{\beta}_{in}$ by using the relation

$$\widehat{\text{Var}} \left[\log \hat{\beta}_{in}\right] = \frac{\widehat{\text{Var}} \; (\hat{\beta}_{in})}{\hat{\beta}_{in}^{\,2}}$$

where $\widehat{\text{Var}}(\hat{\beta}_{in})$ is the least squares estimate of the variance of $\hat{\beta}_{in}$.

relation

$$\frac{\alpha_{in}}{\beta_{in}} = \frac{\alpha_i}{\beta_i} - \theta_o \log n \qquad \ldots (4.2.6)$$

In other words, the regression of $(\frac{\hat{\alpha}_{in}}{\hat{\beta}_{in}})$ on log n provides the estimate of θ_o. Here also the weights for the weighted least squares estimation should be the reciprocals of the estimated variances of $(\frac{\hat{\alpha}_{in}}{\hat{\beta}_{in}})$.[6]

4.2.2 Log-inverse (LI) engel curves :

For the LI of engel relation (4.1.1) we have

$$\log \left[\frac{y_{ijn}}{n^{\theta_i}}\right] = \alpha_i + \beta_i \left[\frac{n^{\theta_o}}{x_{jn}}\right] + \varepsilon_{ijn} \qquad \ldots (4.2.7)$$

which may be written as

$$\log y_{ijn} = \alpha_{in} + \beta_{in}/x_{jn} + \varepsilon_{ijn} \qquad \ldots (4.2.8)$$

where $\alpha_{in} = \alpha_i + \theta_i \log n$ ... (4.2.9)

and $\beta_{in} = \beta_i \, n^{\theta_o}$ ... (4.2.10)

In this case too, β_{in} and β_{in} are estimated separately for e from (4.2.8) and the resulting estimates $\hat{\alpha}_{in}$ and $\hat{\beta}_{in}$ are used to yield θ_i and θ_o from (4.2.9) and (4.2.10) respectively through obvious weighted least squares technique.

4.2.3 Other forms :

Similar method can be devised for situations where the engel function is of the HYP, L or LLI form (say). For the HYP form we get

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[6] Actually, in the empirical work ordinary least squares method has been used for estimating (4.2.6). This simplification seems admissible sinc an examination of the divergence between half-samplewise estimates $(\frac{\hat{\alpha}_{in}}{\hat{\beta}_{in}})$ indicated homoscedasticity over household size for the ite

$$y_{ijn} = \alpha_{in} + \beta_{in}/x_{jn} + \varepsilon_{ijn} \qquad \ldots (4.2.11)$$

where $\alpha_{in} = \alpha_i n^{\theta_i}$, $\beta_{in} = \beta_i n^{(\theta_i + \theta_o)}$ and ε_{ijn} is the random disturbance term. Similarly for the linear form

$$y_{ijn} = \alpha_{in} + \beta_{in} x_{jn} + \varepsilon_{ijn} \qquad \ldots (4.2.12)$$

where $\alpha_{in} = \alpha_i n^{\theta_i}$ and $\beta_{in} = \beta_i n^{(\theta_i - \theta_o)}$. Finally for the LLI form we have

$$\log y_{ijn} = \alpha_{in} + \beta_{in} \log x_{jn} + \gamma_{in}/x_{jn} + \varepsilon_{ijn} \qquad \ldots (4.$$

where $\alpha_{in} = \alpha_i + (\theta_i - \beta_i \theta_o) \log n$, $\beta_{in} = \beta_i$, $\gamma_{in} = \gamma_i n^{\theta_o}$.

The empirical results obtained by using the above method for the SL and LI engel curves are in many cases satisfactory. However, for the items considered in this study comparison of different forms of itemwis engel curves for each household size indicate that LLI gives excellent fit to the data. But, by and large, the present approach did not quite succeed with this form since the movements of the estimated paramet household sizewise LLI curves failed to show the specified relationship with n.

4.3 Parameters of fitted SL and LI engel curves : graphical examination of shifts with increasing household size

The method outlined in Section 4.2 was applied to budget data f the 18th Round of the NSS (Feb. 1963- Jan. 1964) covering the whole of rural and urban India. For each sector, household-sizewise engel curves DL, SL, LI and LLI forms were fitted for cereals and cereals substitute meat, fish and egg, milk products and fuel and light (vide Chapter 3, Section 3 supra for a comparison of alternative forms of engel cur each item). Table 4.1 and 4.2 show the estimated parameters of SL and I curves by item and household size separately for the two half-samples and the combined sample for each of the sectors.

Table 4.1 : Estimated coefficients ($\hat{\alpha}_{in}$, $-\hat{\beta}_{in}$) of LI form of engel curves by household size and half-sample for rural and urban India based on NSS 10th Round data.

house-hold size	rural India						urban India					
	$\hat{\alpha}_{in}$			$-\hat{\beta}_{in}$			$\hat{\alpha}_{in}$			$-\hat{\beta}_{in}$		
	hs 1	hs 2	comb.	hs 1	hs 2	comb.	hs 1	hs 2	comb.	hs 1	hs 2	comb.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
					(a) cereals and cereal substitutes							
1	2.8	2.8	2.8	11.1	11.4	11.2	2.0	1.9	1.9	10.4	5.7	5.4
2	3.6	3.6	3.6	18.9	24.0	21.5	3.3	3.1	3.2	15.9	10.9	..
3	3.9	4.0	3.9	29.7	33.3	31.8	3.5	3.6	3.5	12.6	23.3	13.0
4	4.1	4.2	4.2	37.3	42.7	38.4	3.8	3.7	3.7	29.7	28.8	28.3
5	4.3	4.4	4.4	46.8	48.0	47.5	3.9	3.9	3.9	20.9	29.8	29.4
6	4.5	4.5	4.5	51.6	52.7	52.3	4.1	4.0	4.0	39.8	33.0	35.7
7	4.5	4.6	4.6	50.0	60.4	55.6	4.3	4.2	4.3	59.7	49.7	56.0
8	4.7	4.8	4.8	62.9	76.3	69.5	4.3	4.6	4.4	42.9	86.1	54.3
9	4.8	4.9	4.8	77.3	81.4	79.6	4.4	4.5	4.5	48.9	74.2	61.9
10	4.8	4.8	4.9	61.9	67.9	67.8	4.5	4.5	4.5	45.6	75.1	45.9
					(b) meat, fish and egg							
1	0.3	0.8	0.5	30.8	48.4	37.2	1.2	0.4	0.5	86.4	43.9	51.5
2	1.3	1.5	1.4	60.5	67.6	61.8	2.1	1.9	2.1	97.3	71.3	91.9
3	1.4	1.2	1.3	67.5	62.6	66.0	1.4	2.2	1.8	35.8	92.5	60.0
4	1.4	1.7	1.5	69.0	93.3	76.5	2.1	2.2	2.1	121.4	98.1	[illegible]
5	1.7	1.8	1.8	95.6	106.8	99.1	2.0	2.4	2.1	94.9	109.2	92.6
6	2.0	1.8	1.9	121.8	119.7	120.7	3.1	2.2	2.5	227.6	108.6	145.2
7	2.0	2.0	2.1	124.1	139.4	136.0	2.3	2.3	2.1	131.8	149.8	132.0
8	2.0	2.2	2.0	127.3	165.7	137.9	2.5	2.7	2.7	186.8	207.3	215.9
9	1.9	2.3	2.1	145.4	165.5	163.9	3.4	2.9	3.1	304.3	235.2	262.9
10	2.3	2.9	2.5	192.4	259.3	209.3	3.4	3.5	2.5	67.0	304.8	79.4

Table 4.1 (contd.)

House-hold size	rural India						urban India					
	$\hat{\alpha}_{in}$			$-\hat{\beta}_{in}$			$\hat{\alpha}_{in}$			$-\hat{\beta}_{in}$		
	hs1	hs2	comb.	hs1	hs2	comb.	hs1	hs2	comb.	hs1	hs2	comb.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
						(c) <u>milk products</u>						
1	0.8	1.5	0.9	32.2	51.5	34.0	1.0	0.7	1.1	38.5	23.8	37.9
2	1.1	1.7	1.2	50.2	86.6	57.7	2.2	2.8	2.4	94.9	121.0	100.3
3	1.8	2.3	1.9	91.4	136.9	100.3	1.0	3.2	1.1	16.2	201.3	--
4	2.1	1.8	2.0	119.2	103.1	100.5	2.3	2.2	2.3	101.2	126.9	118.2
5	2.1	2.5	2.2	121.2	166.1	135.1	1.6	2.6	2.1	22.1	122.4	73.9
6	2.6	2.8	2.7	172.6	196.4	184.6	2.3	3.5	3.3	123.5	264.6	223.8
7	2.3	3.0	2.6	138.8	234.2	169.0	3.0	3.1	3.5	212.8	225.2	291.2
8	2.8	2.8	2.8	183.5	190.5	185.7	3.9	3.1	3.5	360.5	244.4	300.5
9	2.9	3.0	3.3	370.7	217.9	262.4	2.5	3.3	3.0	170.1	263.8	239.9
10	2.6	2.7	2.7	137.5	204.3	173.2	2.2	2.7	2.7	141.0	121.7	166.2
						(d) <u>fuel and light</u>						
1	1.4	1.6	1.5	11.9	12.6	12.2	0.7	1.0	0.7	1.9	17.4	[illegible]
2	2.1	2.2	2.1	23.5	23.7	23.6	2.1	2.0	2.1	24.6	21.8	27.4
3	2.2	2.3	2.3	31.4	32.2	31.9	2.0	2.6	2.0	11.2	70.2	12.6
4	2.4	2.4	2.4	40.4	39.3	39.9	2.5	2.4	2.5	45.5	42.2	43.9
5	2.7	2.5	2.6	56.7	47.3	52.4	2.4	2.6	2.5	21.9	58.7	46.0
6	2.6	2.7	2.7	54.5	59.2	57.1	2.8	3.0	2.9	67.0	103.3	86.1
7	2.7	2.7	2.8	62.0	58.6	67.9	2.9	2.7	2.8	63.9	54.4	59.1
8	2.8	2.8	2.8	70.4	70.2	71.0	3.0	2.9	3.0	106.0	88.6	93.7
9	2.9	2.9	2.9	86.4	77.7	82.1	2.9	3.2	3.0	88.6	139.2	113.1
10	3.0	3.0	3.0	94.9	77.8	89.2	2.8	3.4	3.0	74.8	137.7	79.7

Table 4.2 : Estimated coefficients ($-\hat{\alpha}_{in}$, $\hat{\beta}_{in}$) of SL form of engel curve by household size and half-sample for rural and urban India based on NSS 18th Round data.

household size	rural India						urban India					
	$-\hat{\alpha}_{in}$			$\hat{\beta}_{in}$			$-\hat{\alpha}_{in}$			$\hat{\beta}_{in}$		
	hs 1	hs 2	comb.	hs 1	hs 2	comb.	hs 1	hs 2	comb.	hs 1	hs 2	comb.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
						(a) cereals and cereal substitutes						
1	2.1	6.0	4.0	3.8	4.9	4.4	-3.6	-6.3	-5.4	0.6	-0.1	[illegible]
2	21.1	20.5	22.2	11.4	10.9	11.6	11.4	1.4	7.3	7.4	4.8	6.3
3	25.0	34.5	30.3	13.2	15.7	14.5	6.3	3.4	5.5	7.4	6.8	7.3
4	50.8	73.7	59.5	20.3	25.6	22.4	3.7	12.7	8.0	7.6	9.4	8.5
5	64.9	71.3	68.0	24.3	25.9	25.1	13.7	2.8	10.7	11.8	8.2	10.2
6	73.1	82.8	77.0	26.9	28.8	27.6	-4.4	-0.9	-2.6	8.2	8.1	8.1
7	74.5	103.4	89.4	27.7	34.1	31.0	40.1	17.7	31.5	17.6	13.1	15.9
8	101.1	156.5	128.7	34.2	45.7	39.9	31.9	96.4	54.9	17.3	[illegible]	
9	105.9	132.2	120.2	35.5	41.0	38.4	16.5	36.7	34.0	15.6	18.7	18.3
10	132.5	98.1	135.6	42.4	34.7	42.6	74.4	65.5	66.7	27.2	23.9	24.9
						(b) meat, fish and egg						
1	1.5	2.2	1.8	0.6	0.8	0.7	1.7	2.0	1.8	0.6	0.7	0.6
2	5.3	5.1	5.3	1.7	1.6	1.7	8.7	12.6	10.4	2.6	3.6	3.1
3	6.5	4.4	5.3	1.9	1.4	1.6	10.7	10.8	11.1	3.1	3.1	3.2
4	6.3	8.6	6.7	1.9	2.4	1.9	24.3	23.8	24.1	6.1	6.1	6.1
5	7.9	8.6	8.2	2.2	2.4	2.3	10.5	13.8	11.7	2.9	3.8	3.3
6	9.7	9.7	9.6	2.6	2.5	2.5	19.9	9.6	14.6	5.0	2.8	3.8
7	11.9	13.2	12.6	3.0	3.3	3.2	14.7	14.2	13.0	3.8	3.6	3.4
8	12.2	19.1	14.3	3.1	4.5	3.5	28.1	9.6	19.8	6.4	2.8	4.7
9	15.1	27.4	15.4	3.6	6.3	3.6	36.8	27.8	33.0	8.3	6.3	7.4
10	20.1	41.3	23.0	4.6	8.9	5.2	19.1	76.7	39.7	5.4	16.1	9.3

Table 4.2 (contd.)

house-hold size	rural India						urban India					
	$-\hat{\alpha}_{in}$			$\hat{\beta}_{in}$			$-\hat{\alpha}_{in}$			$\hat{\beta}_{in}$		
	hs 1	hs 2	comb.	hs 1	hs 2	comb.	hs 1	hs 2	comb.	hs 1	hs 2	comb.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
						(c) milk products						
1	4.8	4.9	4.8	1.8	1.8	1.7	6.3	9.1	7.7	2.1	2.8	2.4
2	9.0	11.6	10.4	2.7	3.3	3.1	12.8	19.1	15.8	3.8	5.5	4.6
3	11.2	15.5	13.2	3.2	4.1	3.6	15.8	31.3	20.9	4.5	7.8	5.6
4	20.6	19.1	18.5	5.3	4.9	4.9	22.2	31.0	26.3	5.7	7.6	6.6
5	21.7	21.6	21.6	5.5	5.4	5.4	21.3	43.6	34.1	5.6	10.6	8.3
6	28.9	29.7	29.5	7.0	7.1	7.1	38.4	50.3	44.7	8.8	11.6	10.3
7	39.5	35.4	37.4	9.2	8.2	8.7	39.3	43.0	41.0	9.1	10.0	9.5
8	44.1	45.0	44.5	10.0	10.2	10.1	96.6	55.5	74.4	20.9	12.2	16.1
9	39.9	51.6	48.9	9.1	11.4	10.9	46.8	64.0	56.1	10.0	13.8	12.0
10	48.2	46.6	53.5	10.7	10.2	11.7	25.7	9.9	20.7	6.2	3.4	5.3
						(d) fuel and light						
1	2.2	2.8	2.4	1.4	1.8	1.6	-0.2	1.3	0.4	0.4	0.8	0.6
2	7.9	6.4	7.3	3.3	3.0	3.2	6.4	12.5	9.3	2.8	4.2	3.5
3	7.4	9.4	8.4	3.1	3.7	3.4	10.9	14.4	11.6	4.1	4.6	4.1
4	12.9	12.1	12.4	4.4	4.3	4.4	16.4	7.9	12.9	5.3	3.2	4.4
5	26.7	14.4	20.9	7.7	4.8	6.3	18.2	19.2	19.9	5.7	5.7	5.9
6	16.2	18.6	17.3	5.2	5.8	5.5	24.4	25.6	25.4	6.9	7.0	7.0
7	18.6	19.0	39.8	5.7	5.9	10.4	73.5	26.3	55.6	17.5	7.3	13.6
8	46.7	21.6	34.0	11.5	6.4	8.9	22.2	28.5	24.9	6.4	7.7	7.0
9	20.4	29.6	25.4	6.0	8.1	7.1	27.9	51.5	39.4	7.4	12.2	9.7
10	39.2	26.0	37.2	9.9	7.4	9.6	24.9	23.5	24.5	7.1	7.2	7.2

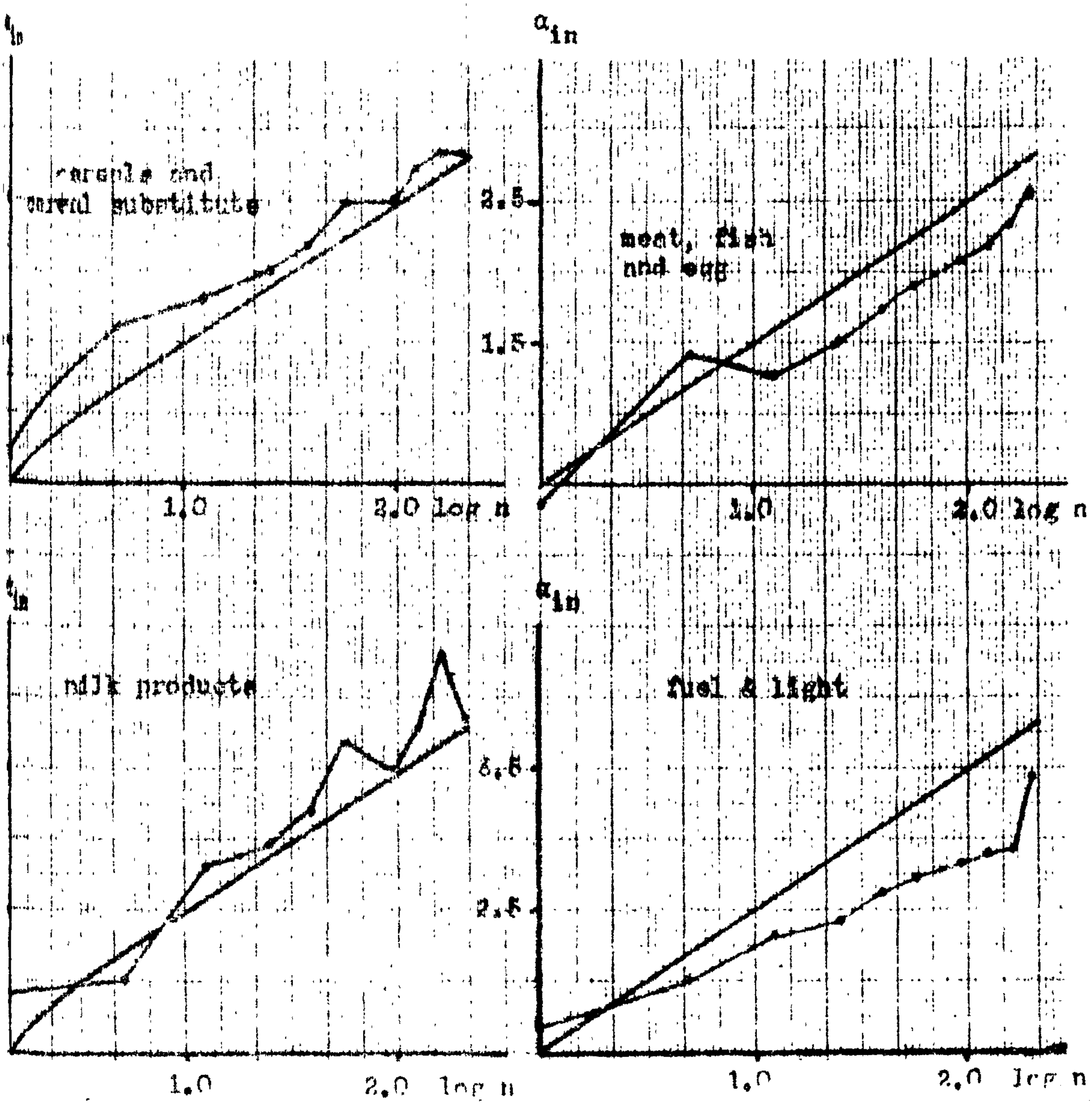

Fig.4.1 : Showing α_{in} against log n for fitted 11 engel curves by items : Combined sample, All-India rural, NSS 18th Round.

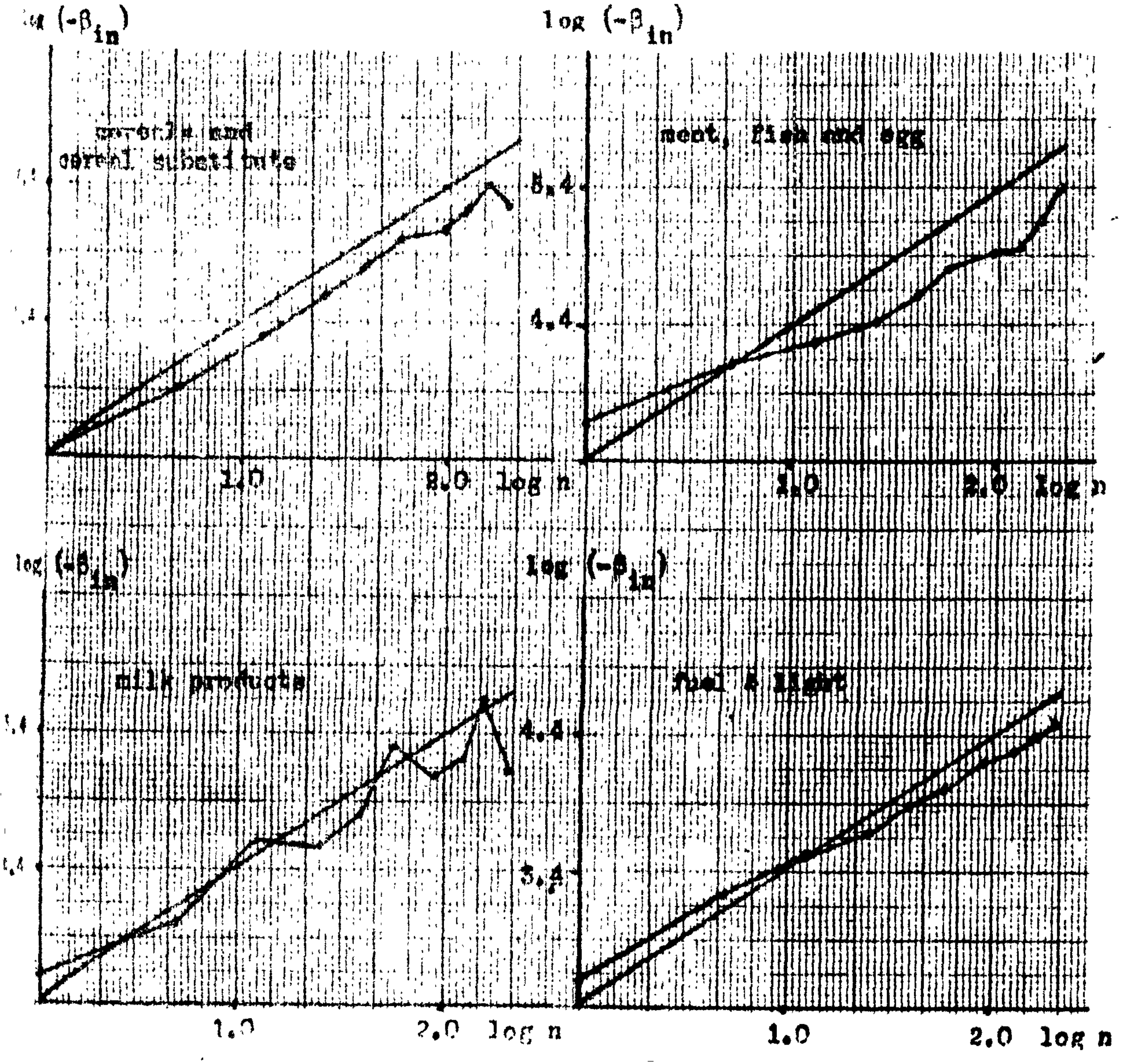

Fig.4.2 : Showing log ($-\beta_{in}$) against log n for LJ engel curves by items : Combined sample, All-India rura, NSS 18th Round.

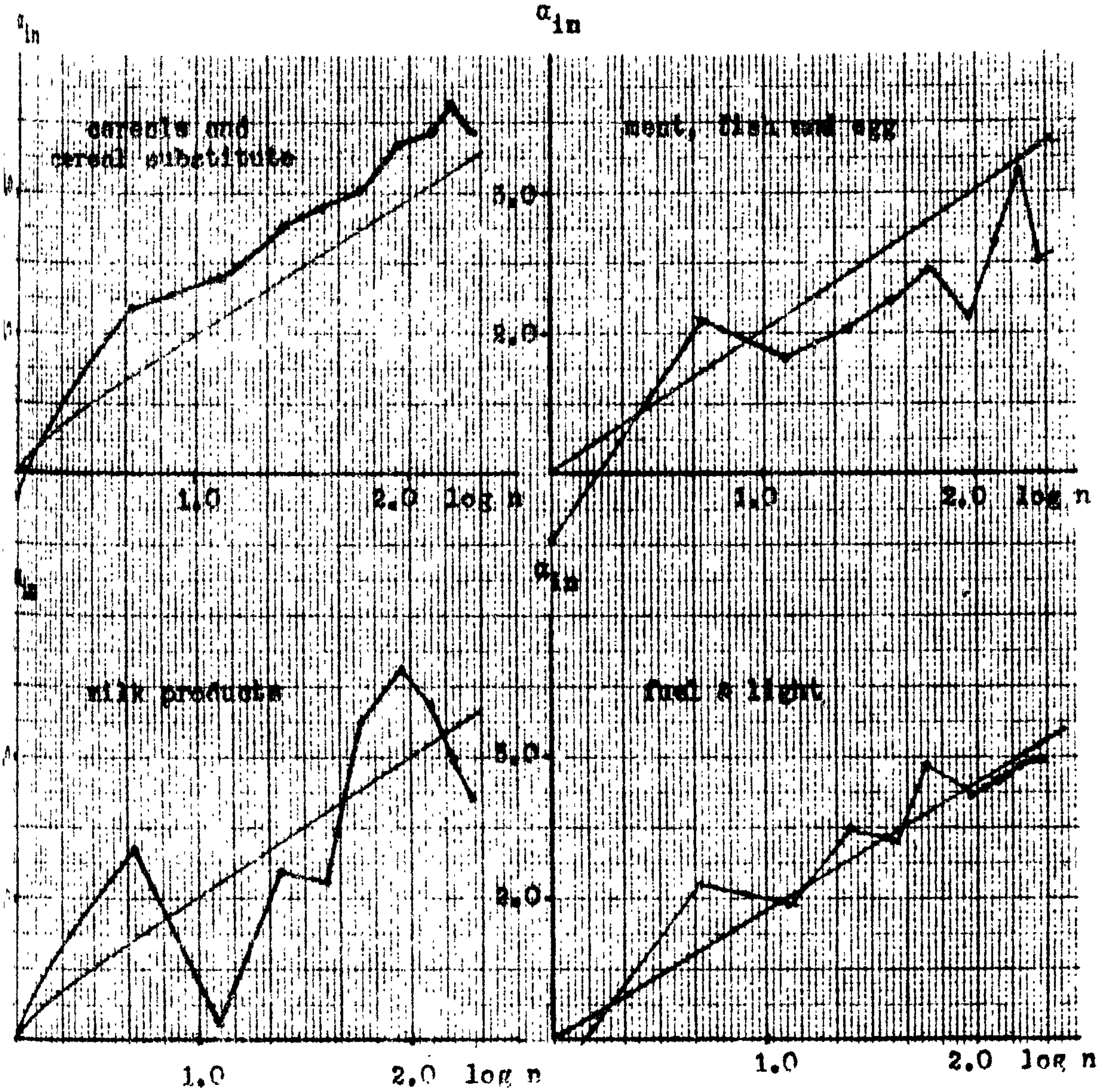

Fig.4.3 : Showing α_{in} against log n for the fitted LI engel curves by items : Combined sample, All-India urban, NSS 18th Round.

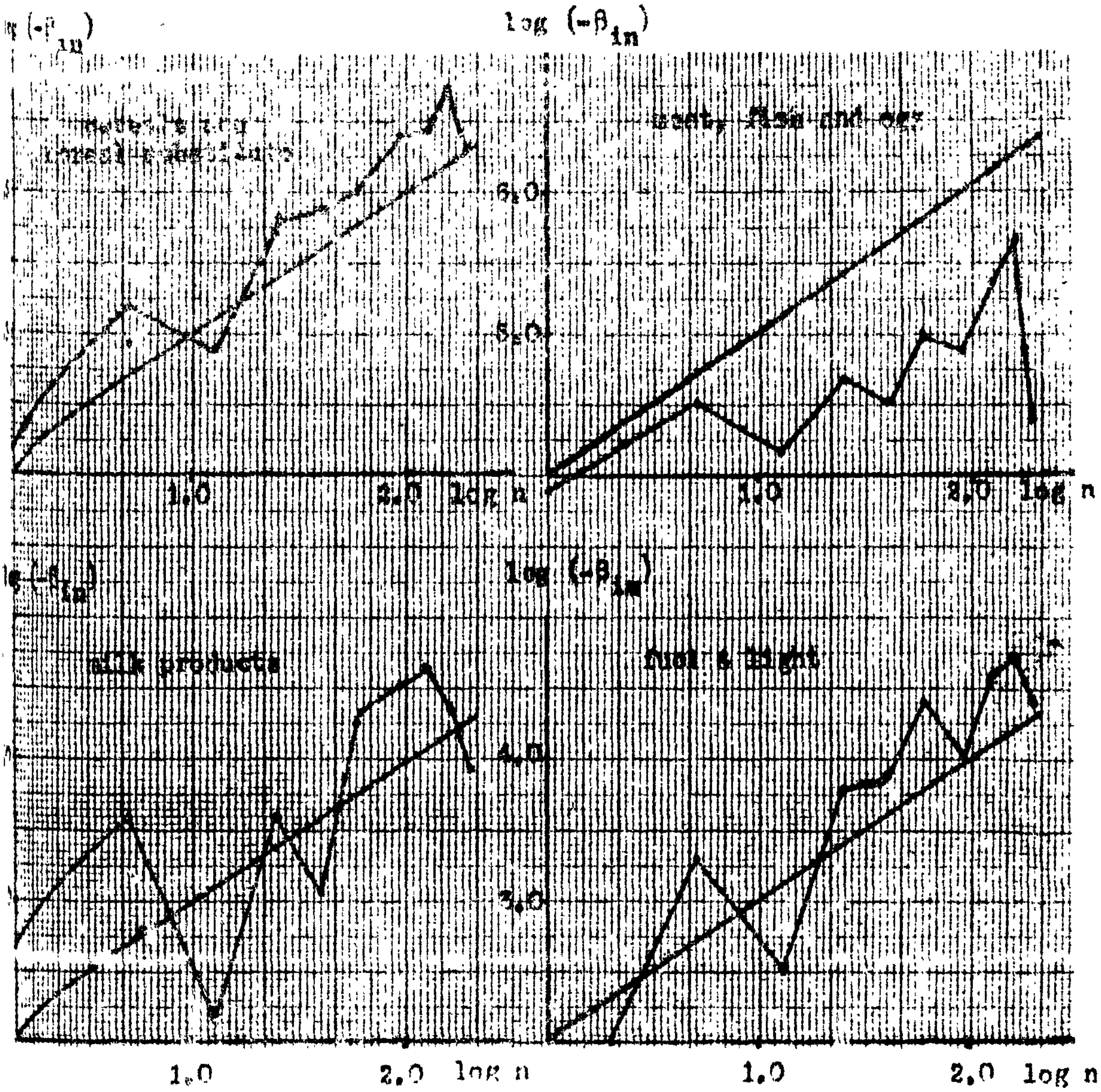

Fig.4.4 : Showing log $(-\beta_{in})$ against log n for the fitted LI engel curves by items : Combined sample, All-India urban, NSS 18th Round.

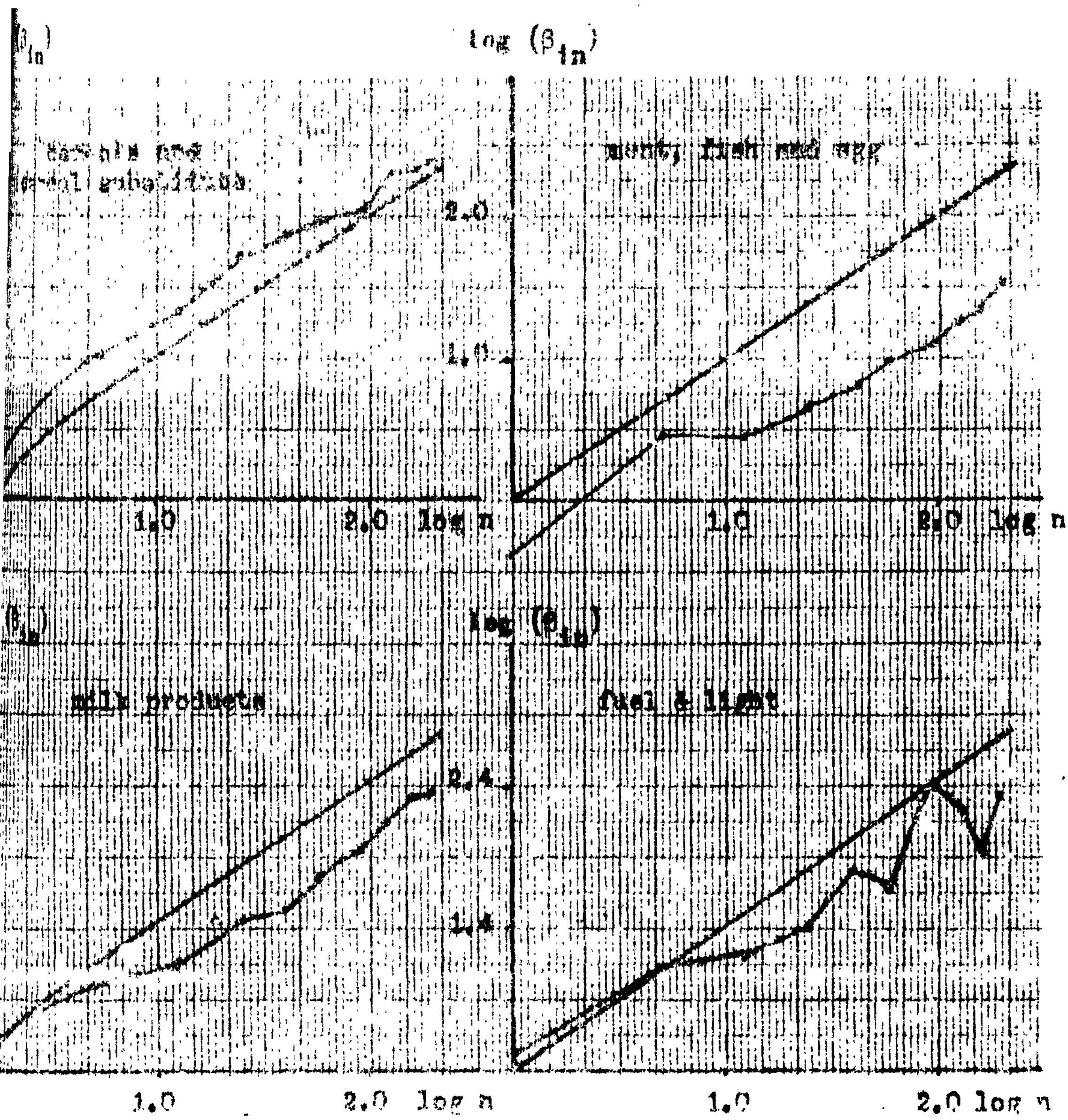

Fig.4.5 : Showing log(β_{in}) against log n for the fitted SL engel curves by items : Combined sample, All-India rural, NSS 18th Round.

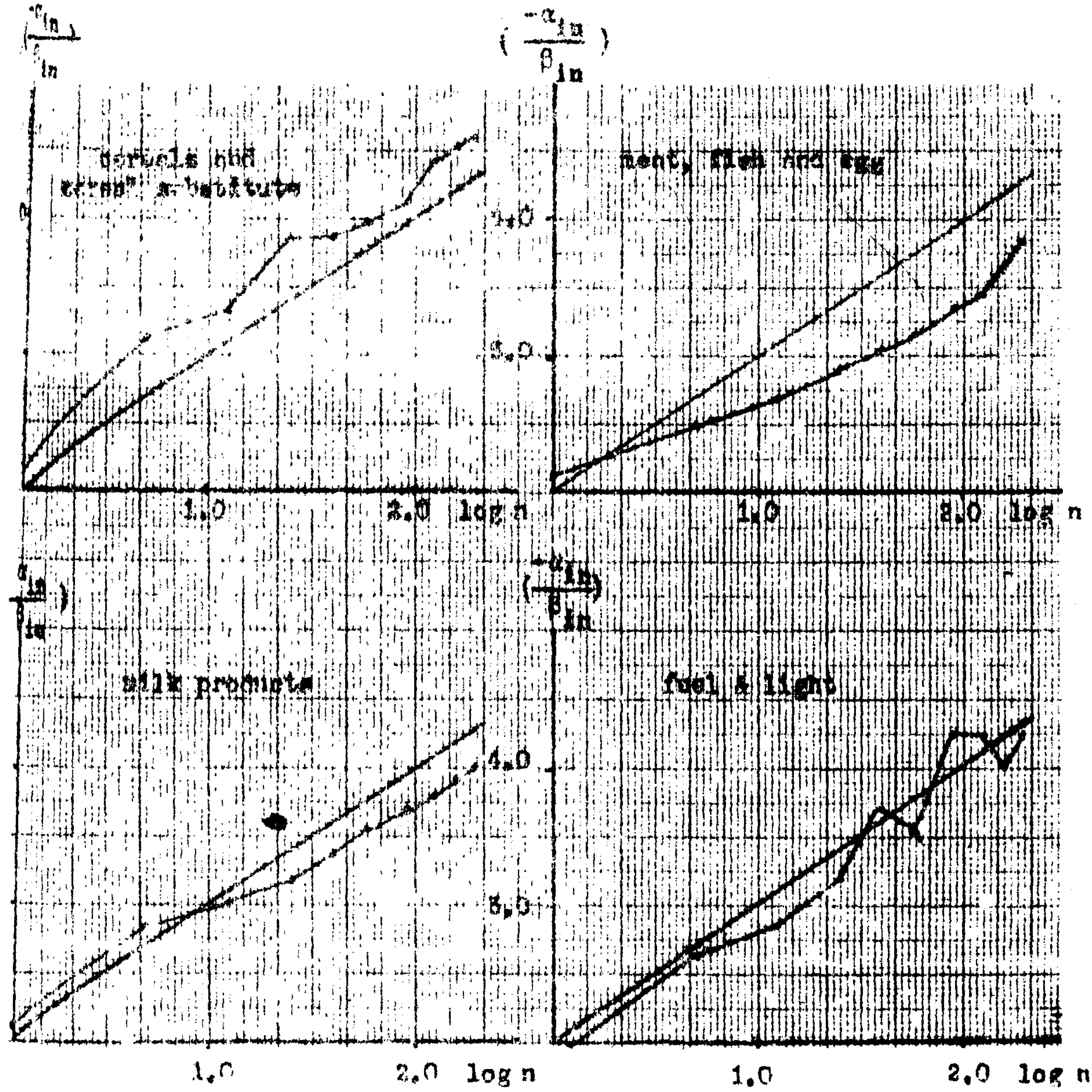

Fig.4.6 : Showing $(\frac{-\alpha_{in}}{\beta_{in}})$ against log n for the fitted SL engel curves by items : Combined sample, All-India rural, NSS 18th Round.

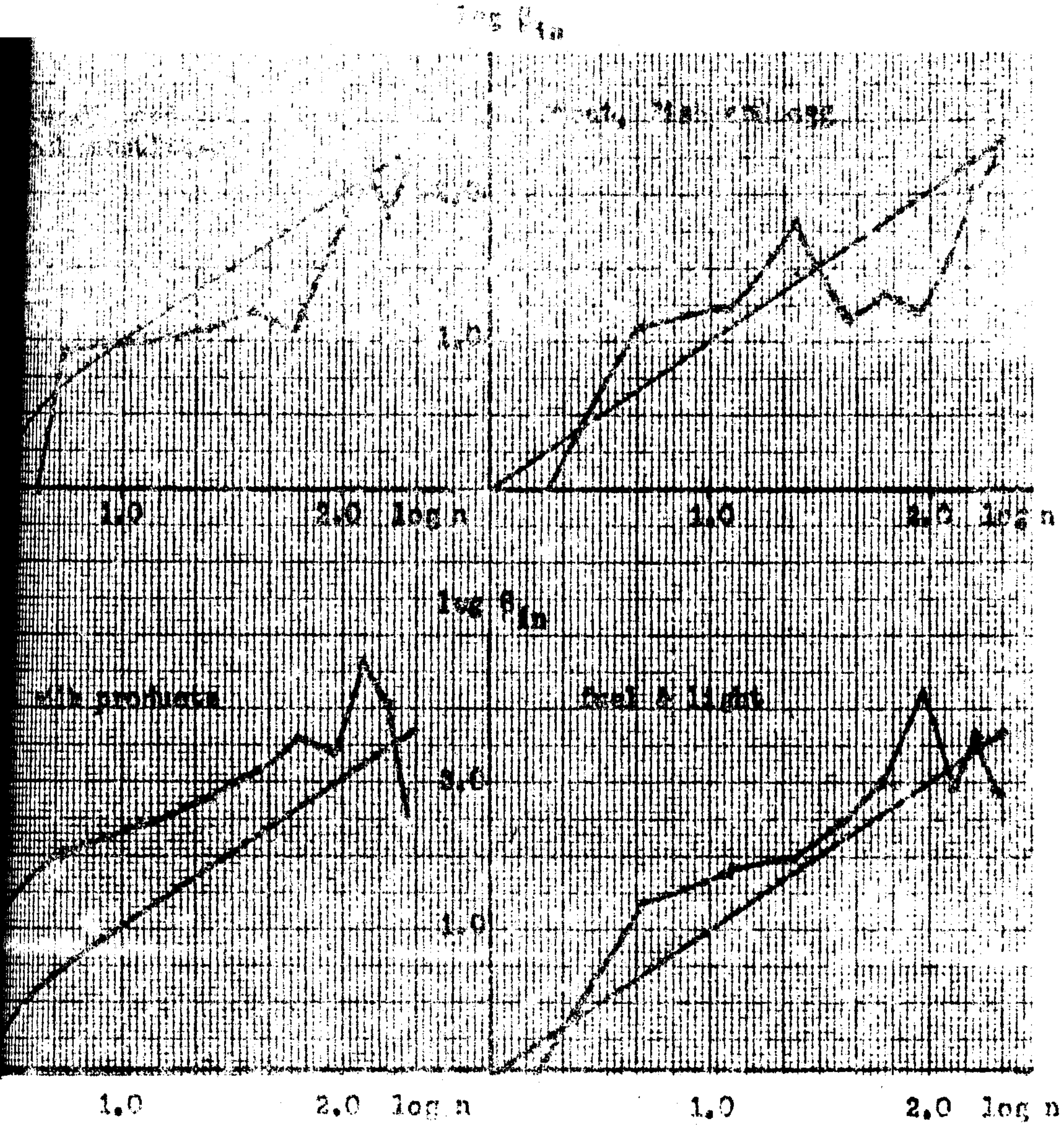

Fig.4.7 : Showing log β_{in} against log n for fitted SL engel curve by items : Combined sample, All-India urban, NSS 18th Round.

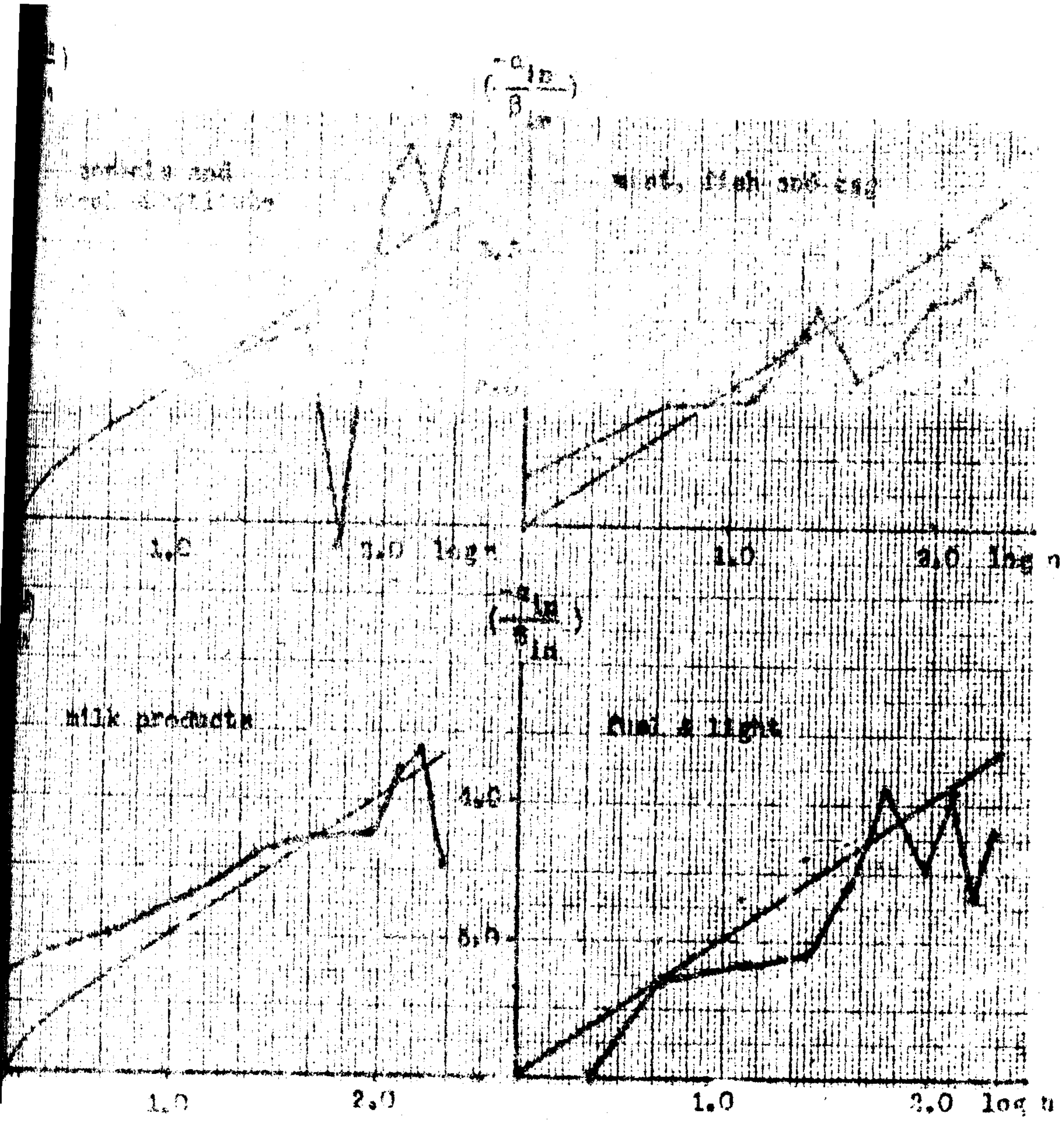

Fig.4.8 : Showing $(\frac{-\alpha_{in}}{\beta_{in}})$ against log n for the fitted SL engel curves by items : Combined sample, All-India urban, NSS 18th Round.

Figure 4.1 shows the itemwise combined sample estimates $\hat{\alpha}_{in}$ of LI curves fitted for rural households plotted against log n separately for the four items. The graphs for cereals and cereal substitutes and fuel and light are clearly linear, while those for milk products and meat, fish and egg indicate broad linear relationship. It should be noted that the slopes of the underlying lines measure the specific economies of scale. (For the sake of convenience, lines with 45° slope have been shown in the graphs.) It is evident that θ_i is lowest for fuel and while this appears to be larger (but $\theta_i < 1$) for cereals and cereal substitutes and meat, fish and egg. For milk products the slope of the scatter appears to be close to unity, thus indicating negligible specific economies/diseconomies of scale for this item.

The graphs for urban households also indicate broad linear relationships for fuel and light and cereals and cereal substitutes (vide Figure 4.3). For meat, fish and egg and milk products the relationships are linear but rather erratic. For this sector the specific economies of scale appear to be low for all the items (although for cereals and cereal substitutes, fuel and light and meat, fish and egg $\theta_i < 1$ seems plausible if household size 1 is ignored[7]).

Figures 4.2 and 4.4 present the graphs of log $(-\hat{\beta}_{in})$ against log for the fitted LI curves separately for the four items and for the rural and urban sectors respectively. For the rural sector, the graphs for all

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[7] While judging linearity of the scatter diagrams in Figures 4.1-4.6 we have sometimes ignored the household size 1.

the items are sensibly linear and the underlying slopes appear to be similar for milk products, fuel and light and cereals and cereal substitutes and the common value of the slope is slightly below unity. Incidentally, the slopes here measure the coefficient pertaining to the overall economy of scale (θ_o). The graph for meat, fish and egg, however, shows some amount of non-linearity. At least, in this case θ_o appears to be less than those for other items. Corresponding graphs for urban households depict a more erratic picture. Linearity of the graphs is clear only for fuel and light and cereals and cereal substitutes. The graphs for meat, fish and egg and milk products are, too erratic to show any clear pattern.

Shifts in the parameters of fitted SL curves in response to change in log n are depicted in Figures 4.5-4.8. The graphs of log $\hat{\beta}_{in}$ against log n are sensibly linear with reasonable slopes for different items in the rural sector (vide Figure 4.5). In this case the slopes measure the specific coefficient θ_i. Corresponding graphs for the urban sector, however, are less systematic. However, for cereals and cereal substitutes and fuel and light the graphs show broad linearity with slopes close to unity if household size 1 is ignored. For milk products, on the other hand, exclusion of household size 10 leads to a smooth linear pattern with slope clearly less than unity. For meat, fish and egg, the graph moves erratically.

As regards the graphs of $(\frac{\hat{\alpha}_{in}}{\hat{\beta}_{in}})$ against log n, it may be mentioned that for the rural sector these graphs are fairly linear for different items (vide Figure 4.6). Underlying slopes are similar for cereals and cereal substitutes and fuel and light. (In this case, the slope indicates θ_0.) For milk products and meat, fish and egg the slopes appear to be smaller. The corresponding graphs for the urban sector (Figure 4.8) indicate broad linearity for meat, fish and egg and for milk products (if household size 10 is ignored for the latter item). For cereal - cereal substitutes and fuel and light, graphs are erratic. Even for meat, fish and egg and milk products the underlying slopes are clearly smaller than unity.

On the whole, for the rural sector the shifts in the parameters of fitted SL and LI curves in response to changes in n are quite systematic and are expected to yield reasonable estimates of θ_i for different items as well as of θ_0. For the urban sector, however, the corresponding shifts are less regular. The reasons for this may be twofold. First of all, the regression equations for the urban sector are based on smaller sample sizes and as such the estimated parameters of the SL and LI curves may have fluctuated due to sampling error. Perhaps more importance should be attached to our omission of household composition in this study of economies of scale. In fact, shifts in preferences (i.e., tastes and needs) with changing household size are very important specially for urban households in India, because of compositional variations and also due to variations in occupational category. Practically, adequate consideration of household composition would have ensured more systematic results.

4.4 Estimation of economies of scale from SL and LI engel curves :

Tables 4.1 and 4.2 show the half-samplewise estimates of the parameters $\hat{\alpha}_{in}$ and $\hat{\beta}_{in}$ of SL and LI engel curves fitted for different items separately by household size (n) for the rural and urban sector. We have used them for obtaining estimates of θ_i and θ_o through equations (4.2.4), (4.2.6), (4.2.9) and (4.2.10).

As noted in Chapter III, the behaviour of single-member households is appreciably different from the behaviour of the multi-member households (vide the results of ANOVA in Table 3.4). In view of this, the scale coefficients have been estimated once including household size 1 and again excluding this particular group of households. The itemwise estimates of θ_i and θ_o based on curve-type giving satisfactory fit are presented in Table 4.3.

Table 4.3 : Estimates of specific ($\hat{\theta}_i$) and overall ($\hat{\theta}_o$) scale for different items obtained from SL and LI forms of engel curves based on 18th Round NSS data for rural and urban India.

curve type	half-sample	cereals and cereal substitute		meat, fish and egg		milk products		fuel and light	
		$\hat{\theta}_i$	$\hat{\theta}_o$	$\hat{\theta}_i$	$\hat{\theta}_o$	$\hat{\theta}_i$	$\hat{\theta}_o$	$\hat{\theta}_i$	$\hat{\theta}_o$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				(i) including single member household					
				(a) rural India					
	1	0.90	1.03	0.75	0.72	0.81	0.78	0.65	1.01
SL	2	0.98	0.87	0.72	0.80	0.81	0.75	0.62	0.89
	comb.	0.97	0.97	0.73	0.73	0.84	0.78	0.72	1.05
				(b) urban India					
	1	0.83	-	1.02	-	0.87	-	0.84	-
SL	2	1.17	-	0.99	-	0.61	-	0.61	-
	comb.	0.97	-	0.91	-	0.67	-	0.89	-
				(ii) excluding single member households					
				(a) rural India					
	1	0.76	0.82	0.54	0.73	0.95	0.75	0.53	0.98
SL	2	0.89	0.78	0.69	0.94	0.83	0.70	0.59	0.89
	comb.	0.82	0.84	0.66	0.79	0.93	0.75	0.69	1.06
				(b) urban India					
	1	0.80	0.56	-	-	-	-	0.69	0.94
SL	2	1.17	1.46	-	-	-	-	0.55	0.60
	comb.	0.96	0.96	-	-	-	-	0.61	0.79

Table 4.3 (contd.)

curve type	half-sample	cereals and cereal substitute		meat, fish and egg		milk products		fuel and light	
		$\hat{\theta}_i$	$\hat{\theta}_o$	$\hat{\theta}_i$	$\hat{\theta}_o$	$\hat{\theta}_i$	$\hat{\theta}_o$	$\hat{\theta}_i$	$\hat{\theta}_o$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		(iii) including single member households							
		(a) rural India							
	1	0.92	0.85	0.77	0.70	1.30	1.20	0.65	0.89
LI	2	0.90	0.82	0.70	0.64	0.67	0.69	0.55	0.80
	comb.	0.93	0.86	0.75	0.72	1.01	0.87	0.62	0.86
		(b) urban India							
	1	0.94	1.02	-	-	-	-	0.87	0.93
LI	2	0.98	1.30	-	-	-	-	0.80	0.68
	comb.	0.98	1.11	-	-	-	-	0.97	0.93
		(iv) excluding single member households							
		(a) rural India							
	1	0.81	0.81	0.59	0.68	1.54	1.31	0.56	0.88
LI	2	0.79	0.76	0.68	0.76	0.69	0.57	0.51	0.77
	comb.	0.81	0.79	0.66	0.77	1.15	0.85	0.56	0.84
		(b) urban India							
	1	0.85	1.15	-	-	-	0.88	0.53	0.86
LI	2	0.91	1.30	-	0.83	-	-	0.63	0.61
	comb.	0.85	1.13	-	-	-	0.98	0.66	0.81

As regards the magnitudes of θ_i and θ_o, it is encouraging to note that plausible estimates of these parameters have been obtained for most of the items in the rural sector. The discripancies between half-sample estimates are often reasonably small. To illustrate, θ_i for cereals and cereal substitutes for the rural sector is estimated to be around 0.80 from both the curve-forms when household size 1 is excluded. The corresponding estimates θ_o lie around 0.80-0.85. Inclusion of household size 1 tends to raise the magnitude of the estimated θ_i and θ_o. For fuel — light in the rural sector the LI estimates of θ_i (excluding household size 1) is around 0.55 and the corresponding SL estimate is somewhat higher (0.69). The estimate of θ_o from LI is around 0.85; here the SL estimate is above unity for the combined sample, even though half-sample estimates are less than 1. In this case also the inclusion of household size 1 tends to raise θ_i. The overall coefficient estimated for meat, fish and egg from SL and LI curves seem to be slightly below 0.80. θ_i for this item decreases from about 0.75 to 0.66 as a result of exclusion single-member households. Milk products presents some anomalous results : for this item the SL fits indicate a small diseconomy. Also, in this case θ_i increases when household size 1 is excluded. As regards the estimate of θ_o, SL tends to give a smaller θ_o (around 0.75) while LI gives a more reasonable estimate (0.85) of this parameter. However, the discripancies between half-sample estimates are very large for the LI form.

As regards the estimates for the urban sector, the estimated scale values turn out to be less sensible. Moreover, the divergence between half-sample estimates is generally wider, partly due to the smaller sample sizes for this sector. It is in fact possible that the present approach which ignores age-sex composition of the household among other things is relatively inadequate for the urban sector. Among the estimates that appear reasonable are the estimate of θ_i around 0.60—0.65 for fuel and light obtained from SL and LI curves wh household size 1 is excluded; also for cereals and cereal substitutes, the LI form yields a θ_i around 0.85 based on multi-member households. In general, it appears that with increasing n, shifts in preferences may be important for urban households because of the differences in consumption attitudes of the relatively small working class households and the relatively large middle class households that charaterise this sector (*vide* Chapter 5 *infra*).

4.5 Estimation of economies of scale from LLI engel curves :

As noted in Chapter III, Section 3 above, the comparison of alternative forms of engel curves brought out the superiority of LLI form over SL, LI etc., for all the items considered in the present study. An attempt, therefore, has been made to estimate θ_i and θ_o from LLI curves as well. Equation (4.2.13) suggests that the shifts of α_{in} and γ_{in} of the LLI are systematically related to n while β_{in} is expected to be constant for different n. In principle, one could estimate θ_o by analysing the shifts in $\hat{\gamma}_{in}$ as n changed, and when θ_o is known, the movement of $\hat{\alpha}_{in}$ with n could yield an estimate of θ_i.

This ideas, however, did not work satisfactorily with empirical data. For most of the items the graphs of $\hat{\gamma}_{in}$ and $\hat{\alpha}_{in}$ against log n showed no clear pattern for either sector. The $\hat{\beta}_{in}$'s did not show any definite trend, but they fluctuated considerably. These capricious movements of the estimated LLI parameters with increasing n are perhaps largely due to the well-known effect of multicollinearity on the estima LLI parameters[8].

An alternative search procedure has therefore been employed to estimate θ_i and θ_o from LLI engel curves. Consider (4.2.13) which can be spelt out as

$$\log y_i = \alpha_i + (\theta_i - \beta_i\theta_o) \log\ n + \beta_i \log x + \gamma_i\left(\frac{n^{\theta_o}}{x}\right) + \varepsilon_i \quad ..(4.5.1)$$

where ε_i is the random disturbance term in the engel curve for item i. Least squares estimation of (4.5.1) is complicated by nonlinearity of this expression in terms of the parameters. If θ_o were known <u>a priori</u>, (4.5.1)couldbe estimated through least squares procedure to obtain θ_i and other parameters. In the present case, we fitted (4.5.1) separately for

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[8] An attempt to estimate θ_o from the movement of $\hat{\gamma}_{in}$ of the LLI led to the following results which appear to be somewhat reasonable : For the rural sector, θ_o was estimated to be 0.87, 0.69 and 0.89 for half-sample 1, 2 and the combined sample from the regression of log $(-\hat{\gamma}_{in})$ on log n when household size 1 was ignored. Inclusion of household size 1 increased the values of θ_o marginally. The θ_o obtained from the $\hat{\gamma}_{in}$ for cereals and cereal substitutes turned out to be lower for th sector. For the urban sector, the few results that were obtained by examining $\hat{\gamma}_{in}$ showed large half-sample divergences.

each item by weighted least squares using different trial values of θ_o in the plausible range 0.70-1.00, and attempted to locate the value of θ_0 which maximized R^2 for each item. An inevitable difficulty with such a single-equation method is that the method itself does not guarantee that the same value of θ_o would simultaneously minimize the residual sums of squares of (4.5.1) for different items. It might be possible to devise a suitable joint estimation procedure by considering the interrelationships among ε_i's in different equations (*vide* Zellner, [illegible]. If ε_i's for different i are assumed to be uncorrelated for a given (group of) household(s), then the single-equation procedure and the joint estimation procedure become equivalent. In such a case, a unique θ_0 might be sought for which the aggregate of the residual sums of squares over all items would be minimum. In the present case, we used this assumption to obtain the θ_o and the θ_i's from LLI curves.

Numerical results of fitting (4.5.1), using expenditure estimates pertaining to household size 2-10 for different trial values of θ_o, revealed that for individual items the change in R^2 in response to change in θ_o is rather sluggish. Moreover, in many instances, specially for the urban sector, R^2 decreased or increased monotonically with increasing values of θ_0 in the range mentioned above. For the rural sector, the aggregate of itemwise residual sums of squares attained a minimum in the range 0.80-0.85 for both the half-samples as also for the combined sample. For this sector, the specific scale values (θ_i) corresponding to different values of θ_o in this range are as follows :

Table 4.4 : Itemwise estimates of θ_i based on LLI engel curves corresponding to different trial values of θ_o : all-India rural, 18th Round NSS.

item	half-sample	value of θ_o		
		0.80	0.85	0.90
(1)	(2)	(3)	(4)	(5)
1. cereals & cereal substitutes	1	0.82	0.84	0.87
	2	0.82	0.85	0.87
	combined	0.82	0.84	0.87
2. meat, fish & egg	1	0.72	0.77	0.83
	2	0.77	0.84	0.91
	combined	0.71	0.77	0.84
3. milk & products	1	1.13	1.22	1.31
	2	1.17	1.27	1.37
	combined	1.10	1.19	1.29
4. fuel & light	1	0.53	0.56	0.60
	2	0.55	0.58	0.61
	combined	0.55	0.58	0.61

The results based on LLI curve are in general sensible except for milk products for which specific diseconomies are indicated. Further, these estimates of θ_i compare favourably with those obtained from SL and LI curves; also the half-sample estimates of θ_i for different values of θ_o show satisfactory agreement.

Thus it would not be unrealistic to accept 0.80-0.90 as the plausible range of θ_o and 0.82-0.87, 0.70-0.85, and 0.55-0.60 as the plausible range of θ_i for cereals and cereal substitutes, meat, fish and egg and fuel and light. For milk products, which excludes liqued milk, specific diseconomies seem unrealistic. However, it should be borne in mind that these estimates are very rough estimates, since omission of age-sex composition and occupational status of households may have biased these estimates.

The results for the urban sector proved far less satisfactory. While for cereals and cereal substitutes R^2 decreased continuously as θ_0 decreased, an opposite tendency was evident for the other items. Only in case of meat, fish and egg in half-sample 2 and for milk products in the combined sample the value of R^2 attained maxima for θ_0 around 0.90. The aggregate of itemwise residual sums of squares also did not help, since for the half-samples as well as the combined sample this decreased monotonically as θ_0 decreased. It appears that for the urban samples compositional variations are quite important and the omission of the age-sex composition of households has led to these unsatisfactory resu

4.6 Estimation of economies of scale : An application of Nicholson's method

Nicholson (1964) suggested a procedure for estimating effective household size with respect to income, n^{θ_0}, for households of different sizes, and therefrom estimating a scale of household equivalence with respect to income position. In the present section we report on an attempt at a careful application of Nicholson's idea to the problem of estimating economies of scale in household consumption in India.

Precisely, Nicholson's suggested procedure is as follows : Suppo

that the following engel curve formulation

$$\frac{y}{n^{\theta_y}} = f\left(\frac{x}{n^{\theta_o}}\right) \qquad \ldots \quad (4.6.1)$$

is correct for all food items taken together. Here θ_y measures the specific economies of scale for all-food. If the engel ratio $(\frac{y}{x})$ for food is a perfect indicator of standard of living, i.e., if it is a monotonically decreasing function of $(\frac{x}{n^{\theta_o}})$, the effective level of income or total expenditure, then obviously $\theta_y = \theta_o = \theta$. Then we can write the 'standa of living function'

$$\frac{y}{x} = g\left(\frac{x}{n^{\theta}}\right) \qquad \ldots \quad (4.6.2)$$

involving the common scale coefficient θ, Nicholson really sought to estimate this parameter θ — more precisely the values of n^{θ} for different values of n — by finding values of x at which households of different size have the same value of $\frac{y}{x}$ on the average. This method is relatively unnoticed in the literature and Nicholson did not mention the underlying assumption $\theta_y = \theta_o$. It is obvious that at a given level of $\frac{x}{n^{\theta}}$ is constant for household sizes and thus θ measures the elasticity of x with respect to n when $\frac{y}{x}$ is kept fixed.

In the present section we have utilized essentially this idea of Nicholson for estimating θ from a suitable specification of (4.6.2) arrived at on the basis of combined sample estimates from NSS 19th Round (July 19 June 1965).

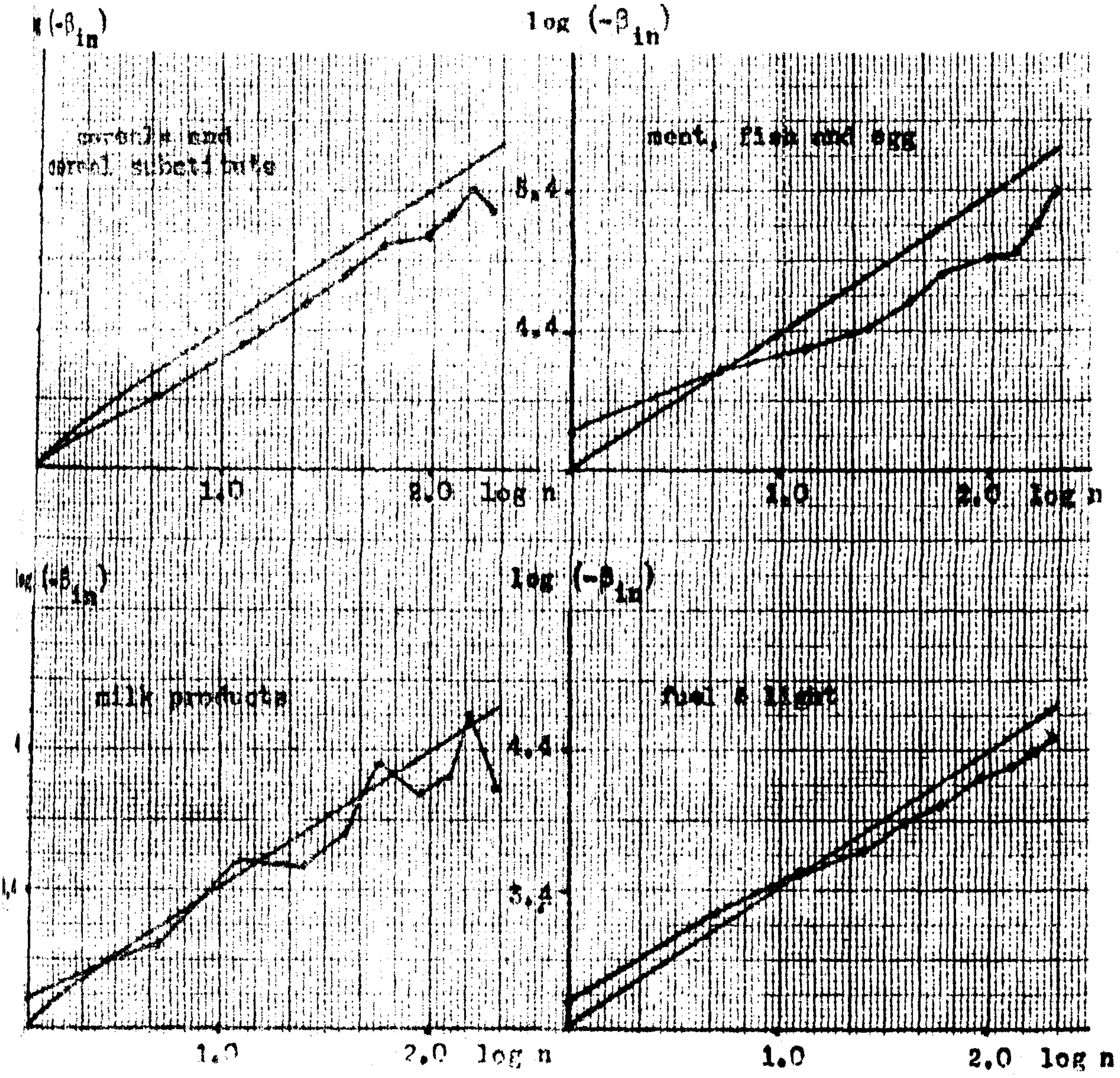

Fig.4.2 : Showing log ($-\beta_{in}$) against log n for LJ engel curves by items : Combined sample, All-India rural, NSS 18th Round.

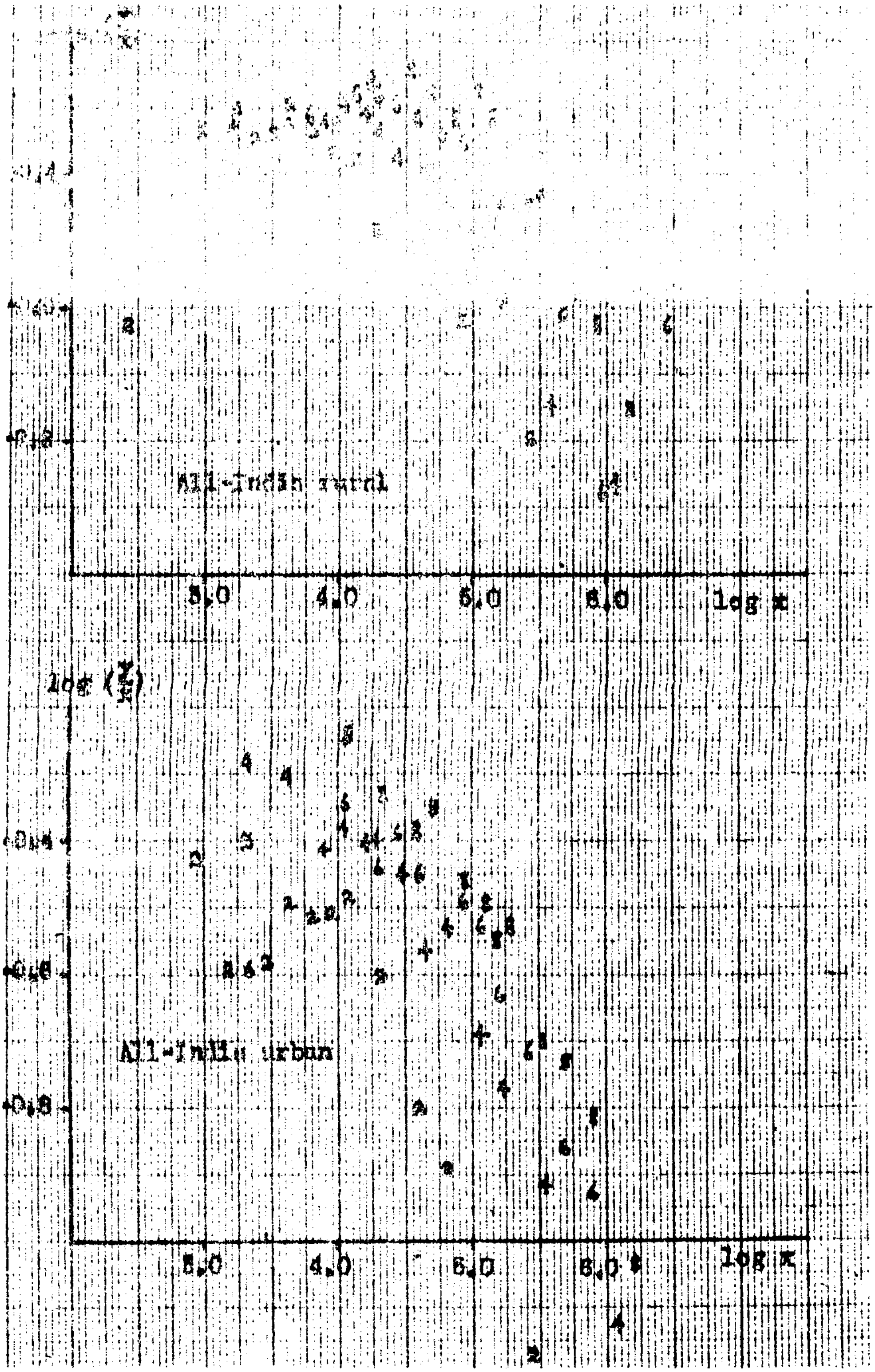

Fig. 4.9: Showing observed values of log ($\frac{y}{x}$) for food against log x by household size (n=2,4,6 & 8): All-India rural and urban, NSS 18th Round.

which may be written as

$$\log\left(\frac{y}{x}\right) = a + b\log x + c\,\frac{n^{\theta}}{x} + d\log n,\ \theta = \left(-\frac{d}{b}\right) \qquad \ldots (4.7.2)$$

Estimation of θ from (4.7.2) is complicated by the non-linearity of this expression in the unknown θ. We, therefore, followed an iterative procedure for estimating θ from (4.7.2). Starting from an initial $\theta = \theta^{o}$, we regress $\log\left(\frac{y}{x}\right)$ on $\log x$, $\log n$, and $\left(\frac{n^{\theta^{o}}}{x}\right)$ and estimate a, b, c and d through minimizing

$$\sum_{j,n} p_{jn}\left\{\log\left(\frac{y}{x}\right)_{jn} - a - b\log x_{jn} - c\left(\frac{n^{\theta^{o}}}{x}\right)_{jn} - d\log n\right\}^{2}$$

with respect to a, b, c and d. Here p_{jn} denotes the estimated number of persons belonging to the jth per capita total expenditure class for household size n. Next, a θ is estimated as $\theta' = -\left(\frac{d}{b}\right)$ and θ' is used to obtain fresh estimates of the parameters of (4.6.2). The process is continued until convergence is evident. In the present case, we continued iteration until $\Delta\theta = \left|\theta^{s} - \theta^{s-1}\right| \leq .00001$, where θ^{s} and θ^{s-1} are estimates of θ from the (s-1)th and sth iterations. The convergence of this procedure was rapid for both the sectors. In fact, starting from an initial value $\theta^{o} = 1$, it took 12 and 10 iterations for the rural and urban sectors respectively to obtain $\Delta\theta \leq .00001$.

The results of fitting (4.7.2) are as follows :

sector	parameters a	b	c	d	θ	R^2	deg. of freedom
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
rural India	1.35	-0.46	-5.74	0.42	0.93	0.89	87
urban India	1.93	-0.62	-9.09	0.49	0.79	0.95	87

A comparison of the R^2's for rural and urban sector suggests that the equation (4.7.2) fits the urban data more satisfactorily. It appears that θ for the rural sector estimated through the above procedure is an overestimate of the underlying true overall scale coefficient. Conversely, however, θ for the urban sector seems to be on the lower side.

4.8 Concluding observations :

The exercises reported in Chapters III and IV indicate the existence of considerable economies of scale in the expenditure pattern of India households. It is also shown that the specific economies for individual items can be quite different from the overall economy of scale. This suggests that the estimation of engel relationships for different items should pay due attention to this phenomenon in order that more accurate estimates of the underlying engel relationships be possible. It is also indicated that the use of the 'per capita formulation' may lead to serious underestimates or overestimates of the true engel elasticity for different items depending upon whether there are diseconomies or economies of scale in consumption of the item.

As regards our methods of estimation of the scale coefficients, it should be mentioned that the first method based on variable elasticity engel curve forms may be deemed superior insofar as it yields estimates of θ_i and θ_o by examining the expenditure pattern for a single item and makes no unwarranted assumptions (such as $\theta_i = \theta_o$ as in Nicholson's method or using the 'quality equation' as in Prais and Houthakker's method). The method, however, does not ensure that θ_o estimated from engel curves for different items would be quite same. It is expected that if the specification of the engel curves for different items are appropriate then estimates of θ_o from engel curves for different items would be comparable.

As regards the magnitude of economies of scale present in the expenditure pattern for the items considered in this study, our results indicate that there exist quite large specific economies of scale for fuel and light in both the sectors. The parameter θ_i for meat, fish and egg is also smaller than unity for the rural sector. As regards milk products, it appears that there is some specific diseconomies for both the sectors. However, the specific diseconomies for this item result probably due to the fact that the larger households contain more children who are the primary consumer of milk products. Specific economies for cereals and cereal substitutes are small for both the sectors. The overall economy is estimated to be around 0.85 for the rural sector. However, the corresponding coefficient for the urban sector could not be estimated satisfactorily.

Attention must now be drawn to the limitations of the present study. First of all, so far as the method of estimating θ_i and θ_o is concerned, it fails when the engel curve is of DL form (because in this case only the compound parameter $(\theta_i - \beta_i \theta_o)$, β_i being the constant engel elasticity, is estimable). It is seen that the method also fails to tackle three parameter engel curves such as the LLI, for which the estimated household-size-wise engel parameters frequently move erratically due to multicollinearity.

Secondly, the simplification introduced by ignoring age-sex composition of households introduces bias in the estimated scale coefficients. It would be, therefore, ideal to proceed by examining separately expenditure patterns of households of different composition (as done by Brown (1954)) and then to study the shifts in the composition-wise estimates of engel parameters using suitable unit consumer scales.

Thirdly, we have ignored the effects of social class/occupation in examining economies of scale in household consumption. Insofar as different occupation/social groups may have different attitudes towards budget reallocation when household size changes, the economies of scale appropriate for different social/occupational groups would be quite different (_vide_ Chapter V _infra_). In that sense, our omission of occupational factors may have vitiated the true picture.

Finally, we have used the simple weighted least squares formula for estimating standard errors of the engel parameters. This procedure may be questionable in view of the fact that the data we have actually used come from a complicated probability sample drawn in the NSS.

Chapter V

Consumption Patterns of Middle Class and Working Class Households in India : A Comparative Study

5.1 Introduction

The importance of social and environmental factors in shaping consumption habits is wellknown. Individual preferences emerge out of the interplay of a whole spectra of variables including occupation, level of education, region and so on. The process of emergence of a stable demand pattern or, equivalently, of a consumption habit out of the interaction of these variables is essentially a dynamic process in which there may be significant short run feed-back effects of the demand pattern itself. This suggests the need for a dynamic analysis for studying the influence of these extra-economic variables on consumer expenditure patterns.

Time series analysis, however, is not at all convenient. For one thing, the inclusion of various factors would make the demand functions complicated, thus creating serious problems of estimation. Cross-section data, on the other hand, may yield meaningful results on the effect of various demographic and sociological factors on consumer expenditure pattern. Cross-clsssification of sample households on the basis of various household characteristics would result in fairly homogeneous groups of households. A comparison of consumer expenditure patterns of these homogeneous groups may indicate the effects of various factors on the consumption pattern.

Numerous cross-sectional studies have explored the effects of such variables as occupation, the level of education of the head of the household, race, region and city size, on the pattern of household consumer expenditure (vide Prais and Houthakker, 1955; Crockett and Friend, 1960; Peters, 1960; Crockett, 1960; Maisel and Winnick, 1960; Lippit, 1960; Hamburg, 1960; Lee, 1971; Palda, 1967). A number of Indian studies, mainly based on NSS household budget data, indicate the nature of differences in consumer expenditure pattern between rural and urban households. Variables such as occupation, region, etc., are also found to be important determinants of consumer expenditure pattern (for instance, Sinha, 1966; Gupta, 1968; Mahajan, 1971; Verma, 1959; Radhakrishna and Misra, 1970; Maitra, 1969)[1].

The present analysis, based on the budget data collected in the NSS Family Living Surveys carried out during 1958-59, attempts to explore the differences in expenditure pattern of Indian Middle Class and Working Class households. The rationale behind such a study is simple. If a society is imagined to be composed of different social classes, demarcated by occupational differences, the inter-class variation in consumption pattern may be thought of arising out of the differences in habits and traditions of the social classes concerned. To be precise, when one considers social classes such as the working class composed of (industrial) manual workers' households and the middle class consisting of non-manual non-industrial employee households, the underlying differences in consumption attitudes emanate basically from physiological, psychological and purely economic factors that implicitly distinguish these two social classes. Often the

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[1] Vide Chap. 1, Section 3, supra

influences are intermingled and cannot be easily separated. However, their total effect on the consumption pattern may be studied with relative ease. Such studies of inter-class differences may be interesting from the poin of view of consumption planning involving widely heterogeneous groups of households and may have important bearing on public policies affecting inter-class reallocation of income.

The plan of exposition is as follows : Section 5.2 briefly discusses the origins of inter-class differences in consumption pattern stresses the interdependence of economic and other factors in shap consumption habits of social classes. Section 5.3 describes the broad features of the NSS Family Living Surveys, 1958-59, on which the empirical exercises presented in this chapter are based. Section 5.4 offers a preliminary analysis of the data that has been used actually. In section 5.5 an examination has been made of the movements of engel ratios for broad groups of items viz., food, housing, clothing and miscellaneous. Results of engel curve analysis for different items based on constant elasticity and log-log-inverse engel curves are discussed in section 5.6. Graphical comparisons of engel curves of the two social classes have also been made in th section. Section 5.7 reports the results of analysis of covariance to test inter-class homogeneity of expenditure patterns. Results of comparison based on both constant elasticity and log-log-inverse engel function have been reported here. In section 5.8 household size is introduced explicitly in the engel curves to examine the extent to which the observed inter-class differences in expenditure pattern could be explained in terms of inter-class divergences in household size. Finally, section 5.9 draws some concluding observations. There are three Appendices attached to this chapter. Appendix A reports on the results of inter-centre differences in consumption pattern separately for the two social classes. Appendix B presents some empirical results regarding the choice of classificatory character in engel curve analysis. Precisely, we have compared the estimates of constant elasticity engel curves obtained from the expenditure estimates classified by per capita monthly income and per capita monthly total expenditure for the middle class. Finally, Appendix C summarises the analysis of covariance technique that we have adopted for inter-class and inter-centre comparison of expenditure pattern.

5.2 Origins of inter-class differences in consumption

Typical differences, both in the way in which a given total expenditure is financed and in the way in which it is distributed among different items, result from economic factors. Prais and Houthakker (1955, pp. 153-164) observed that as far as earnings are concerned middle-class households may be characterised by a relatively regular flow of income, which introduces some stability in their consumption behaviour. The income streams of working class households, on the otherhand, seem to be interrupted by temporary discontinuities either due to casual unemployment of the principal earner or of the subsidiary earner(s) of the household, or due to absence from work for various reasons. One of the reasons for the stability of the middle class earnings may be the existence of regular flow of property income for these households, possession of property being more frequent for middle class households.

As regards the nature of consumer expenditures, both working class and middle class households tend to show a stable pattern of demand for such necessary items as food. The essential reason is that demand for these items are largely conditioned by physio-psychological needs of the households that result from occupational characteristics. Coming to other items, the phenomenon of habit formation turns out to be very important. Consumption of any commodity induces the consumer to build up a psychological stock. For some items these stocks are so important, that consumers form a habit of consuming such items. Moreover, this habit reinforces itself and consumption of the item increases continuously. This habit formation aspect of consumption introduces an element of asymmetry in the consumer's income responses. Obviously, for a habit forming item the changes in consumption in response to income increases and decreases are different. Prais and Houthakker (1955) suggest, in view of the possible uncertainty and irregularity of income stream "a working class household will be acting in a perfectly rational manner if it discounts very heavily its expected future income and establishes habits of expenditure, at any rate as far as the staple items are concerned, which are appropriate to a lower income level than it may in fact be enjoying; that is, habits which on the whole are similar to those of a household expecting a lower but regular income stream. The excess of income is then spent as quickly as possible in some non-habitforming direction". For a middle class household, on the other hand, changes in income level may be expected to affect expenditure pattern with a time lag, since even when the income stream of these households is irregular, they can maintain a stable pattern of living by spending out of their past savings. The long-run level of expenditure for these households is largely determined by the amount of savings they intend to effect in their life time and by their income expectations. It is frequent that middle class households, especially those headed by young professionals, expect a fairly rising income over time. These households, thus, may invest more on such items as education of children and so on even by entering into mortgage agreements and the like.

The extent of feed back effects of changes in income depend upon the nature of income change itself. Thus while a temporary rise in income of a working class household induces it to spend more on entertainment, a permanent increment in income may even lead to a change of social class through an increase in education, a change of occupation and of income.

There may be forces which tend to close the gap in the consumer expenditure pattern of middle class and working class households as well. If there is sufficient 'demonstration effect', the working class households may tend to emulate the consumption pattern of middle class ones, particularly in respect of presitigious items of consumption.

To sum up, proper analysis of the effects of social classes must be based on dynamic concepts; and knowledge about the past and expected future income profile of the households is essential for the reason that long-t and short-term effects of income changes may be quite different. Further, there may be significant asymmetry in the reaction of different social classes to income increases and decreases. However, such analyses can hardly be based on household budget enquiries since such enquiries convey very little about the historical changes in income positions of the households concerned.

5.3 The NSS Family Living Surveys, 1958-59 : Some Broad Features

The Family Living Surveys (FLS) conducted under the auspices of the NSS in 1958-59 were adhoc surveys directed towards the collection of information about household expenditure patterns and other aspects of level of living such as housing conditions, health, literacy and so on from middle class and working class households at a number of selected urban centres all over India. The middle class FLS was conducted at 45 centres while the working class FLS, conducted independently of the middle class ones, covered 50 centres, principally factory, mine and plantation areas.

5.3.1. Definitions of the Two Social Classes

The two social classes in the FLS were defined principally in terms of occupation. As a working basis, the middle class FLS covered households which derived 50 per cent or more of their income from earnings of members who were gainfully employed in non-manual jobs in the non-agricultural sector during the reference month. This included mainly households supported by professional, technical and related workers, administrative, executive and managerial workers, clerical and related workers (except unskilled office workers) and sales workers. A working class household, on the other hand, was defined as one which derived the major part of its total earnings through manual work in a registered factory, mine or plantation.

5.3.2 Sample Design

A two stage sampling design was adopted for the middle class survey; at each centre sample blocks of households were selected at random in the first stage, and sample households were selected at random from each of these sample blocks in the second stage. The working class survey, on the otherhand, resorted to two alternative sampling techniques, viz., tenement sampling and pay-roll sampling, for getting down to the ultimate sample units (households). The choice between these two alternative methods depended upon operational convenience. Thus, at a centre where the working class population was concentrated in definite areas, tenement sampling was followed. If, on the other hand, the working class population in a centre was found to be scattered over a wide geographical area, pay-roll sampling became operationally more convenient.

To even out the effects of seasonality on the household characteristics under study, the survey was spread over a year and the interviews of sample households were staggered uniformly over twelve months. The field investigation was organised in the form of a number of sub-rounds, each sub-round covering a representative sample of households.

5.4 Data Analysed

For the present analysis we have selected four urban centres, namely, Ahmedabad, Calcutta, Kanpur and Madras, each of which happened to be covered by the middle class as well as the working class FLS. The choice of these centres from all the centres covered by both the surveys was made in a purposive manner. It may be noted that each of these centres has a long tradition of industrial activity as also a sizeable middle class population and the geographical locations of these centres are such that intra-class inter-regional differences in consumption pattern could also be easily studies from the data collected from these four centres.

The consumer expenditure data used in the present analysis were collected partly from the published reports on the FLS (Labour Bureau, Govt. of India, 1965) and partly from unpublished tabulations available at the NSS Department of the ISI. For the working class FLS, household expenditure on different items were tabulated by classes of (i) per capita income[2/] and (ii) per household income, but no tabulation by classes of per capita total consumer expenditure were available. For the middle class surveys, however, the expenditure data were tabulated by classes of per capita income as also by classes of per capita total consumer expenditure.

Usually, due to the non-availability of reliable income data, per capita total expenditure is used as the explanatory variable in the engel function. Actually, some analysts have preferred this to per capita income (Prais and Houthakker, 1955; Houthakker and Taylor, 1966). Houthakker and Taylor, in particular, applied principal component analysis to expenditures on a large list of items and observed the first principal component to have higher correlation with per capita total expenditure than with per capita income. This led them to prefer per capita total expenditure to per capita

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[2/] Family income, in both the surveys, excluded windfall gains during the reference period. However, normal incomes in the form of rent, pensions, regular gifts and interests etc., were included in the definition of income. Broadly, thus, income in the FLS approximated to what could be called permanent income.

income. They noted, however, that this result could be due to the lower reliability of the income figures. In such a case, data grouped by per capita income might underestimate the actual between-group variation in the expenditure and yield distorted estimates of the true engel function. If, however, the income data are of high quality, then following Liviatan (1961) one can justify the use of per capita (recorded) income as the classificatory variable : Tabulation of expenditure data by classes of per capita (recorded) income (which is supposed to be highly correlated with permanent income) may help in eliminating the effects of the transitory components in item expenditures and total consumer expenditure that lead to inconsistent estimates of the true engel function.

The items considered in the present analysis include such food items as (1) cereals and cereal products, (2) pulses, (3) edible oil, (4) meat, fish and egg, (5) milk and products, (6) vegetables, (7) fruits, (8) spices and condiments and (9) prepared meals. The non-food items covered are (1) pan, supari and tabacco, (2) fuel and light, (3) housing, (4) clothing, (5) medical care, (6) personal care, (7) education and reading, (8) transport and communication, (9) recreation and amusements and (10) personal effects.

Tables 5.1 and 5.2 present the distribution of sample households by the levels of per capita monthly income along with estimated number of households and percentage of single member households for the working class and middle class FLS respectively. An important finding of the working class surveys at all the centres is that the sample percentage of single

Table 5.1 : Distribution of sample households by levels of per capita income : Workingclass FLS, 1958-59.

centre	estimated no. of households ('000)	percentage of single member households	per capita monthly income (Rs.)									
			0-5	5-10	10-15	15-20	20-25	25-35	35-50	50-65	65-	all
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Ahmedabad	51.5	25.0	1	2	10	41	77	158	154	66	213	722
Calcutta	59.0	54.5	-	5	32	69	75	108	63	109	257	718
Kanpur	60.0	31.0	4	17	76	92	97	122	88	68	159	723
Madras	66.0	13.5	10	38	121	222	174	182	81	30	102	960

Table 5.2 : Distribution of sample households by level of per capita income : Middleclass FLS, 1958-59.

centre	estimated no. of households ('000)	percentage of single member households	per capita monthly income (Rs.)								
			0-10	10-20	20-30	30-40	40-60	60-100	100-150	150-	all
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Ahmedabad	20.6	4.2	3	50	140	133	196	128	34	29	713
Calcutta	80.2	20.3	-	44	155	199	281	316	199	249	1443
Kanpur	24.8	17.8	7	93	131	107	121	95	51	38	643
Madras	63.0	15.9	3	64	146	140	219	256	115	136	1079

member households is usually large. The corresponding percentages for the middle class surveys are less. For the working class surveys the number of sample households in the highest per capita income class, i.e., Rs. 65 & above, is often quite large. This may be explained in terms of the fact that most of the households belonging to this highest class are single member ones. In fact, 87, 63, 65 and 71 per cent of all single member households surveyed at Ahmedabad, Calcutta, Kanpur and Madras respectively belonged to this highest per capita income class. For the middle class surveys, there are a few sample households in the highest income class Rs. 150 & above. However, as compared with the working class surveys the proportion of households belonging to this highest class is not very large.

5.5 Engel ratios for broad groups of items:[3]

For a preliminary examination of the expenditure patterns we examined the trends in the engel ratios for four groups of items (viz.. (i) food and beverages, (ii) clothing, (iii) housing and fuel and light, and (iv) miscellaneous) over size classes of per capita income. Tables 5.3 and 5.4 present the engel ratios for these groups of items by per capita income classes separately for the four centres. Table 5.3 relates to the working class households and Table 5.4 to the middle class households in these centres. A comparison of the engel ratios for the two social classes

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[3] The proportion of total consumer expenditure spent on an item (group) is referred to as the engel ratio for that item (group).

Table 5.3 : Showing engel ratios for different groups of items and average household size by levels of *per capita* income : Workingclass Family Living Survey, 1958-59.

item-group	centre	per capita monthly income (Rs.)									
		0-5	5-10	10-15	15-20	20-25	25-35	35-50	50-65	65-	all
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		(a) engel ratios									
Food	Ahmedabad	0.59	0.65	0.61	0.64	0.59	0.64	0.63	0.56	0.62	0.62
	Calcutta	-	0.73	0.70	0.72	0.69	0.67	0.66	0.71	0.65	0.6[illegible]
	Kanpur	0.52	0.65	0.62	0.60	0.56	0.58	0.55	0.58	0.54	[illegible]
	Madras	0.61	0.67	0.67	0.61	0.57	0.56	0.56	0.57	0.61	0.59
Clothing	Ahmedabad	-	-	0.13	0.08	0.08	0.09	0.08	0.08	0.11	0.09
	Calcutta	-	-	0.11	0.06	0.04	0.05	0.05	0.07	0.08	0.06
	Kanpur	0.02	0.09	0.09	0.08	0.11	0.11	0.12	0.14	0.13	0.11
	Madras	0.02	0.04	0.05	0.06	0.06	0.07	0.09	0.04	0.07	0.06
Housing	Ahmedabad	0.12	0.09	0.12	0.10	0.10	0.12	0.12	0.20	0.10	0.12
	Calcutta	-	0.16	0.13	0.13	0.16	0.14	0.17	0.11	0.11	0.14
	Kanpur	0.14	0.16	0.13	0.15	0.15	0.14	0.15	0.12	0.13	0.14
	Madras	0.23	0.16	0.14	0.15	0.14	0.17	0.16	0.18	0.10	0.15
Miscellaneous	Ahmedabad	0.29	0.26	0.14	0.18	0.23	0.15	0.17	0.16	0.17	0.[illegible]
	Calcutta	-	0.11	0.06	0.09	0.11	0.14	0.12	0.11	0.16	0.12
	Kanpur	0.32	0.10	0.16	0.17	0.18	0.17	0.18	0.16	0.20	0.18
	Madras	0.14	0.13	0.14	0.18	0.23	0.20	0.19	0.21	0.22	0.20
		(b) average household size									
	Ahmedabad	2.00	4.36	7.68	6.30	6.07	5.29	4.12	2.92	1.33	3.81
	Calcutta	-	4.42	5.01	5.73	4.40	4.63	2.64	1.16	1.06	2.53
	Kanpur	1.00	5.30	6.10	5.48	4.23	3.31	2.53	1.66	1.10	3.23
	Madras	6.93	6.69	6.80	5.99	5.44	4.83	3.95	2.93	1.13	4.92

Table 5.4 : Showing engel ratios for different groups of items and average household size by levels of per capita income : Middleclass Family Living Survey, 1958-59.

item-group	centre	per capita monthly income (Rs.)								
		0.10	10-20	20-30	30-40	40-60	60-100	100-150	150-	all
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
					(a) engel ratios					
Food	Ahmedabad	0.77	0.51	0.50	0.48	0.43	0.38	0.33	0.30	0.44
	Calcutta	-	0.62	0.56	0.55	0.48	0.44	0.39	0.30	0.42
	Kanpur	0.66	0.54	0.52	0.54	0.47	0.42	0.37	0.28	0.45
	Madras	0.69	0.60	0.55	0.51	0.49	0.44	0.39	0.27	0.42
Clothing	Ahmedabad	0.06	0.13	0.14	0.15	0.16	0.13	0.22	0.17	0.15
	Calcutta	-	0.05	0.08	0.08	0.10	0.09	0.09	0.09	0.09
	Kanpur	0.05	0.13	0.14	0.11	0.13	0.13	0.12	0.16	0.13
	Madras	0.03	0.09	0.11	0.13	0.11	0.12	0.15	0.11	0.12
Housing	Ahmedabad	0.15	0.17	0.17	0.18	0.20	0.21	0.19	0.21	0.19
	Calcutta	-	0.20	0.19	0.19	0.21	0.23	0.22	0.24	0.22
	Kanpur	0.18	0.16	0.15	0.15	0.16	0.16	0.17	0.15	0.16
	Madras	0.17	0.17	0.17	0.18	0.18	0.19	0.19	0.21	0.19
Miscellaneous	Ahmedabad	0.02	0.19	0.19	0.19	0.21	0.28	0.26	0.30	[illegible]
	Calcutta	-	0.13	0.17	0.18	0.21	0.24	0.30	0.47	0.27
	Kanpur	0.11	0.17	0.19	0.20	0.24	0.29	0.34	0.41	0.26
	Madras	0.11	0.14	0.18	0.18	0.22	0.25	0.27	0.41	0.27
					(b) average household size					
	Ahmedabad	11.29	7.15	6.20	5.60	4.83	3.73	3.38	2.40	5.10
	Calcutta	-	7.62	7.14	6.53	6.15	5.23	3.31	2.31	4.94
	Kanpur	6.77	6.90	6.24	6.11	5.05	3.29	1.73	1.84	4.81
	Madras	7.73	6.67	6.14	5.51	5.26	4.27	2.98	2.40	4.56

at the same level of per capita income should reveal the effect of social class on patterns of consumer expenditure.[4/] For the sake of interest, corresponding average household sizes are also shown at the bottom of these tables.

For middleclass households at all the centres, the engel ratio for food shows a systematic declining tendency as per capita income increases. It falls from about 70 per cent to nearly 30 per cent, roughly speaking. For workingclass households, however, this ratio does not show any rising or falling trend but seems to fluctuate around 60 per cent, broadly speaking. A comparison of the engel ratio for food between middleclass and workingclass households suggests that at all the centres at the same level of per capita income a workingclass household tends to have a higher engel ratio for food than a middleclass household. Only at very low levels of per capita income the interclass difference in engel ratio for food appear to be small.

Engel ratios for non-food items, however, fail to show any clear pattern for either of the social classes. A broad increasing tendency is observed for the engel ratio for clothing for the workingclass households at Kanpur and Madras. The corresponding ratios for middleclass households at these centres do not show any definite trend. However, for the middleclass households at Ahmedabad the engel ratio for clothing tends to rise with per capita income. A similar tendency is observed, though less

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[4/] Similar comparisons will be made later (<u>vide</u> Section 5.6.2 <u>Infra</u>) on the basis of the log-log-inverse engel curves fitted to the expenditure data for the two social classes in respect of a detailed list of items.

vividly, for the middleclass households at Calcutta. For the workingclass households at Calcutta and Ahmedabad, the engel ratio for clothing does not show any clear trend.

The engel ratio for housing and fuel and light shows an increasing tendency for the middleclass households at Ahmedabad, Calcutta and Madras. In all the remaining cases, the engel ratio does not seem to follow any simple pattern over the size classes of per capita income.

Finally, for the miscellaneous group of items, the middleclass households at all the four centres show a sharply rising trend in the engel ratio, while for the workingclass households at different centres the engel ratio for miscellaneous items increases less with per capita income. Only for the workingclass at Madras this ratio increases steadily from 0.13 to 0.23 over the observed range of per capita income.

On the whole a middleclass households at all the centres tend to spend relatively more on non-food items, viz., clothing, housing and fuel and light and miscellaneous items than a workingclass household at the same level of per capita income. A workingclass household on the other hand, tends to have a relatively large food expenditure compared to a middleclass household at the same level of per capita income. This interclass difference in the engel ratio food cannot be fully accounted for by factors like household size (<u>vide</u> Section 5.8 <u>Infra</u>). It is true that the workingclass households are generally smaller in size than the middleclass ones at the same centre.[5] It may thus appear that the inter-class divergences in the engel ratio for food can be explained in terms of the inter-class differences in household size. But since ecoromies of scale in food consumption are generally small only a part of the divergence between the food expenditure patterns for the two classes of households would be removed if the household sizes of the two social classes could be equalized. However, usually the proportion of adult members in workingclass households is higher, and since the adults in such households are mostly engaged in sedentary work, a part of the divergence in food expenditure would be explained by compositional factors. Below we have attempted an examination of the inter-class differences in expenditure pattern by eliminating the effects of the household size factor. It must be noted, however, that in this examination as elsewhere in this study, we have ignored the influences of household composition altogether.

5.6 Engel curve analysis :

As mentioned above, inter-class differences in expenditure pattern arise partly out of differences in consumption attitude and need of the two classes of households under study and partly out of the inter-class differences in household size and composition. In the present section we have summarised the results of engel curve analyses carried out for the two social classes in respect of a number of items of expenditure. This

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[5] Only exception to this general tendency is seen for Madras where the inter-class divergence in household size is clearly very small.

detailed study of the component of total consumer expenditure will give a more detailed picture of the inter-class differences in consumption attitude.

5.6.1 Results based on constant elasticity engel curves :

For both the social classes at each centre constant elasticity (DL) engel curves of the form $\log y = \alpha + \beta \log x$ (where y : per capita item expenditure, x : per capita total consumer expenditure and α, β are parameters) were fitted for the items mentioned in section 5.4. In each case, the usual weighted least squares procedure was applied to the expenditure data classified by per capita monthly income, taking the number of sample persons in different intervals of per capita income as the weights. Thus, in each case $\Sigma_i (\log \bar{y}_i - \alpha - \beta \log \bar{x}_i)^2 p_i$ is minimized with respect to α and β . Here $\bar{y}_i$ and $\bar{x}_i$ are the estimated average per capita item expenditure and total consumer expenditure, respectively, for the ith per capita income class and p_i, the number of sample persons in that class.

Tables 5.5 and 5.6 present the estimates of engel elasticity (π) and the coefficients of determination (R^2) associated with the DL engel curves fitted to expenditure data on different items. Tables 5.5 and 5.6 cover the workingclass and middleclass at the four different centres respectively.

Judged by the R^2, it appears that for middleclass households at all the centres, the DL form gives satisfactory description of the expenditure pattern for most of the non-food items, e.g., fuel and light,

Table 5.5 : Engel elasticity (π) based on constant elasticity engel curves along with associated coefficients of determination (R^2) obtained from itemwise expenditure estimates tabulated by classes of per capita income : Workingclass FLS, 1958-59.

item	Ahmedabad		Calcutta		Kanpur		Madras	
	π	R^2	π	R^2	π	R^2	π	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. cereals & products	0.55	0.90	0.21	0.56	0.63	0.98	0.14	0.06
2. pulses	0.49	0.89	0.72	0.93	0.76	0.96	0.56	0.43
3. cereals & pulses	0.54	0.91	0.23	0.73	0.65	0.98	0.19	0.10
4. edible oil	0.63	0.80	0.58	0.93	0.75	0.95	0.55	0.47
5. meat, fish & egg	0.39	0.47	0.92	0.87	0.93	0.68	0.72	0.63
6. milk & products	1.26	0.97	0.50	0.34	1.47	0.98	1.09	0.71
7. fruits	1.12	0.76	1.10	0.46	1.38	0.95	1.37	0.9[illegible]
8. vegetables	0.59	0.97	0.87	0.94	1.17	0.98	0.42	0.32
9. spices	0.51	0.91	0.78	0.90	0.88	0.99	0.50	0.35
10. prepared meals	2.48	0.95	3.11	0.96	2.07	0.97	1.70	0.79
11. food - total	1.00	0.99	0.89	0.99	0.89	0.99	0.83	0.96
12. pan, supari & tobacco	1.54	0.96	1.47	0.85	1.03	0.97	[illegible]	[illegible]
13. fuel & light	1.07	0.68	0.82	0.97	0.83	0.97	0.58	[illegible]
14. housing	1.18	0.90	0.82	0.78	1.05	0.95	1.25	0.95
15. clothing	1.25	0.98	1.21	0.62	1.37	0.99	1.34	0.9[illegible]
16. education & reading	-	-	-	-	-	-	0.95	0.67
17. personal care	1.09	0.96	1.15	0.94	1.13	0.99	0.91	0.93
18. medical care	1.28	0.55	1.24	0.44	1.05	0.89	1.22	0.85
19. recreation	1.69	0.85	2.53	0.84	1.66	0.82	1.80	0.99
20. transport	1.14	0.85	2.04	0.94	1.71	0.89	1.49	0.95
21. personal effects	0.69	0.15	1.61	0.52	1.36	0.64	3.05	0.69

Table 5.6 : Engel elasticity (π) based on constant elasticity engel curves along with associated coefficients of determination (R^2) obtained from itemwise expenditure estimates tabulated by classes of per capita income : Middleclass FLS, 1958-59.

item	Ahmedabad		Calcutta		Kanpur		Madras	
	π	R^2	π	R^2	π	R^2	π	R^2
(1)	(2)	(3)	(		(6)	(7)	(8)	(9)
1. cereals & products	0.22	0.64	0.12	0.54	0.32	0.77	0.07	0.22
2. pulses	0.07	0.04	0.12	0.48	0.24	0.57	0.28	0.54
3. cereals & pulses	0.20	0.55	0.12	0.55	0.32	0.78	0.10	0.32
4. edible oil	0.28	0.74	0.42	0.84	0.40	0.64	0.36	0.80
5. meat, fish & egg	0.83	0.36	0.82	0.92	1.34	0.84	0.77	0.95
6. milk & products	0.97	0.93	1.02	0.93	0.94	0.93	0.89	0.85
7. fruits	1.09	0.92	1.45	0.98	1.36	0.94	1.12	0.98
8. vegetables	0.61	0.85	0.30	0.79	0.80	0.92	0.42	0.88
9. spices	0.45	0.90	0.33	0.87	0.38	0.40	0.27	0.66
10. prepared meals	2.06	0.95	1.75	0.98	1.61	0.92	1.52	0.97
11. food - total	0.65	0.98	0.67	0.99	0.75	0.98	0.66	0.99
12. pan, supari & tobacco	1.01	0.86	1.24	0.98	0.99	0.93	0.91	0.93
13. fuel & light	0.68	0.94	0.65	[illegible]	0.67	0.78	0.65	0.98
14. housing	1.38	0.99	1.25	[illegible]	1.19	0.98	1.27	0.99
15. clothing	1.16	0.96	1.12	0.95	1.02	0.97	1.11	0.97
16. education & reading	0.91	0.51	1.04	0.91	1.03	0.83	1.21	0.83
17. personal care	0.84	0.96	0.89	0.99	1.01	0.99	0.77	0.99
18. medical care	1.04	0.49	0.98	0.98	1.26	0.80	1.00	0.74
19. recreation	2.24	0.91	1.73	0.96	1.23	0.97	1.59	0.97
20. transport	1.76	0.82	1.28	0.99	1.28	0.81	1.58	0.95
21. personal effects	1.39	0.79	1.90	0.96	0.98	0.73	1.64	0.85

housing, clothing, personal care and recreation. But the fits are relatively poor for most of the food items. Only in the cases of prepared meals, fruits, milk and products and total food the DL form provides satisfactory explanation of the variation in item expenditures. It is interesting to note that most of these food items may be regarded as "relative luxuries". For workingclass households at Kanpur, the DL form explains the variation in expenditure on many food and non-food items quite satisfactorily. For Madras the DL form is more or less satisfactory for most of the non-food items. However, for this centre the expenditure pattern for individual food items of the workingclass is not explained satisfactorily by the DL form. For Calcutta, the DL form appears to be satisfactory in all the cases excepting cereals and products, milk and products, fruits, clothing, medical care and personal effects. Finally, Ahmedabad, the DL engel curves prove to be satisfactory in general, the exceptions being meat, fish and egg, fuel and light, medical care and personal effects.

As regards the nature of the items of consumption, the estimated elasticities indicate that among the food-items fruits and prepared meals are luxuries for the both the social classes at all the centres. In addition to this, milk and product is also a luxury item for the workingclass at Ahmedabad, Kanpur and Madras and for the middleclass at Calcutta. The other food items are necessaries for both the social classes. For the workingclass the engel elasticity for total food varies between 0.83 (for Madras) and 1.00 (for Ahmedabad); for both Calcutta and Kanpur the elasticity is estimated to be 0.89. The estimated engel elasticities for total food for the middleclass are appreciably smaller than those for workingclass at different centres. In this case the engel elasticity ranges between 0.65 (for Ahmedabad) and 0.75 (for Kanpur). For Calcutta and Madras the corresponding elasticities are 0.67 and 0.66 respectively.

5.6.2 Results based on log-log-inverse (LLI) engel curves :

Although the DL curves appear to be satisfactory in many cases, for some food items mentioned above the fits are relatively poor, especially for the workingclass households. For example, expenditure on cereals and products, pulses and cereals and pulses by both the classes, those on spices and vegetables by workingclass at Madras, those on milk and products and fruits by workingclass at Calcutta, those on meat, fish and egg and pulses by middleclass at Ahmedabad are not explained satisfactorily by this form (this is shown by the low values of R^2 - vide tables 5.5 and 5.6). This deficiency might be partly due to inappropriate specification of the algebraic form of the engel curves. To illustrate, for workingclass households at Madras the per capita expenditure on cereals and products shows an absolute decline with rising level of per capita total consumer expenditure (PCE) beyond some level of PCE. The DL form naturally fails to describe such situations. We therefore tried the log-log-inverse (LLI) form of engel curve, i.e., $\log y = \alpha + \beta \log x + \frac{\gamma}{x}$ (where the symbols are as defined in section 5.6.1, γ being an extra parameter) as an alternative description of expenditure patterns for different items. It is wellknown that this form can explain widely varying situations because of the flexibility of its shape. This superiority of the LLI curve has also been established empirically (Goreux, 1964; Sinha, 1966; Singh, 1968; Maitra, 1969; Bhattacharya and Maitra, 1970).

For both the social classes at different centres the LLI curves were fitted for each item through weighted least squares procedure, i.e., by minimising $\Sigma\,(\log \bar{y}_i - \alpha - \beta \log \bar{x}_i - \frac{\gamma}{\bar{x}_i})^2\, p_i$ with respect to α, β and γ, where $\bar{y}_i$, $\bar{x}_i$ and p_i are as defined in section 5.6.1. The estimates of variable elasticity at any specified value of x is given by

$$\pi\,(x) : \hat{\beta} - \frac{\hat{\gamma}}{x}$$

where '$\wedge$' indicates estimated value.

To compare the engel elasticities based on the LLI form with those obtained from the DL curves, we used the notion of 'average elasticity' of a variable elasticity engel curves (Bhattacharya, 1972). The average elasticity, $\bar{\pi}$, of a variable elasticity engel curve is defined as

$$\bar{\pi} = \frac{\int_0^\infty \pi\,(x)\; f(x)\; g(x)\,dx}{E(y)}$$

where $y = f(x)$ ($= E(y|x)$) is the engel curve, $\pi\,(x)$ is variable elasticity at x and $g(x)$ is the density function of the marginal distribution of $x (0 \leq x < \infty)$. For the LLI curve, the $\bar{\pi}$ can be obtained from

$$\bar{\pi} = \hat{\beta} - \frac{\hat{\gamma}\, E(\frac{y}{x})}{E(y)}$$

where $E(\frac{y}{x})$ is expectation of the engel ratio, $\frac{y}{x}$, for the particular item, E(y) is of course, the overall mean of y.[6]

Tables 5.7 and 5.8 present the estimated $\bar{\pi}$ and the corresponding coefficient of determination (R^2) for the LLI curves fitted for different items separately by centre. Table 5.7 relates to the workingclass households and Table 5.8 to the middleclass households. A comparison of the R^2's associated with the LLI and DL forms show that in almost all the cases the LLI explains a substantially larger proportion of the variation in item expenditures (c.f. Tables 5.5 and 5.7; also Tables 5.6 and 5.8). For many food items the improvement in goodness of fit is quite remarkable. Even without calculating $\bar{R}^2$ and carrying out tests of significance, it seems safe to conclude that the improvement is often significant.

The estimated average elasticity, $\bar{\pi}$, from the LLI curves show satisfactory conformity with the correspond π estimated from DL curves. The cases where π and $\bar{\pi}$ differ appreciably are mostly those for which the DL curve gives a relatively poor fit as compared with the corresponding LLI curve. To illustrate, the divergence between π and $\bar{\pi}$ is considerable for cereals and pulses, prepared meals for the workingclass in Madras, for milk and products and recreation for the workingclass in Calcutta, and for meat, fish and egg for the middleclass in Ahmedabad. In all these cases the R^2 improved considerably as a result of fitting the LLI curves. There are also a few cases where the R^2's of DL and LLI

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[6] In actual practice, we have estimated $E(\frac{y}{x})$ for each item as the weighted average of $\frac{y(\bar{x}_i)}{\bar{x}_i}$ where $y(\bar{x}_i)$: the estimated y from the fitted LLI curve corresponding to $\bar{x}_i$ for the ith class of per capita income. The weights chosen were the share of total expenditure $\frac{\bar{x}_i p_i}{\Sigma \bar{x}_i p_i}$ going to the ith class.

Table 5.7 : Average engel elasticity ($\bar{\pi}$) based on log-log-inverse (LLI) engel curves along with associated coefficient of determination (R^2) obtained from itemwise expenditire estimates tabulated by classes of per capita income : Workingclass FLS, 1958-59.

item	Ahmedabad		Calcutta		Kanpur		Madras	
	$\bar{\pi}$	R^2	$\bar{\pi}$	R^2	$\bar{\pi}$	R^2	$\bar{\pi}$	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. cereals & products	0.66	0.93	0.31	0.76	0.63	0.98	0.29	0.52
2. pulses	0.65	0.97	0.75	0.93	0.76	0.97	0.64	0.77
3. cereals & pulses	0.59	0.93	0.35	0.86	0.65	0.98	0.33	0.55
4. edible oil	0.84	0.94	0.65	0.97	0.75	0.97	0.61	0.68
5. meat, fish & egg	0.56	0.48	0.95	0.90	0.90	0.75	0.79	0.87
6. milk & products	1.32	0.98	0.81	0.76	1.39	0.98	1.05	0.75
7. fruit	1.41	0.89	1.10	0.57	1.42	0.96	1.32	0.94
8. vegetables	0.68	0.97	0.92	0.98	1.16	0.98	0.53	0.65
9. spices	0.62	0.97	0.82	0.93	0.87	0.99	0.61	0.75
10. prepared meals	2.80	0.97	3.75	0.97	1.92	0.98	2.45	0.91
11. food - total	0.99	0.99	0.89	0.99	0.90	0.99	0.83	0.99
12. pan, supari & tobacco	1.52	0.96	1.56	0.89	1.04	0.97	0.96	0.98
13. fuel & light	1.18	0.72	0.84	0.98	0.84	0.99	0.65	0.82
14. housing	1.29	0.94	0.91	0.90	1.02	0.97	1.21	0.91
15. clothing	1.17	0.95	1.26	0.72	1.36	0.99	1.35	0.91
16. education & reading	0.59	0.21	1.10	0.42	-	-	0.96	0.74
17. personal care	1.12	0.96	1.16	0.97	1.13	0.99	0.91	0.93
18. medical care	1.70	0.73	1.38	0.65	1.02	0.90	1.19	0.91
19. recreation	1.78	0.93	1.84	0.92	2.14	0.88	1.79	0.99
20. transport	1.02	0.92	2.35	0.96	1.75	0.89	1.50	0.95
21. personal effect	1.17	0.26	1.36	0.65	1.21	0.68	3.03	0.69

Table 5.8 : Average engel elasticity ($\bar{\pi}$) based on log-log-inverse (LLI) engel curves along with associated coefficient of determination (R^2) obtained from item-wise expenditure estimates tabulated by classes of per capita income : Middleclass FLS, 1958-59.

item	Ahmedabad		Calcutta		Kanpur		Madras	
	$\bar{\pi}$	R^2	$\bar{\pi}$	R^2	$\bar{\pi}$	R^2	$\bar{\pi}$	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. cereals & products	0.23	0.65	0.15	0.93	0.37	0.88	0.11	0.70
2. pulses	0.12	0.09	0.17	0.92	0.23	0.57	0.31	0.88
3. cereals & pulses	0.21	0.56	0.15	0.86	0.35	0.85	0.14	0.77
4. edible oil	0.26	0.76	0.45	0.97	0.51	0.85	0.38	0.94
5. meat, fish & egg	0.70	0.70	0.79	0.99	1.29	0.87	0.79	0.97
6. milk products	1.04	0.98	0.95	0.99	0.98	0.99	0.83	0.99
7. fruit	1.08	0.92	1.37	0.99	1.29	0.98	1.07	0.99
8. vegetables	0.67	0.92	0.34	0.95	0.82	0.98	0.43	0.97
9. spices	0.49	0.94	0.34	0.89	0.24	0.61	0.29	0.91
10. prepared meals	2.04	0.95	1.80	0.98	1.90	0.97	1.52	0.97
11. food-total	0.63	0.98	0.67	0.99	0.76	0.99	0.66	0.99
12. pan, supari & tobaco	0.98	0.90	1.24	0.98	0.99	0.94	0.98	0.95
13. fuel & light	0.77	0.96	0.65	0.99	0.68	0.99	0.65	0.99
14. housing	1.37	0.99	1.24	0.99	1.19	0.98	1.26	0.99
15. clothing	1.20	0.96	1.05	0.98	1.07	0.97	1.06	0.98
16. education & reading	0.93	0.52	0.94	0.99	1.01	0.88	1.03	0.96
17. personal care	0.86	0.97	0.89	0.99	1.01	0.99	0.76	0.99
18. medical care	1.01	0.49	1.00	0.98	1.20	0.88	0.98	0.75
19. recreation	2.08	0.92	1.46	0.99	2.03	0.98	1.47	0.98
20. transport	1.74	0.82	1.72	0.99	1.40	0.84	1.72	0.96
21. personal effects	1.40	0.79	1.74	0.97	0.97	0.75	1.55	0.86

curves do not differ substantially but π and $\bar{\pi}$ show some divergence. This happens, for example, for fuel and light for the middleclass in Ahmedabad, for recreation for the middleclass in all the centres, for transport for the middleclass in Kanpur and Madras and for personal effects for the middleclass in Calcutta and Madras.

5.6.3 Graphical comparisons of engel curves for the two social classes

To bring out the nature of divergence between the consumer expenditure patterns of the two social classes, we present here the graphs of the fitted LLI curves for selected items. Figure 5.1 depicts the graphs for the four centres drawn over the range of per capita total consumer expenditure Rs. 20—Rs.80. This range seems appropriate since majority of the workingclass households in different centres fall in this range of per capita total expenditure (PCE). These graphs may be used for a preliminary comparison even though such comparisons are somewhat subjective. Since for most items the LLI curves give very good fit to the expenditure data, this type of comparison should be fairly adequate.

The graphs suggest that for Ahmedabad, the expenditure pattern for milk and products, fuel and light and personal care are fairly similar for the two types of households. For cereals and products, vegetables and prepared meals, on the other hand, the workingclass households tend to spend more than the middleclass ones at the same level of PCE and in each case the divergence tends to increase with PCE. Expenditure on transport incurred by middleclass households is somewhat higher than

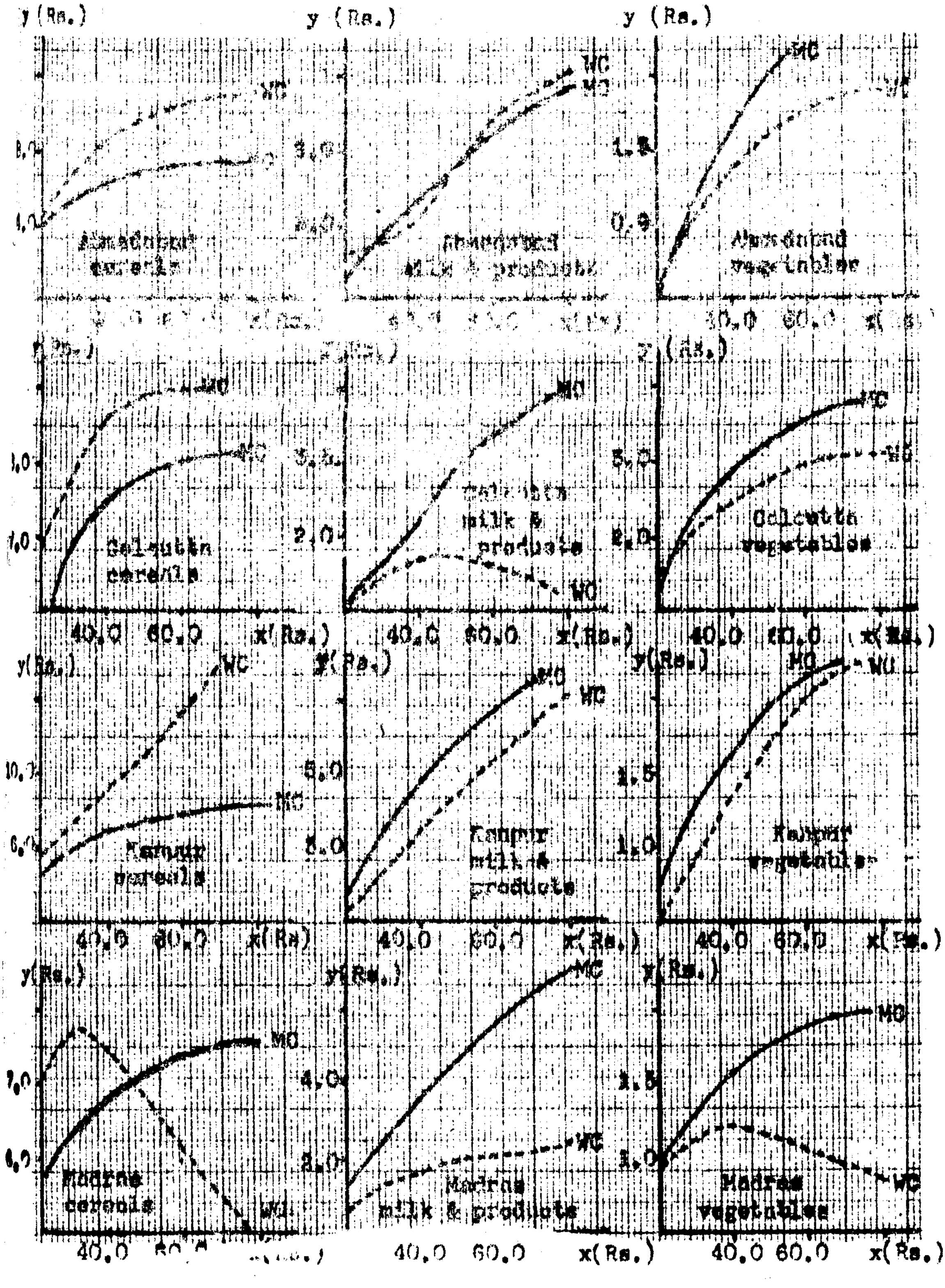

Fig. 5.1 : Showing the fitted LLI curves for the working class (WC) and middle class (MC) households at different centres for selected items : middle class and working class family living survey, 1958-59.

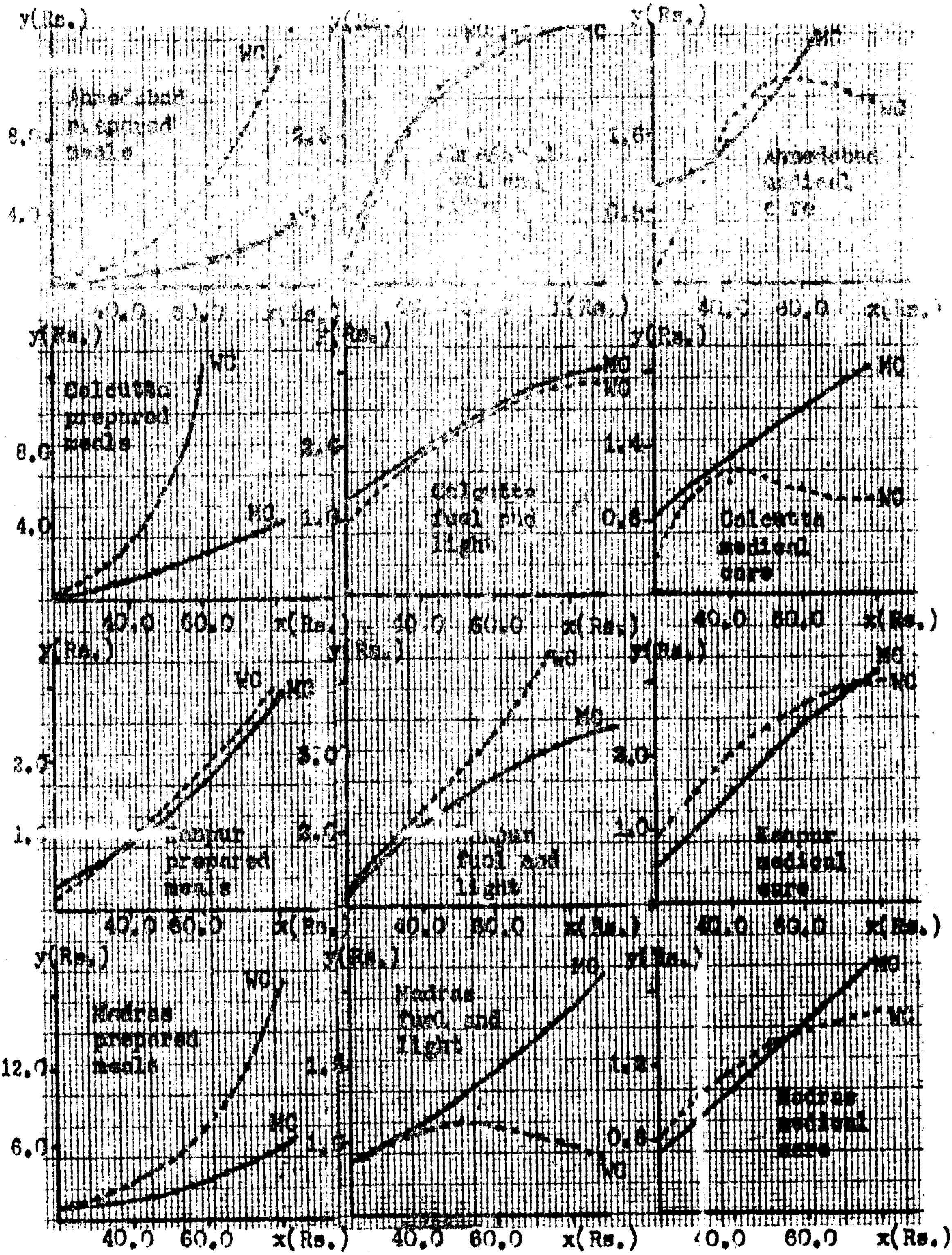
y(Rs.)
WC
MC
Ahmedabad
prepared
meals
8.0
4.0
40.0
60.0
x(Rs.)
y(Rs.)
MC
WC
Ahmedabad
fuel and
light
2.6
x(Rs.)
y(Rs.)
MC
WC
1.6
0.8
Ahmedabad
medical
care
40.0
60.0
x(Rs.)
y(Rs.)
WC
MC
Calcutta
prepared
meals
8.0
4.0
40.0
60.0
x(Rs.)
y(Rs.)
MC
WC
2.6
1.0
Calcutta
fuel and
light
40.0
60.0
x(Rs.)
y(Rs.)
MC
WC
1.4
0.6
Calcutta
medical
care
40.0
60.0
x(Rs.)
y(Rs.)
WC
MC
2.0
1.
Kanpur
prepared
meals
40.0
60.0
x(Rs.)
y(Rs.)
WC
MC
3.0
2.0
Kanpur
fuel and
light
40.0
60.0
x(Rs.)
y(Rs.)
MC
WC
2.0
1.0
Kanpur
medical
care
40.0
60.0
x(Rs.)
y(Rs.)
WC
MC
Madras
prepared
meals
12.0
6.0
40.0
60.0
x(Rs.)
y(Rs.)
MC
Madras
fuel and
light
1.8
1.2
WC
40.0
60.0
x(Rs.)
y(Rs.)
MC
WC
1.2
0.8
Madras
medical
care
40.0
60.0
x(Rs.)

Fig. 5.1 (contd.)

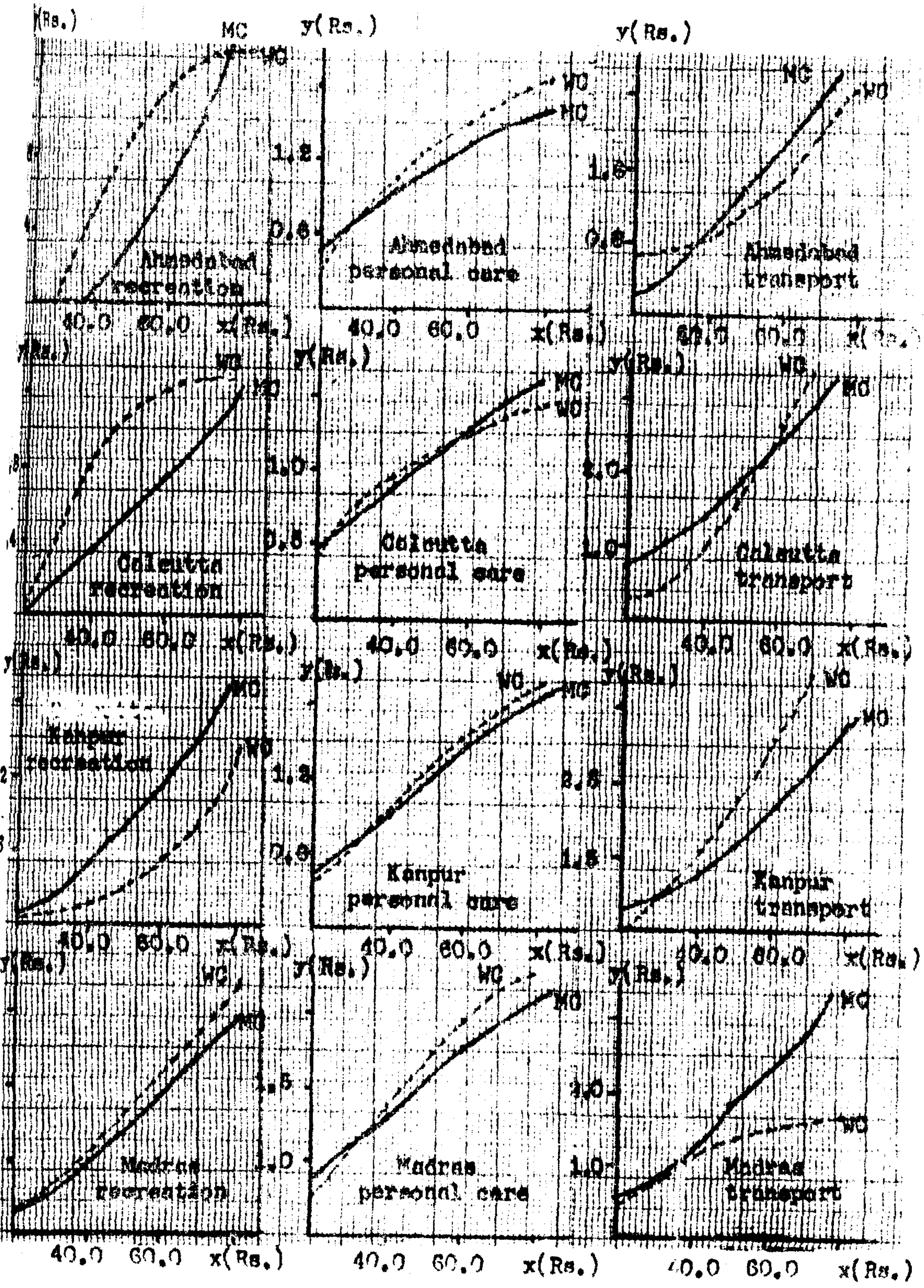
y(Rs.)
MC
WC
Ahmedabad recreation
40.0
60.0
x(Rs.)
y(Rs.)
WC
MC
1.2
0.8
Ahmedabad personal care
40.0
60.0
x(Rs.)
y(Rs.)
MC
WC
1.6
0.8
Ahmedabad transport
60.0
x(Rs.)
y(Rs.)
WC
MC
Calcutta recreation
40.0
60.0
x(Rs.)
y(Rs.)
MC
WC
1.0
0.5
Calcutta personal care
40.0
60.0
x(Rs.)
y(Rs.)
WC
MC
2.0
1.0
Calcutta transport
40.0
60.0
x(Rs.)
y(Rs.)
MC
Kanpur recreation
WC
40.0
60.0
x(Rs.)
y(Rs.)
WC
MC
1.2
0.6
Kanpur personal care
40.0
60.0
x(Rs.)
y(Rs.)
WC
MC
2.5
1.5
Kanpur transport
40.0
60.0
x(Rs.)
y(Rs.)
WC
MC
Madras recreation
40.0
60.0
x(Rs.)
y(Rs.)
WC
MC
1.5
1.0
Madras personal care
40.0
60.0
x(Rs.)
y(Rs.)
MC
2.0
WC
1.0
Madras transport
40.0
60.0
x(Rs.)

Fig. 5.1 (contd.)

those incurred by workingclass households at the same level of PCE. Similar inter-class divergences in expenditure pattern prevail also in Calcutta. The only exception is milk and products for which the workingclass households in Calcutta tend to spend much less than the middleclass ones at the same level of PCE.

The pattern of inter-class divergence is somewhat different in Kanpur, where the two social classes show similar expenditure patterns for prepared meals and personal care. The workingclass households tend to spend relatively more on cereals and products, transport, medical care and fuel and light, while for the other three items (viz., milk and products, vegetables and recreation) the reverse appears to be true.

For Madras, the expenditure pattern for medical care, personal care and recreation appear to be similar for the two social classes, while those for milk and products, fuel and light, prepared meals and transport indicate wide inter-class divergence. A peculiar phenomenon in the expenditure patterns of the workingclass is observed for this centre. The expenditures on cereals and products and vegetables tend to decline with increasing PCE. This apparently anomalous result may be partly explained by the relative large and increasing expenditure on prepared meals incurred by these households.

The observations based on graphical comparison of expenditure pattern of the two social classes thus indicate certain definite differences. However, it must be mentioned that not all of these differences need be significant. In the next section, therefore, we have tested the significance of the these differences through the analysis of co-vari technique.

5.7 Test of inter-class homogeneity of engel curves :

We next applied the analysis of covariance technique to test inter-class homogeneity of expenditure patterns. This was done in two ways; once employing the DL engel curves and again employing the LLI curves for describing the patterns of consumer expenditure in all the centres. Obviously, the results based on the LLI curves would be more definitive than those based on the DL curves.

5.7.1 Analysis of covariance based on DL curves :

We have tested the homogeneity of the engel curves of the form $\log y = \alpha + \beta \log x$ for the two social classes at each centre in respect of all the individual items of expenditure. Specifically, we tested three null hypotheses : (i) the hypothesis of homogeneity of slopes between the classes, (ii) the hypothesis of homogeneity of intercepts (assuming slopes to be same for both the classes), and (iii) the hypothesis of homogeneity of the relationship as a whole between the classes.[1/]

Precisely, we first tested whether the slopes are homogeneous. When the hypothesis of homogeneous slopes was not rejected, we tested whether the intercepts were homogeneous (assuming the slopes to be same). If this

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[1/] vide Appendix C for a detailed description of the procedure of analysis of covariance employed here.

was also not rejected we tested whether there was overall homogeneity, i.e. whether a single DL curve would be suitable for both the classes.

Table 5.9 presents the computed values of F-ratios associated with the three null hypotheses. These indicate whether the inter-class differences in the expenditure pattern for various items are statistically significant or not. The engel curves, it must be noted, have been assumed to have the DL form, and this is unrealistic for many items.

For Ahmedabad, complete homogeneity of the engel curves is established at the 5 per cent level of significance for milk and products, fruits, fuel and light, personal care, medical care, transport and personal effects. For meat, fish and egg, vegetables, spices, prepared meals, housing, clothing, education and reading and recreation only the slopes (elasticities) turn out to be same. In all other cases, even the slopes of the DL curves differ significantly between the two social classes.

For Calcutta, the engel curves for edible oil, meat, fish and egg, fuel and light, clothing, medical care, recreation and personal effects are homogeneous at the 5 per cent level of significance. Homogeneity of slopes is established for cereals and products, pulses, milk and products, fruits, pan supari and tobacco and education and reading. In the remaining cases the slopes i.e., engel elasticities are significantly different.

Complete inter-class homogeneity of engel curves at Kanpur is established for fruits, prepared meals, medical care and transport. For meat, fish and egg, pan supari and tobacco, housing recreation and personal effects the slopes are homogeneous while the intercepts vary for

Table 5.9 : Values of F-ratio associated with different null hypotheses obtained in the analysis of covariance tests of inter-class homogeneity of DL engel curves for different items, by centre : Working Class and Middle Class FLS, 1958-59*

item	Ahmedabad			Calcutta		
	F_1	F_2	F_3	F_1	F_2	F_3
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. cereals & products	9.55	-	-	0.51	5.74	-
2. pulses	6.78	-	-	1.58	8.22	-
3. cereals & pulses	9.62	-	-	19.42	-	-
4. edible oil	5.78	-	-	0.75	0.74	0.74
5. meat, fish & egg	0.63	41.94	-	0.12	0.12	0.12
6. milk & products	3.33	0.38	1.89	2.16	8.08	-
7. fruits	0.03	2.70	2.42	0.60	15.83	-
8. vegetables	0.50	12.22	-	11.98	-	-
9. spices	0.65	695.70	-	9.82	-	-
10. prepared meals	2.27	61.33	-	18.21	-	-
11. food-total	39.50	-	-	21.92	-	-
12. pan, supari & tobacco	5.40	-	-	0.76	114.60	-
13. fuel & light	1.80	0.38	1.10	4.06	1.98	3.28
14. housing	1.44	122.38	-	6.11	-	-
15. clothing	0.22	96.12	-	0.98	4.70	2.21
16. education & reading	3.10	49.12	-	2.08	18.38	-
17. personal care	4.78	0.51	3.03	6.30	-	-
18. medical care	0.12	0.52	0.54	0.30	2.26	2.28
19. recreation	1.35	5.15	-	2.65	1.90	3.49
20. transport	2.14	0.16	1.24	16.17	-	-
21. personal effects	0.85	0.58	1.00	0.21	0.02	0.12
degrees of freedom	(1,11)	(1,12)	(2,11)	(1,10)	(1,11)	(2,10)
critical F (5%)	4.84	4.75	3.98	4.96	4.84	4.10

* F_1 is associated with the null hypothesis : the slopes are equal, F_2 with the null hypothesis : the intercepts are equal (assuming equality of slopes) and F_3 with the null hypothesis : both slopes and intercepts are equal.

Table 5.9 (contd.)

item	Kanpur			Madras		
	F_1	F_2	F_3	F_1	F_2	F_3
(1)	(8)	(9)	(10)	(11)	(12)	(13)
1. cereals & products	11.87	-	-	0.13	0.50	0.30
2. pulses	14.24	-	-	0.15	0.15	0.15
3. cereals & pulses	23.74	-	-	1.29	0.86	1.52
4. edible oil	4.89	-	-	0.68	8.92	-
5. meat, fish & egg	1.16	5.46	-	0.02	17.08	-
6. milk & products	12.06	-	-	0.35	31.24	-
7. fruits	0.07	0.01	0.01	2.42	20.06	-
8. vegetables	9.36	-	-	0.03	3.18	2.97
9. spices	5.24	-	-	0.93	6.12	-
10. prepared meals	3.39	1.08	2.96	0.30	2.47	2.49
11. food-total	7.49	-	-	7.77	-	-
12. pan, supari and tobacco	0.02	141.92	-	0.03	88.52	-
13. fuel & light	5.58	-	-	0.14	0.70	0.40
14. housing	1.12	6.58	-	0.19	15.64	-
15. clothing	14.95	-	-	1.71	28.82	-
16. education & reading	14.99	-	-	0.47	15.71	-
17. personal care	5.10	-	-	2.18	2.22	3.49
18. medical care	0.45	3.41	3.50	0.36	0.05	0.23
19. recreation	2.95	5.02	-	1.71	0.07	0.93
20. transport	1.45	0.04	0.77	0.22	0.05	0.16
21. personal effects	0.73	6.45	-	2.91	1.38	3.05
degrees of freedom	(1,11)	(1,12)	(2,11)	(1,11)	(1,12)	(2,11)
critical F (5%)	4.84	4.75	3.98	4.84	4.75	3.98

the remaining items the engel curves are significantly different in respect of slopes.

Madras shows maximum inter-class homogeneity of expenditure patterns. For this centre, the expenditure patterns for cereals and products, pulses, vegetables, prepared meals, fuel and light, personal care, medical care, recreation, transport and personal effects are homogeneous at the 5 per cent level of significance. Only the slopes turn out to be similar in case of edible oils, meat, fish and egg, milk and products, fruits, spices, fuel and light, housing, clothing and education and reading. Only for food-total the slopes turn out to be significantly different between the two social classes.

5.7.2 Analysis of covariance based on LLI engel curves :

More definite results were obtained by applying the analysis of covariance to test the inter-class homogeneity of the LLI curves, $\log y = \alpha + \beta \log x + \gamma/x$.[8] Table 5.10 summarises the F-values associated with the null hypothesis that for both the social classes at any centre the LLI engel curves are exactly the same. These tests based on the LLI curve corroborated the main conclusions reached on the basis of the analysis of covariance tests applied to the DL engel curves.

The results of Table 5.10 indicate that for Ahmedabad, the hypothesis of inter-class homogeneity of the LLI curves can not be rejected at the 5 per cent level of significance for pulses, milk and products, fruits, fuel and light, personal care, medical care, transport and personal effects.

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[8] The actual procedure of analysis of covariance followed is described in Appendix C.

Table 5.10 : Values of F-ratio associated with the analysis of co-cariance tests for inter-class homogeneity of LLI engel curves for different items by centre: Workingclass and Middleclass FLS, 1958-59.

item (1)	Ahmedabad (2)	Calcutta (3)	Kanpur (4)	Madras (5)
1. cereals & products	28.12	10.79	23.10	2.68
2. pulses	2.67	38.92	11.12	2.23
3. cereals & pulses	22.73	16.32	20.03	2.39
4. edible oil	21.17	1.06	1.02	5.16
5. meat, fish & egg	33.73	2.27	3.44	18.43
6. milk & products	0.59	14.02	14.24	16.13
7. fruits	2.98	10.31	2.07	17.32
8. vegetavles	9.49	4.48	8.70	5.18
9. spices	702.47	61.58	26.32	13.48
10. prepared meals	47.23	15.85	7.03	5.20
11. food-total	37.51	41.00	4.97	6.52
12. pan, supari & tobacco	78.99	33.65	46.51	38.90
13. fuel & light	0.10	0.43	8.81	3.58
14. housing	60.03	21.38	5.08	3.20
15. clothing	47.66	2.40	1.63	7.60
16. education & reading	41.86	23.05	31.15	21.36
17. personal care	1.32	3.98	0.93	1.84
18. medical care	0.66	2.96	4.59	0.24
19. recreation	9.78	7.11	7.71	0.62
20. transport	0.57	20.17	1.01	0.33
21. personal effects	0.89	0.75	3.26	0.81
degrees of freedom	(3,11)	(3,9)	(3,11)	(3,11)
5 per cent critical value	3.59	3.86	3.59	3.59

It may be noted here that the tests based on DL curves also indicated overall homogeneity in all these cases excepting pulses.

For Calcutta, the inter-class homogeneity of the LLI curves is established in respect of edible oil, meat, fish and egg, fuel and light, clothing, medical care and personal effects. Here also, the results based on LLI curves confirm those obtained from the DL curves. The only exception is recreation, for which the DL curves appeared to be homogeneous for the two social classes whereas the test based on the LLI curves rejected the hypothesis of homogeneity.

Overall inter-class homogeneity of LLI engel curves at Kanpur is established for edible oil, meat, fish and egg, fruits, clothing, personal care, transport and personal effects. For this centre the tests based on DL and LLI curves give somewhat different pictures. Thus, while the tests based on the DL curves indicate that expenditure patterns are homogeneous only for fruits, prepared meals, medical are and transport, the tests based on the LLI curves show homogeneity for many other items, and reject the homogeneity of expenditure pattern for prepared meals and medical care.

For Madras, the results for the DL and LLI curves are quite similar; only the tests based on DL curves suggest homogeneity of expenditure patterns for spices and prepared meals which is not corroborated by the corresponding tests bases on the LLI curves.

To sum up, it may be mentioned that the pattern of inter-class homogeneity of expenditure behaviour is similar over centres for some of the items. For example, for personal effects the LLI curves are homogeneous for the two social classes at all the centres. Expenditure pattern for edible oil, meat, fish and egg, and clothing indicate inter-class homogeneity in Calcutta, Kanpur and Madras. Similarly, there is seem to be inter-class homogeneity in respect of expenditure on fruits, personal care and transport in Ahmedabad, Kanpur and Madras. Finally, it must be mentioned that for certain items such as education and reading and personal effects for the working class, even the LLI specification of engel curve seems inadequate. For these cases, the test of homogeneity of engel curves based on analysis of covariance would not be decisive.

5.8 Adjustments for differences in household size :

All the numerical exercises reported above are based on the tacit assumption that changes in household size would not result in any significant economies of scale in household consumption. This may be unrealistic for many items of expenditure for which economies are known to be substantial. The observed inter-class differences in engel curves might then be explained, at least partly, by the divergence in household size between the two social classes at different centres.

That there exists a systematic pattern of divergence in household size between the two social classes at each centre is borne out by Figure 5.2. For each centre the average of household size is plotted here against the logarithm of average per capita total expenditure as obtained from the data grouped by levels of per capita household income; the

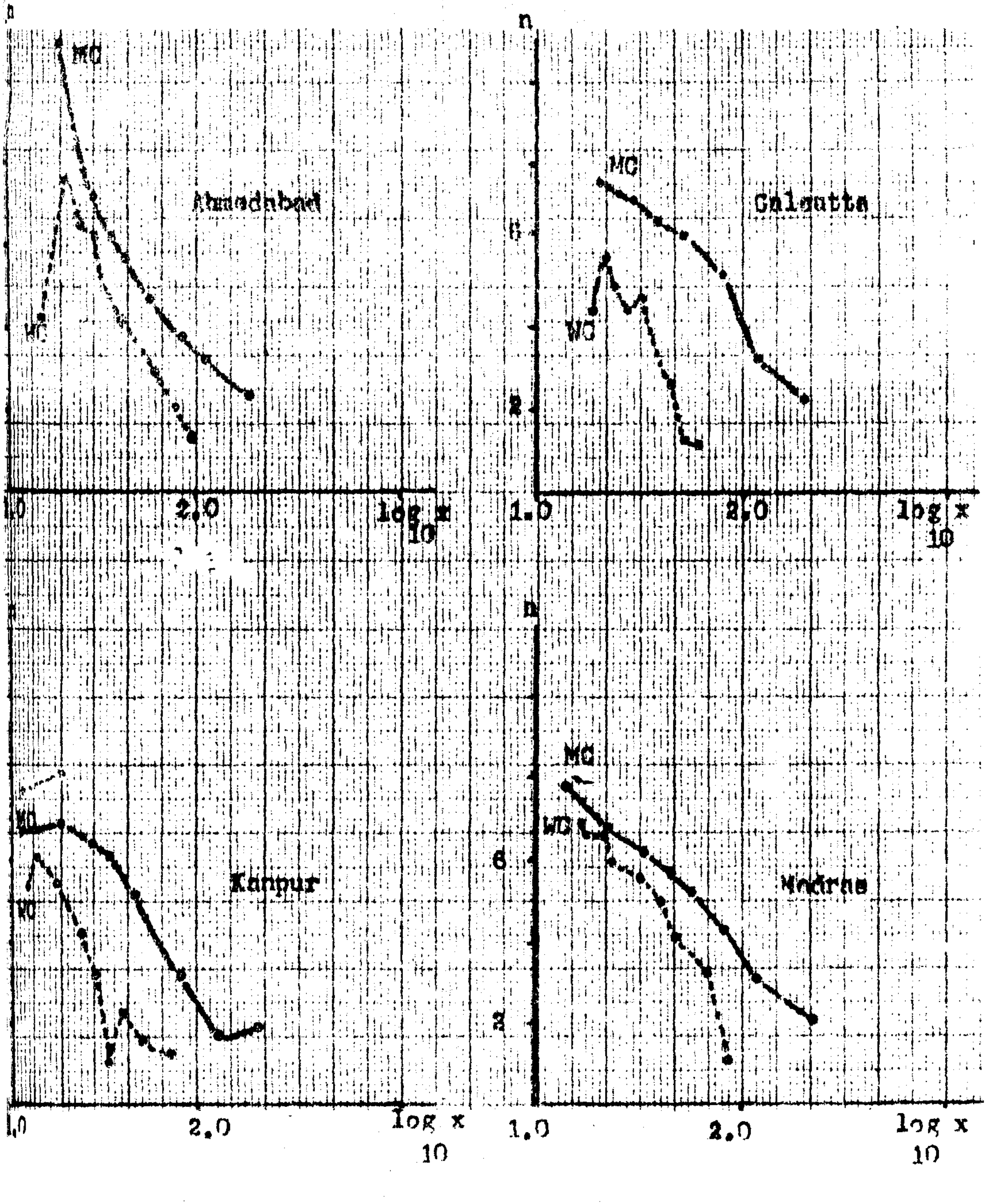

Fig. 5.2 : Showing observed household size (n) against logarithm of per capita total expenditure (x) for the working class (WC) and middle class (MC) households at different centres : working class and middle class family living survey, 1958-59.

graphs for middle class and working class are drawn on the same axes to facilitate comparison. The salient features of these graphs are :

(i) For both the social classes average household size decreases with increasing levels of per capita total expenditure.

(ii) For all the centres, the middle class households tend to have a larger average household size than the working class ones at the same level of per capita total expenditure.

(iii) The magnitude of inter-class differences in household size varies to some extent from centre to centre.

Figure 5.2 thus indicates that household size should be brought in for a more careful comparison of the expenditure patterns of middle class and working class households. An elaborate analysis of expenditure pattern using household size as an additional explanatory variable would require budget estimates cross-classified by per capita income/total expenditure and household size. Unfortunately, these were not available from the existing tabulations of NSS data. We, therefore, attempted to bring out the effect of household size on expenditures on some broad groups of items — viz., (i) food including beverages and tobacco, (ii) housing including fuel and light, (iii) clothing, and (iv) miscellaneous items — for which estimates were available for the middle class survey by classes of per capita household income and also, separately, by classes of household size[9]. Using these data we estimated the following

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[9] These two tables, each using one-way classification, were used to get the estimates that could be obtained from the two-way table (not available) using both the classifications.

generalized log-log-inverse (GLLI) engel function for the middleclass households at each of the four centres :

$$\log \left(\frac{Y}{n}\right) = \alpha + \beta \log \left(\frac{X}{n}\right) + \gamma \frac{n}{X} + \delta \log n$$

where α , β , γ and δ are the parameters. From the estimates of this function we worked out the estimated per capita item expenditure $\left(\frac{Y}{n}\right)$ for the middleclass households when the size (n) of middleclass was equated to that of the workingclass households at the same level of per capita total expenditure $\left(\frac{X}{n}\right)$. We then compared these estimates with the corresponding $\frac{Y}{n}$ for the workingclass households estimated from the ordinary log-log-inverse engel function fitted to the workingclass expenditure data. Such comparisons may be expected to give some idea about the contribution of household size to the observed inter-class differences in expenditure pattern.

5.8.1. Estimation procedure and numerical results :

For estimating the GLLI function introduced above, we combined the data available from the two one-way classifications. Precisely, the variance-covariance matrix of the explanatory variables was constructed by calculating the variances and covariances of $\log \left(\frac{X}{n}\right)$ and log $\left(\frac{Y}{X}\right)$ from the data classified by per capita income, and the variance of log n from the data classified by household size. Cov. $\left(\log \left(\frac{X}{n}\right), \log n\right)$ and Cov. $\left(\frac{n}{X}, \log n\right)$ were calculated as averages of the corresponding covariances obtained from the two classifications. Similarly, Cov $\left(\log \frac{Y}{n}, \log \frac{X}{n}\right)$ and Cov $\left(\log \frac{Y}{n}, \frac{n}{X}\right)$ were calculated from the table using per capita income classification, while the cov $(\log \frac{y}{n}, \log n)$ was obtained from the tabulations by classes of household size.

As per capita income is highly correlated with per capita expenditure, this procedure yields estimates of the parameters of the GLLI that are satisfactory approximations to the corresponding estimates which could be obtained from the ungrouped data 10/.

Table 5.11 presents the estimates of the parameters of the GLLI function. On the basis of these estimates we examined graphically the extent to which inter-class differences in expenditure pattern could be explained in terms of the divergences in household size. To be precise, we have compared the per capita item expenditure for the workingclass households estimated from the ordinary LLI engel function for this class with the corresponding per capita item expenditure for the middleclass households at same level of per capita total expenditure obtained from the GLLI function assuming the sizes of the middleclass and workingclass households to be same.

Figure 5.3 presents itemwise graphs of (i) the GLLI curve for the middleclass households, (ii) the GLLI curve for the middleclass households assuming that the two social classes have same household size at different levels of per capita total expenditure, and (iii) the ordinary LLI curve for the workingclass households, separately for each centre. For convenience of comparison Figures (i) - (iii) are drawn using the same scales

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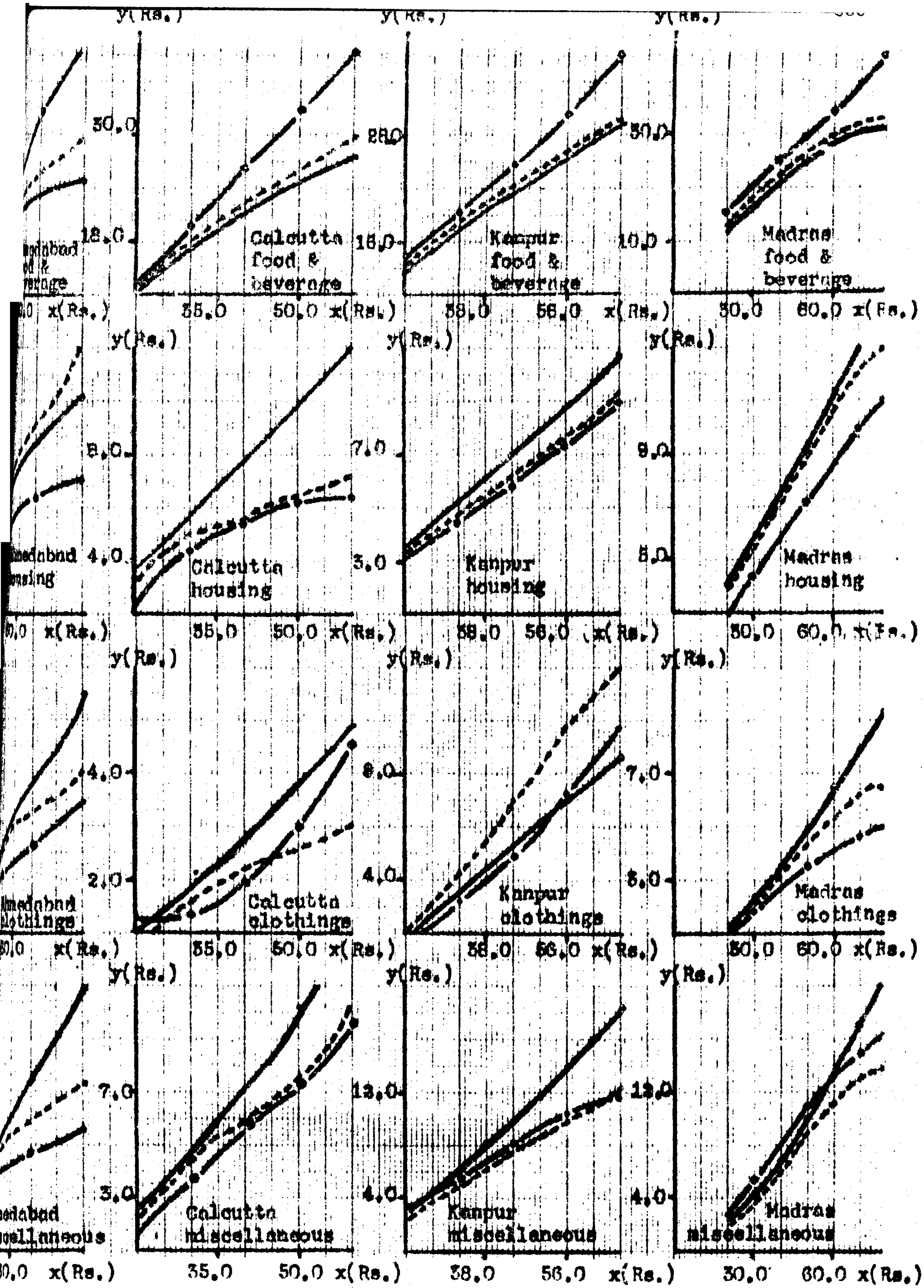
10/ Haitovsky (1968) developed an efficient procedure for the estimation of multiple regression equation from the tables based on (all the) one-way classifications of the data. The procedure followed here is simpler but perhaps less efficient.

Table 5.11 : Estimated values of the parameters of the generalized log-log-inverse engel function, by items and centres : Middle Class Family Living Survey, 1958-59.

centre	estimates of parameters			
	α	β	γ	δ
(1)	(2)	(3)	(4)	(5)
	(i) food including beverage			
Ahmedabad	2.42	0.30	-7.96	-0.18
Calcutta	1.24	0.55	-6.35	-0.03
Kanpur	0.98	0.59	-4.75	-0.01
Madras	1.51	0.49	-8.26	-0.02
	(ii) housing and fuel & light			
Ahmedabad	-1.00	0.88	8.33	-0.22
Calcutta	-3.79	1.38	6.18	0.34
Kanpur	-3.00	1.21	9.47	0.10
Madras	-2.35	1.11	3.98	0.11
	(iii) clothing			
Ahmedabad	-2.04	1.09	-33.87	0.24
Calcutta	-4.06	1.29	- 6.91	0.28
Kanpur	2.32	0.17	-36.33	-0.24
Madras	-4.26	1.39	- 9.30	0.36
	(iv) miscellaneous			
Ahmedabad	-3.89	1.52	-18.09	0.33
Calcutta	-4.41	1.61	3.93	0.21
Kanpur	-4.47	1.65	- 0.89	0.31
Madras	-4.69	1.65	2.17	0.32



ig. 5.3 : Showing the fitted GLLI curve for middle class (——), the fitted GLLI curve for middle class with household sizes of the two classes equalized (••••••) and the fitted LLI curve for the working class (—— • ——) at different centres for broad groups of items : middle class and working class family living survey, 1958-59.

(measuring per capita total expenditure and per capita item expenditure), separately for each item-group and also for each centre. It may be noted that these graphs have been drawn over the effective range of per capita total expenditure appropriate for the workingclass households. As stated earlier, the effect of household size is indicated by the divergence between graphs (ii) and (iii).

One common feature of the inter-class divergences can be read from the graphs; at all the centres, the per capita expenditure on food by workingclass households is appreciably higher than those incurred by middleclass ones at the same level of per capita total expenditure. Furthermore, the gap tends to increase with improvements in the level of living. No such uniformity is revealed by the graphs for other groups of items.

The graphs for Ahmedabad suggest that the equalization of household size tends to reduce the differences in expenditure pattern for food, clothing and miscellaneous items, although it does not eliminate the divergence completely. For housing, on the otherhand, the observed gap actually widens as a result of equalization of household size.

The graphs for Calcutta show that the inter-class differences in expenditure pattern for housing and miscellareous items tend to be eliminated as a result of the equalization of household size. For the other two item-groups the gap persists and tends to widen with increase in per capita total expenditure.

In case of Kanpur, the equalization of household size reduces the gap in expenditure patterns for food and housing but for food the gap that remains after the adjustment is still quite large. For clothing and miscellaneous items, equalization of household size tends to widen the divergence in expenditure pattern.

Finally graphs for Madras suggest, that the equalization of household size has little effect on the wide inter-class differences in expenditure pattern for food, housing and clothing. In case of miscellaneous items, the equalization of household size tends to increase the underlying differences.

To sum up, it is clear that inter-class differences in expenditure patterns, by and large, cannot be explained satisfactorily in terms of divergences in household size between the two social classes under study. In most of the cases, especially for food expenditure, the equalization of household size does not eliminate or substantially narrow observed inter-class differences in engel functions.

5.9 Some concluding observations :

In view of the results obtained above, it is clear that inter-class differences in consumer expenditure pattern are significant and systematic for many items. Since the equalization of the size of middle-class and workingclass households at any centre is seen to have very little effect on the observed differences, these differences cannot be explained by inter-class divergences in household size. In general, working class households tend to more on food than middleclass ones at the same level of per capita expenditure, while the position is reversed for non-food items such as housing and clothing. In fact, these differences reflect the differences in tastes/ needs of the two social classes that arise for two primary reasons. First, the workingclass households engaged in manual works have a typical calorie requirement and need for other consumables which is entirely different fro those of middleclass households engaged in sedentary jobs. Finally, size and compositional difference of the two types of households also give rise to different types of needs and tastes.

As regards the forms of engel function for different items, the LLI form provides satisfactory description of the expenditure pattern for most of the items for both the social classes. The constant elasticity form* gives comparable fit for most of the non-food items. It is interesting to note that in many cases the average elasticity of the LLI curve compares satisfactorily with the constant elasticity based on the double-log curves.

We may conclude the analysis by pointing out some of its procedural limitations. First, we have explored only the overall effects of differences in social class on expenditure pattern and have made no attempt to identify the origin of these differences which would require an essentially dynamic analysis of the income-expenditure process. In the present case, we have abstracted from all such complications.

Next, the procedure adopted for fitting the GLLI engel function might have been improved through adopting Haitovsky's technique which is known to yield efficient results. However, it is believed that the results arrived at through our simplified procedure have not given any distorted or biased picture of the inter-class differences.

Third, the effects of household composition on expenditure pattern have been ignored altogether in the study. Presumably proportion of males is higher in workingclass households; and the same is probably true of the proportion of adults. As it has been mentioned already, this means that the needs of the two types of households are somewhat different in nature. Thus the neglect of household composition may partly be responsible for the failure to explain the observed pattern of inter-class differences in expenditures.

Finally, we have ignored the inter-class differences in consumer prices which may have some role in the shaping of the divergent expenditure patterns.

Chapter VI

Effect of relative prices on engel elasticity for cereals in India

6.1 Introduction :

An explanation of internatonal variation in engel elasticity for any specific commodity has been that this elasticity depends upon the standard of living of the society in view. Since income level reflects this standard, inter-country differences in engel elasticity can largely be explained by the corresponding differences in the level of income. The same argument may be advanced to explain, to a considerable extent, the intertemporal movements of engel elasticity for a specific commodity in any society.

In this chapter we report the results of examination of another hypothesis regarding the variation of engel elasticity for a specific commodity proposed by Houthakker (1957). Precisely, we have examined how far intertemporal movements of engel elasticity for cereals and cereals substitutes in India could be explained by the corresponding movements in relative prices of this item-group of consumption.

It may be worthwhile to refer here to work done by Stone (1954) and Houthakker (1957) in this context. Stone showed how the engel elasticity for food changed with variation in income, demonstrating a negative correlation between the two. As for example, the expenditure elasticity for food in the U.K. declined from 0.96 in 1900 to 0.57 in 1938 and to 0.26 in 1960, presumably as a result of economic development[1]. This idea apparently simplified many developmental issues : If international differences in demand pattern result primarily from differences in income levels, the future demand pattern for the poorer countries could, in principle, be projected on the basis of the experience of the more advanced countries, provided the expected change in the level of income were known.

Table 6.1 : Country-wise estimates of engel elasticity for food

country/region	food elasticity	
	unadjusted*	adjusted**
(1)	(2)	(3)
Australia, Queensland	0.390(0.037)	a***
Canada	0.867(0.051)	0.712
China, Peiping	0.651(0.011)	0.591
China, Sanghai	0.769(0.085)	0.617
France	0.581(0.035)	a
United States	0.816(0.015)	0.642

* These are gross estimates of food elasticity with respect to total expenditure, no allowance being made for variation in household size. Figures in parentheses indicate standard errors.

** These are obtained by reducing each elasticity in col. (2) by 0.28γ, where γ is the estimated elasticity of household size with respect to total expenditure and 0.28 measures the elasticity of food expenditure with respect to household size estimated over all countries.

*** Estimates were not available.

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[1] Such variation of engel elasticity with level of living can be captured very conveniently by an engel curve of the log-log-inverse or the Aitchison-Brown sigmoid form.

In a study on international comparison of household expenditure pattern Houthakker (1957) pointed out the inadequacies of such an explanation of international variation in engel elasticity by citing examples which contradicted the hypothesis. Table 6.1 presents some interesting food elasticities estimated for a few countries. It may be noted from Table 6.1 that the adjusted elasticity for the U.S.A. and Canada are high compared to those of China and France. Houthakker suggested that such differences in engel elasticity might be explained by (i) variations in the price of the commodity concerned relative to the general price level and (ii) also by the variations in the relative prices of the items constituting the commodity group. As the price of the commodity-group rises relative to the general price level, its engel elasticity may rise. Again, if the items in the commodity-group are split up into superior and inferior items, a change in the prices of superior items relative to those of the inferior items may affect the engel elasticity for the commodity-group as a whole[2].

Thus in any situation the pattern of demand reflected by the engel elasticities possibly depends upon the price structure. If this is

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[2] Cramer (1970) also conjectured a positive correlation between the engel elasticity and the relative price of a 'good' (i.e., a specific variety or brand of a consumable sold at a single price). He argued that for any commodity (meaning thereby a set of 'goods' quantities of which can be added) the quality elasticity measures simply a weighted covariance of the relative prices and the quantity elasticities of the constituent 'goods'. Since empirical results indicate all quality elasticities to be positive, this means that the relatively expensive 'good' has the higher engel elasticity.

true, then a knowledge of the interrelationships between relative prices and engel elasticities may be useful for forecasting patterns of demand where relative prices cannot be assumed to remain unaltered through time. This may also throw some light on the nature of the dependence of demand on prices in addition to income or total expenditure.

In the present study we have attempted to examine the extent to which the engel elasticity for cereals and cereal substitutes in India is influenced by the relative price of cereals and cereal substitute as a group and also by the ratio of prices of superior and inferior items in the cereals group. In fact, the analysis reported here is based on time series of crosssectional estimates of engel elasticity for cereals estimated from different rounds of the NSS.

The organisation of the present chapter is as follows : Section 6.2 describes the sources and nature of the data, i.e., the time series of the value elasticity for cereals and cereal substitutes and the time series of prices that have been used in this study. Section 6.3 outlines the regression models that have been employed for studying the interrelationship between the engel elasticity and the relative prices. In Section 6.4 the nature of intertemporal movements of the variables have been briefly examined. Section 6.5 presents the results of regression analyses. Based on these results we indicate, in Section 6.6, how one could obtain empirical demand functions by studying the shifts in engel curves in response to relative prices. Finally, some concluding observations have been made in Section 6.7.

6.2 The data :

In the present chapter we examine the relationship between the engel elasticity for cereals and cereal substitutes and relative prices separately for rural and urban India. The data required for this purpose are basically the time series of (i) engel elasticity (value) for cereals and cereal substitutes, (ii) relative price of cereals and cereal substitutes, and (iii) the ratio of prices of superior and inferior cereals.

The value elasticities for cereals and cereal substitutes were estimated separately for the rural and urban sectors of the country using budget data from NSS Rounds 4, 5, 7-19 and 22 (covering the period from April, 1952 to June 1968)[3]. For each round, the constant elasticity engel curve $\log y = \alpha + \beta \log x$ (where y is per capita expenditure on cereals and cereal substitutes and x is per capita total consumer expenditure) was fitted by weighted least squares method; that is,

$$\sum_i w_i (\log \bar{\bar{y}}_i - \alpha - \beta \log \bar{\bar{x}}_i)^2$$

is minimized with respect to α and β , where $\bar{\bar{x}}_i$: estimated average per capita total consumer expenditure per 30 days for the i-th class of per capita monthly total consumer expenditure, $\bar{\bar{y}}_i$: the corresponding estimate of average expenditure on cereals and cereals substitutes per capita per

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[3] In the NSS cereals include rice, wheat, jowar, bajra, barley, maize, small millets, ragi, Bengal gram and their products obtained by parching, powdering etc. Cereal substitutes, on the other hand, include tapioca, pea etc. Since the earlier Rounds of NSS report total expenditure on cereals and cereal substitutes, the present analysis was carried out by considering the total expenditure on cereals and cereal substitute as a single group.

30 days, and w_i : the estimated proportion of population in the said class. Table 6.2 below gives the estimated engel elasticity for different rounds of the NSS separately for the rural and urban sectors of India as a whole[4].

Table 6.2 : Number of sample households and estimated engel elasticy (based on constant elasticity engel curves) for cereals and cereal substitutes by NSS rounds : all India rural and urban

NSS round number	period of enquiry	no. of sample households		engel elasticity for cereals and cereal substitutes	
		rural India	urban India	ruran India	urban India
(1)	(2)	(3)	(4)	(5)	(6)
4	April - Sept. 1952	8045	3887	0.6900	0.3100
5	Dec. 1952- March 1953	4190	1968	0.5900	0.3700
7	Oct. 1953- March 1954	1413	558	0.5075	0.3033
8	July 1954- March 1955	1869	1855	0.5471	0.2989
9	May 1955 - Nov. 1955	1616	2100	0.5647	0.3405
10	Dec. 1955 - May 1956	1616	1320	0.6136	0.3118
11	Aug. 1956 - Jan. 1957	7255	2840	0.5775	0.3013
12	March 1957-Aug. 1957	7248	2858	0.5696	0.3017
13	Sept. 1957- May 1958	6738	3583	0.5777	0.3106
14	July 1958 -June 1959	7589	2218	0.6065	0.2965
15	July 1959 -June 1960	7700	2201	0.5616	0.3371
16	July 1960 -Aug. 1961	3763	2568	0.5292	0.2685
17	Sept. 1961-Aug. 1962	7173	5247	0.5305	0.3041
18	Feb. 1963- Jan. 1964	21776	4296	0.5473	0.2455
19	July 1964- June 1965	14974	9943	0.5980	0.2459
22	July 1967- June 1968	15768	8623	0.6656	0.2888

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[4] It is wellknown that the constant elasticity form of engel curve is not fully satisfactory for cereals and cereal substitutes in India (Roy and Dhar, 1960; Maitra, 1969; Bhattacharya and Maitra, 1969; Sinha, 1966). However, we believe that for purposes of intertemporal comparisons the estimated constant elasticities would be more or less adequate. In fact, it has been shown that the bias in the estimated elasticity resulting from the constant elasticity specification of the engel curve is uniformly in the upward direction (Prais and Houthakker, 1955, pp. 3-95).

As regards the price statistics used in the present study, a co may be necessary at the outset. Since we are primarily interested in movements of price reatios (cereals price to general price level and superior cereals price to inferior cereals price), we have worked with consumer price indices (with base 1952-53 = 100) instead of using actual price estimates. Two sources of information have been utilized. First, we have made use of the all-India official monthly wholesale price indices for (i) cereals and cereal substitutes and (ii) for all items, and have averaged them over the months covered by different NSS rounds. We also have estimates of retail prices of cereals and cereal substitutes from different NSS rounds separately for rural and urban India. We thus constructed two series of relative price of cereals and cereal substitutes, one by deflating the wholesale price index of this group of items by the general wholesale price index $(\frac{P_w}{\bar{P}})$, and the other by deflating the NSS (retail) cereals price index by the general wholesale price index $(\frac{P_n}{\bar{P}})$[5/]. Table 6.3 gives these price relatives.

[5/] Since the wholesale price index of cereals and cereal substitutes and the corresponding general index are not available separately for the rural and urban sector of the country, we used the same $(\frac{P_w}{\bar{P}})$ for both sectors. The $\frac{P_n}{\bar{P}}$, on the other hand, could be constructed for each of the rural and urban sector separately since NSS retail cereals price index is available separately for these sectors. It may be mentioned that the general wholesale price index was adjusted by omitting two groups of items, viz., industrial raw materials and semi-manufactures.

Table 6.3 : Index of relative price of cereals and cereal substitutes (base 1952-53 = 100) over NSS rounds : all-India rural and urban.

NSS round number	NSS retail cereals, price index (P_w)/wholesale all commodity price index ($\bar{P}$)		Wholesale cereals price index (P_w)/wholesale all commodity price index ($\bar{P}$)
	rural India	urban India	all-India
(1)	(2)	(3)	(4)
4	1.08	1.02	0.97
5	0.96	1.02	0.93
7	0.86	0.86	0.91
8	0.75	0.78	0.81
9	0.76	0.76	0.80
10	0.82	0.82	0.86
11	0.88	0.86	0.91
12	0.90	0.85	0.94
13	0.90	0.85	0.92
14	0.96	0.86	0.94
15	0.86	0.84	0.89
16	0.83	0.81	0.82
17	-	-	0.80
18	-	-	0.85
19	-	-	0.92
22	-	-	0.99

* Since NSS retail cereals price index was available upto the 16th round the $\frac{P_n}{\bar{P}}$ ratio could be computed only for the period covered by NSS 4th - 16th round.

The series of indices of relative price of superior and inferior cereals ($\frac{P_s}{P_i}$) has been constructed by dividing the wholesale price index of superior cereals by the corresponding price index of inferior cereals. Here, rice and wheat have been taken as superior cereals, while jowar, bajra and ragi have been taken to represent inferior cereals. Table 6.4 presents the time series of the wholesale price indices of these items (averaged over the months covered by different NSS rounds) and also the superior-inferior cereals price ratios separately for the rural and urban sector.

In Table 6.4 the price indices for superior and inferior cereals have been worked out as weighted averages of the price indices of the constituent items of each group. The weights used are the percentages of total expenditure spent on each type of cereals estimated from NSS 14th round budget data. Since the weights are different for the rural and urban sectors of the country, the price indices for superior and inferior cereals and their ratio have been computed separately for rural and urban India.

Table 6.4 Movement of wholesale price indices (base 1952-53 = 100) of rice, wheat, jowar, bajra and ragi and the movement of ratio of price index of superior to inferior cereals over NSS rounds all-India rural and all-India urban.

NSS round number	price index of					price index*				ratio of price indices superior to inferior cereals	
	rice	wheat	jowar	bajra	ragi	rural India		urban India			
						superior cereals	inferior cereals	superior cereals	inferior cereals	rural India	urban India
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
4	85.1	84.8	102.5	90.6	-	85.05	98.03	85.00	98.95	0.8676	0.8590
5	78.5	89.6	97.1	93.4	-	80.03	95.72	82.51	96.01	0.8444	0.8594
7	92.8	91.3	95.3	94.5	98.7	92.49	95.44	92.26	95.42	0.9691	0.9669
8	80.0	74.2	71.6	76.8	73.6	78.79	73.57	77.91	73.20	1.0710	1.0644
9	78.3	66.8	58.2	80.3	62.7	75.90	66.07	74.16	64.62	1.1488	1.1476
10	83.8	82.2	95.0	93.0	63.8	83.46	90.53	83.22	91.34	0.9219	0.9111
11	97.8	90.3	127.8	129.8	92.2	96.23	124.11	95.10	124.78	0.7754	0.7621
12	105.0	92.4	124.5	136.5	102.3	102.37	125.72	100.46	125.52	0.8143	0.8003
13	103.6	85.9	102.6	115.5	104.8	99.90	107.14	97.23	106.30	0.9324	0.9147
14	103.4	107.0	108.6	128.6	104.0	104.15	114.67	104.70	113.54	0.9083	0.9221
15	108.3	94.2	121.3	124.7	115.4	105.35	121.71	103.22	121.63	0.8656	0.8486
16	106.5	89.6	118.0	134.1	120.1	102.93	123.59	100.34	122.56	0.8328	0.8187
17	106.9	92.2	120.2	128.7	113.1	103.83	122.15	101.61	121.79	0.8500	0.8343
18	122.6	93.5	112.1	126.8	110.3	116.51	116.34	111.66	115.48	0.9975	0.9670
19	133.7	136.0	200.4	180.1	186.3	133.60	191.19	133.94	192.74	0.6988	0.6949
22	212.0	199.1	222.5	242.5	213.6	208.43	227.13	206.53	226.10	0.9177	0.9134

* Weights used for averaging for superior cereals rural - rice : 79.11, wheat 20.89
urban - rice : 64.00, wheat : 36.00
for inferior cereals rural - jowar 54.65, bajra 33.14, ragi 12.21
urban - jowar 63.00, bajra 27.00, ragi 10.00

6.3 The regression model :

To examine the influence of relative price of cereals and cereal substitutes on the engel elasticity for this group of items, we have chosen the following constant elasticity specification

$$\log \pi_{vt} = \alpha + \beta \log \left(\frac{P}{\bar{P}}\right)_t + \varepsilon_t \qquad \ldots (6.3.1)$$

Here,

π_{vt} : estimated engel elasticity (value) of cereals and cereal substitutes during NSS round t ($t = 4, 5, \ldots, 22$).

$\left(\frac{P}{\bar{P}}\right)_t$: relative price of cereals and cereal substitutes during NSS round t.

For examining the effect of the superior cereals-inferior cereals price ratio, we have

$$\log \pi_{vt} = \alpha + \beta \log \left(\frac{P}{\bar{P}}\right)_t + \gamma \log \left(\frac{P_s}{P_i}\right)_t + \varepsilon_t \qquad \ldots (6.3.2)$$

where $\left(\frac{P_s}{P_i}\right)_t$ is the superior-inferior cereals price ratio during NSS round t. In both the specifications, ε_t is the disturbance term assumed to satisfy all the requirements of single equation classical least squares estimation.[6]

Finally, it may be mentioned that examination of the scatter diagrams relating $\log \pi_v$ to $\log \left(\frac{P_n}{\bar{P}}\right)$, $\log \left(\frac{P_{\text{[illegible]}}}{\bar{P}}\right)$ and $\log \left(\frac{P_s}{P_i}\right)$ showed

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[6] *It may be possible that ε_t in (6.3.1) and (6.3.2) is heteroscedastic because of variation in sample sizes among different* NSS rounds. Therefore, the ideal procedure would be using weighted least squares method of estimation where the weights should be the reciprocal of sampling variance of $\log \pi_{vt}$.

no significant nonlinearity. Hence, the log-linear specifications seem to be justified.

6.4 Intertemporal movements and simple correlations :

Intertemporal variation in engel elasticity, relative price of cereals and cereal substitutes and also of the superior-inferior cereals price ratio are shown in Figures 6.1 and 6.2 for rural and urban India respectively.

None of the variables in either sector shows any trend. As regards the range of π_v, for the rural sector this is 0.51-0.69 and ~~for the rural sector this is 0.51-0.69 and~~ for the urban sector it is 0.25-0.37. Movements of the two estimates of $\frac{P}{\bar{P}}$, viz., $\frac{P_w}{\bar{P}}$ and $\frac{P_n}{\bar{P}}$, and also of $\frac{P_s}{P_i}$ reveal some interesting features upto the 11th round of NSS (i.e., upto January 1957). During this period whenever $\frac{P}{\bar{P}}$ fell the $\frac{P_s}{P_i}$ increased. However, no such tendency is visible after this period presumably because of Government's intervention in the market for foodgrains. Government control over prices of superior cereals through rationing and imports led to a partly administered market for foodgrains, especially for superior cereals and in urban areas, so that one cannot expect to see the normal interplay of supply and demand in price movements over time.

The movement of π_v appears to be fairly correlated with those of $\frac{P_w}{\bar{P}}$ and $\frac{P_n}{\bar{P}}$ for rural India. For urban India, however, such correlations appear to be small. This is only to be expected since in urban areas the consumer were generally able to consume foodgrains according to their physical needs and limitations of budget did not matter much. The movement of $\frac{P_s}{P_i}$ over time fails to bear any definite relationship with π_v for both the sector.

6.5 Regression results :

Empirical results of relating the value elasticity of cereals and cereal substitutes (π_v) to relative price of cereals ($\frac{P_w}{\bar{P}}$ or $\frac{P_n}{\bar{P}}$), and the superior-inferior cereals price ratio ($\frac{P_s}{P_i}$) are presented in Table 6.5 separately for the rural and urban sectors of the country.

A glance at Table 6.5 at once suggests $\frac{P}{\bar{P}}$ to be an important factor influencing π_v for cereals and cereal substitutes in rural India. In almost all the estimated equations for this sector the coefficient of $\frac{P}{\bar{P}}$ is positive and significant, the only exception being the equation estimated from half-sample 1 data. $\frac{P_s}{P_i}$, on the otherhand, seems to have no significant influence on the engel elasticity for the item-group concerned for this sector. The computed values of von-Neumann ratio for the significant equations indicate the regression disturbances to be sensibly random; and thus the parameters need not be re-estimated by using autoregressive transformations of the variables.

Table 6.5 : Showing the estimates of the equations (6.3.1) and (6.3.2) : all-India rural and urban.

srl. no.	NSS rounds covered	half sample	constant term	estimate of coefficient of a/			R^2 b/	d. f. of residual s. s.	von Neu- [illegible]
				$\frac{P_n}{\bar{P}}$	$\frac{P_w}{\bar{P}}$	$\frac{P_s}{P_i}$			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				all India : rural					
1	4 - 16	comb.	-0.209	0.509** (0.980)	-	-	0.460** (8.520)	10	1.53*
2.	4 - 22	comb.	-0.201	-	0.842** (3.140)	-	0.413** (9.861)	14	1.42*
3.1	7 - 22	h. s. 1	-0.217	-	0.568 (1.652)	-	0.186 (2.730)	12	1.13*
3.2	"	h. s. 2	-0.209	-	0.691* (2.255)	-	0.298* (5.085)	12	1.66*
3.3	"	comb.	-0.212	-	0.662* (2.524)	-	0.348* (6.369(	12	1.40*
4.	4 - 22	comb.	-0.189	-	0.967** (3.058)	0.125 (0.775)	0.439* (5.090)	13	-
5.1	7 - 22	h. s. 1	-0.208	-	0.667 (1.636)	0.099 (0.504)	0.204 (1.407)	11	-
5.2	"	h. s. 2	-0.193	-	0.877* (2.478)	0.178 (1.040)	0.361 (3.100)	11	-
5.3	"	comb.	-0.204	-	0.759* (2.432)	0.093 (6.616)	0.368 (3.209)	11	-

a/ figures in parenthesis indicate t-ratios
b/ figures in parenthesis indicate F-ratios

* significant at 5 % level.
** significant at 1 % level.

Table 6.5 (contd.)

srl. no.	NSS rounds covered	half sample	constant term	estimate of coefficient of[a/] $\frac{P_n}{\bar{P}}$	$\frac{P_w}{\bar{P}}$	$\frac{P_s}{P_i}$	R^2 [b/]	d. f. of residual s.s.	von Neumann ratio
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(1
				all-India : urban					
6	4 - 16	comb.	-0.489	0.245 (0.980)	-	-	0.080	10	-
7	4 - 22	comb.	-0.508	-	-	0.260 (1.169)	0.089	14	-
8	"	comb.	-0.482	-	0.463 (0.914)	0.372 (1.458)	0.144	13	-
9.1	7 - 22	h.s.1	-0.499	-	-	0.638** (3.120)	0.449	12	-
9.2	"	h.s.2	-0.530	-	-	-0.015 (-0.069)	0.001	12	-
9.3	"	comb.	-0.510	-	-	0.300 (1.533)	0.164	12	-
10.1	"	h.s.1	-0.479	-	0.359 (0.716)	0.719* (3.024)	0.473	11	-
10.2	"	h.s.2	-0.514	-	0.278 (0.515)	0.048 (0.189)	0.024	11	-
10.3	"	comb.	-0.497	-	0.290 (0.599)	0.366 (1.596)	0.190	11	-

a/ figures in parenthesis indicate t-ratios

b/ figures in parenthesis indicate F-ratios

* significant at 5 % level.

** significant at 1 % level.

The results for the urban sector indicate that here the intertemporal variation of engel elasticity cannot be explained by the variation in relative prices. In fact, none of the estimated regression coefficients are statistically significant, excepting the coefficient of $\frac{P_s}{P_i}$ in the equation estimated on the basis of half-sample 1 data. Lack of correlation between π_v and the relative prices of cereals and cereal substitutes may be perhaps explained in the following manner : Distributional restrictions were imposed in respect of price and quantity of foodgrains available to urban consumers on several occasions during the period considered here. The consumers were not quite free to react to changes in relative price of cereals and cereal substitutes by varying quantities of cereals items to be purchased from the market. In fact, the urban market for foodgrains had been an administered one in which administered quantity did not perhaps maintain any relation with the corresponding administered price. If this were so and the administered quantity was smaller than actual need of the consumer, it is difficult to find any relation between engel elasticity of cereals and cereal substitutes and the corresponding relative price[7].

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[7] Actually, the quantity elasticity for cereals etc., in the urban sector is close to zero, indicating that the urban consumers, by and large, are able to consume this item according to their needs. But the value elasticity (π_v) that we have used is positive, though small. There is some variation of this elasticity over NSS rounds. Thus one could expect a relation between π_v and the relative price of cereals and cereal substitutes (although it is expected that the urban π_v would be less sensitive to relative price than that in the rural sector). Actually, this could not happen because of governmental controls in the urban markets for foodgrains,

6.6 Empirical demand functions for cereals and cereal substitutes :

Economic theory suggests the demand function for a commodity in its simplest form to be

$$q = q\,(\mu', P') \qquad \ldots \quad (6.6.1)$$

$$\mu' = \frac{\mu}{\bar{P}}, \quad P' = \frac{P}{\bar{P}}$$

where q is quantity demanded, μ is the money income of the consumer, P is the price of the commodity concerned and $\bar{P}$ is the all-commodity price level. In a study of cross-section data the engel elasticity (quantity) is defined as

$$\pi_q = \frac{\delta \log q}{\delta \log \mu} \qquad \ldots \quad (6.6.2)$$

π_q here is the quantity elasticity. In our empirical exercise we have worked with π_v. Let us assume (i) $\pi_q = \pi_v$, i.e., quality elasticity to be zero or (ii) π_v to be proportional to π_q. Our empirical results suggest π_v to be related to P through a relationship of the form, at least in rural India,

$$\pi_v = aP'^{\,b} \qquad \ldots \quad (6.6.3)$$

where a and b are constants. On integrating (6.6.3) we obtain

$$q = A\, f\,(P')\,(\mu')^{a(P')^{b}} \qquad \ldots \quad (6.6.4)$$

where $f(P')$ is some arbitrary function of P', and a, b and A are the structural parameters. Thus, formally we end up with an empirical demand function appropriate for rural India (where (6.6.3) holds good). It is clear that to have some idea about the nature of $Af(P')$, we must relate the level constants (as distinct from the elasticities) of the fitted constant elasticity engel curves to P' in the same way as done here for the elasticity. If this is done, we have an empirical demand function of the form (6.6.4) suitable for projection of demand for cereals and cereal substitutes in situations where both the level of income and relative price of the commodity are expected to vary.

In this context, we may refer to another extensive study of a similar nature by Bhattacharya and Maitra (1969). In their study based on all-India expenditure estimates from NSS rounds 7-19 and 22, the log-log-inverse (LLI) form of engel curve, $\log y = \alpha + \beta \log x + \gamma / x$, was found to be superior to three other forms, viz., hyperbola, semi-log and double-log. An examination of the time trends of the estimated parameters α, β and γ of the LLI form for different items over NSS rounds indicated that in most cases.

(i) $\alpha - \log P$ is linearly related to $\log(\frac{P}{\bar{P}})$, where P is the price index of the item concerned and $\bar{P}$ is the all-commodity price index;

(ii) β to be more or less stable over rounds; and

(iii) γ to be broadly proportional to $\bar{P}$ (excepting in cases where the double-log form was as good as the LLI, in these cases γ moved erratically over time).

On the basis of these observations, they specified the demand function as

$$\log\left(\frac{y}{p}\right) = \alpha + \beta \log\left(\frac{x}{\bar{p}}\right) + \gamma \frac{\bar{P}}{x} + \delta \log\left(\frac{P}{\bar{P}}\right) \qquad \ldots \quad (6.6.5)$$

However, this equation proved inadequate in many situation as this gives

$$\pi_{\bar{x}} = \beta - \gamma \frac{\bar{P}}{\bar{x}} \qquad \ldots \quad (6.6.6)$$

as the elasticity at average per capita total expenditure ($\bar{x}$) in any round. Since $\left(\frac{\bar{x}}{\bar{P}}\right)$ showed little trend over round, $\gamma_{\bar{x}}$ should have been stable over rounds in case (6.6.6) was fully satisfactory. Actually, clear trend in $\pi_{\bar{x}}$ was observed for several items such as clothing and sugar in the urban sector.

A closer examination revealed that for some items β of the LLI curve was linearly related to $\left(\frac{P}{\bar{P}}\right)$. Introducing this in (6.6.5) Bhattacharya and Maitra tried the form

$$\log\left(\frac{y}{p}\right) = \alpha + \left(\beta_0 + \beta_1 \frac{P}{\bar{P}}\right) \log\left(\frac{x}{\bar{P}}\right) + \left(\gamma_0 + \gamma_1 \frac{P}{\bar{P}}\right) \frac{\bar{P}}{x}$$

$$+ \delta \log\left(\frac{P}{\bar{P}}\right) \qquad \ldots \quad (6.6.7)$$

Finally, a third model

$$\log\left(\frac{y}{p}\right) = \alpha + \beta \log\left(\frac{x}{\bar{P}}\right) + \gamma \frac{\bar{P}}{x} \qquad \ldots \quad (6.6.8)$$

based on the usual notion of invariance of engel curves over different price situations was tried.

Equations (6.6.5), (6.6.7) and (6.6.8) were fitted for such items as cereals and cereal substitutes, pulses, milk and products, meat, fish, egg, sugar, edible oil and clothing separately for rural and urban India taking together the expenditure-classwise data for all the 14 rounds of NSS mentioned above. The price variables P and $\bar{P}$ were computed by averaging the monthly official wholesale price index (1952-53 = 100) for the item concerned and the all-commodity price index (excluding prices of industrial raw materials and semi-manufactures) over the months covered by each NSS round.

Table 6.6 : Coefficients of determination (R^2) for demand functions and engel curves for different items*: all-India rural and urban, NSS 7-22nd rounds.

item	rural India				urban India			
	eqn. (6.6.7)	eqn. (6.6.5)	eqn. (6.6.8)	LLI**	eqn. (6.6.7)	eqn. (6.6.5)	eqn. (6.6.8)	LLI
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. cereals & cereal substitutes	0.994	0.992	0.989	0.994	0.950	0.947	0.874	0.972
2. pulses	0.998	0.986	0.918	0.998	0.981	0.972	0.912	0.983
3. milk & milk products	0.979	0.977	0.976	0.987	0.982	0.982	0.981	0.987
4. edible oils	0.974	0.972	0.971	0.987	0.980	0.980	0.979	0.983
5. meat, fish & egg	0.955	0.954	0.943	0.963	0.974	0.974	0.959	0.974
6. sugar	0.983	0.982	0.970	0.987	0.970	0.963	0.917	0.984
7. clothing	0.985	0.981	0.977	0.986	0.972	0.970	0.969	0.981

* Source : Bhattacharya and Maitra (1969).

** Average over different NSS rounds.

Table 6.6 presents the coefficient of determination (R^2) for equations (6.6.5), (6.6.7), (6.6.8) and the corresponding values of R^2 for the LLI engel curve averaged over NSS rounds. These indicate that (6.6.5) and (6.6.7) are equally good while (6.6.8) is clearly inferior in some cases. However, in many cases this simple model proves to be nearly as good as the more elaborate ones.

6.7 Concluding observations :

In view of the results obtained above, it is clear that there is considerable evidence of the interrelatedness of the engel parameters and the level/structure of prices. In particular, our results show that at least for rural households in India the engel elasticity for cereals and cereal substitutes tend to vary with the price of cereals relative to general price level. This is important from the point of view of demand projection. If we succeed in identifying the factors responsible for the intertemporal drifts in engel elasticity, these factors may be incorporated in empirical studies to yield better predictions about the pattern of future demand.

We may conclude the present analysis by pointing out some of its procedural limitations. First, the engel elasticities examined here are based on constant elasticity engel curve, which does not have unquestionable merits so far as cereals and cereal substitutes are concerned[8].

Secondly, we have mostly worked with wholesale price indices and have therefore used the same set of price indices for rural and urban India in some of the steps. We should ideally use consumer price data and separate estimates for the rural and urban sectors of the country.

The third, and perhaps the most important, limitation is that the elasticities considered here refer to the total expenditures. Since majority of the households in rural India are agricultural in nature and the proportion of non-monetized transactions is quite high and since further, the pattern of consumption out of cash earnings and earnings in kind differ markedly (Mukherjee and Prasadarao, 1970) it would have been interesting to examine the effect of relative prices on the engel elasticity for cash and kind expenditures on cereals separately.

Finally, we have ignored the effects of varying age-sex composition of households as also other factors affecting consumption pattern, e.g., regional and occupational differences.

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[8] We checked that the squared correlation coefficient between the engel elasticity (π) computed from the constant elasticity engel curve and the elasticity at average x($\pi_{\bar{x}}$) computed from the LLI curve was 0.9996 for the rural sector. This suggests that for this sector the relationship between the engel elasticity and relative price obtained on the basis of constant elasticity engel curve is not vitiated by the choice of the engel curve form. For the urban sector, on the other hand, the R^2 between π and $\pi_{\bar{x}}$ turned out to be 0.62. However, even the variation of $\pi_{\bar{x}}$ could not be explained by the model (6.3.1).

Chapter VII

Occupational Variation in the Pattern of Consumer Expenditure in Rural India*

7.1 Introduction

Very little empirical study has been done in India to analyse the difference in the patterns of consumer expenditure among households belonging to different occupation groups. Needless to say, the primary reason for this is the paucity of relevant expenditure data. The present study based on a special tabulation of 18th round NSS data (February 1963-January 1964) covering the whole of rural India, is concerned primarily with the examination of differences in expenditure pattern of rural households having different types of agricultural occupations.

Rural households in India are predominantly agricultural and are engaged in a variety of agricultural activities. It is, therefore, natural to expect considerable variation in the patterns of consumption among households having different types of activities. Further, since the rural sector of the country is relatively less monetized, a part of total consumer expenditure of a rural household is of the nature of expenditure in kind incurred through consumption out of home-grown stocks or through barter exchange. The extent of such transactions would normally vary across households depending, among other things, on the

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* The results reported in this Chapter constitute a part of an yet unfinished wider study on different aspects of monetized and non-monetized consumer expenditure in rural India. The author thanks Dr. Robin Mukherjee and Dr. D. S. P. Rao, with whom he has been working on this project, for their many helpful suggestions in preparation of this Chapter.

level of living, type of occupation and regional factors.

In what follows we have compared the itemwise expenditure patterns of four groups of rural households viz., cultivators, agricultural labourers, other agricultural occupation-holders and non-agricultural households. We have also examined the pattern of cash and kind expenditure on different items for these groups of households and compared the relationships between cash item and total cash expenditure and between kind item and total kind expenditure across occupation types.

The organisation of the present Chapter is as follows : Section 7.2 summarises the earlier India studies on occupational differences in consumer expenditure pattern; Section 7.3 gives a description of the data used in the present study; Section 7.4 presents the analyses of itemwise engel curves for each occupation category; Section 7.5 reports some results of comparison of rates of monetization, and cash and kind expenditure functions (relating item specific cash and kind expenditure to total cash and kind expenditure respectively) across occupation categories mentioned above; and finally Section 7.6 draws some concluding observations.

7.2 Earlier studies on occupational differences in consumer expenditure pattern :

As regards the earlier studies which examined the variation in household consumer expenditure pattern among different occupation groups, mention may be made of those by Ganguly (1960), Singh (1968) and

Jain and Tendulkar (1973). The study by Singh was based on expenditure data of households of different occupation groups in rural and urban sectors of Western Uttar Pradesh. Jain and Tendulkar examined the pattern of occupational differences in consumption separately for the rural and urban sectors of the country as a whole. The occupation classification used in these studies was too broad, especially for the rural sector. Ganguly, on the other hand, compared the expenditure patterns of rural households in Uttar Pradesh having different types of agricultural occupations, but he did not employ any rigorous statistical procedure to confirm his subjective conclusions.

Ganguly, utilizing NSS 7th round data (October 1953-March 1954) found considerable differences in the consumption patterns of households of farmers and cultivators, agricultural labourers, and other types households in rural Uttar Pradesh. In this study occupationwise engel curves for five food items were compared subjectively through graphs. However, this pioneering study has the limitation that the expenditure estimates had been obtained through simple averaging of householdwise data without using the associated probability weights, so crucial for a sample survey like the NSS.

Singh's study, based on ungrouped consumer expenditure data for the rural and urban sectors of Western Uttar Pradesh obtained from the 15th round of NSS (July 1959-June 1960), considered four broad occupational groups viz., (i) semi-professionals, clericals, shop keepers and big cultivators, (ii) cultivators[1],[2], (iii) skilled and semi-skilled workers, and (iv) unskilled, unemployed and unclassifiable workers. Expenditure patterns of these occupation groups were compared on the basis of engel elasticities of 12 food and 9 non-food items. Precisely, for each item-occupation-sector combination 10 engel curve forms were fitted. For each occupation the engel elasticities for different items were estimated separately for the two sectors at the occupation specific average per capita total consumer expenditure on the basis of best-fitting form of engel curve (having the maximum coefficient of determination), and the commodities were classified into luxury, necessary and inferior items according as the computed engel elasticity for any item is greater than or equal to unity, less than unity but positive, and negative respectively. The resultant commodity classifications were found to differ considerably among occupation groups within a sector, and also between sectors for any specific occupation group. This study, though an important empirical exercise has some limitations. First, the magnitudes of some of the estimated elasticities raise suspicion. Indeed, one may question the reliability of these estimates in view of the fact that in most cases the sample size was quite small. Finally, the conclusions about the occupational differences in consumption patterns were not examined through statistical tests.

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[1] The difference between 'big cultivators' and 'cultivators' was that while the former might have some marketable surplus, the latter were 'subsistence farmers'.

[2] For the urban sector 'big cultivators' were grouped with 'cultivators' in (ii).

Jain and Tendulkar's study is elegant and satisfactory in many respects. They used all-India estimates of per capita item expenditure cross-classified by levels of per capita monthly total consumer expenditure and occupation separately for rural and urban India, obtained from the 19th round NSS (July 1964-June 1965). Expenditure patterns for nine item/item groups were examined for each of five occupational categories, viz., (i) professionals, technical, administrative, executive, managerial and clerical and related workers, (ii) sales workers, (iii) farmers, fishermen, hunters, loggers and related workers, (iv) craftsmen, production process and related workers, and (v) miners, quarrymen, workers in transport and communication, services, sports and recreation workers and *workers not classified elsewhere. For comparing expenditure patterns of different occupation groups in respect of specific items of expenditure,* the authors insisted that in a sector the item-specific engel curves must have the same form across occupation groups. They fitted six two-parameter forms of engel curve, viz., linear, semi-log, double-log, log-inverse, hyperbola and exponential, for each item in each sector using all-occupation expenditure data and selected the best-fitting form as the one for which the weighted sum of squares of differences between observed and predicted item expenditures turned out to be minimum, the weights being the estimated population in individual per capita monthly total expenditure classes in the sector. In subsequent analysis, they applied the analysis of covariance tests of homogeneity to the occupation groupwise engel curves for each item of expenditure in each sector. The results of these tests showed considerable inter-occupational differences in consumer expenditure patterns. Having established this, Jain and Tendulkar went on further to identify what they called the 'dominant occupation' in the sense of having a consumption pattern, on the whole, different from the rest. This was done by performing occupation-pairwise tests of homogeneity of engel curves. Their results showed that the agricultural occupations and the professionals, technical and related workers are the dominant groups in rural and urban India respectively.

As already mentioned, studies by Singh and Jain and Tendulkar consider occupation groups that are much too broad and heterogeneous, particularly in the rural sector. The agricultural occupation in the latter study includes agricultural labourers as well as cultivators and accounts for approximately 81 per cent of estimated rural population. These two groups are expected to have considerably different consumption patterns. Jain and Tendulkar themselves admitted this lumping together of all agricultural occupations as a major limitation of their study. In this respect the occupational classification used by Ganguly seems more reasonable for the rural sector of the country.

7.3 Material analysed :

The present study is based on data available from a special tabulation of the 18th round NSS (February 1963-January 1964) household budget enquiry. This tabulation provides, among other things, occupationwise averages of monthly per capita cash (e_m), kind (e_k) and total ($e = e_m+e_k$) expenditures on each of 15 selected items and the corresponding all-items cash (E_m), kind (E_k)[3] and total ($E = E_m + E_k$) expenditures classified by levels of (i) all-items cash, (ii) all-items kind and (iii) all-items total expenditures respectively, separately for rural and urban India. Since our primary interest is to examine the differences in consumption patterns of certain agricultural occupations we have considered only the rural sector. To save time and volume of computational work, we have also confined ourselves to the analyses of combined sample data only, though half-samplewise estimates were also obtained in this tabulation.

It may be mentioned that in the NSS enquiries, household industry-occupation status is also recorded in a six-digit code (first three digits of which represent the industry while the last three digits indicate the type of occupation) along with information about consumer expenditures. Precisely, a household's occupation-type indicates its major source of income during the year preceding the date of enquiry. Based

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3/ In the NSS enquiries data on cash purchases, goods received in exchange of services, consumption out of home-grown stock and also out of gifts and loans are collected for the reference month, in addition to total consumption. For the purpose of the present analysis total consumption has been taken to consist of two parts – monetized and non-monetized. The monetized part of the total consumption is taken to be equal to the cash purchases and the non-monetized part is taken as the residual from total consumption. This procedure gives only approximate figures of kind consumption because the entire quantity purchased in cash need not be consumed during the reference period. Any attempt to get better approximations to cash and kind consumption on the basis of other detailed informations appeared to be computationally prohibitive and therefore was not done.

on these household occupation codes, the present tabulation classified rural sample households covered in the 18th round into four groups, viz., (1) cultivators, (2) agricultural labourers, (3) other agricultural occupations and (4) non-agricultural occupations. The coverage of these groups is briefly as follows : Cultivators include both owner and tenant cultivators who operate on land with household or hired labour; agricultural labourer households include those households for which agricultural wage employment constitutes the major source of income (the term agricultural wage employment may be defined as employment in the capacity of a labourer on hire (paid in cash and/or kind) or on exchange in agricultural activities); Other agricultural occupations include activities of rural artisans primarily and finally, non-agricultural occupation is the residual group. We have taken up in this study all the 15 items of expenditure for which necessary estimates are available. These items are (1) cereals, (2) milk, (3) milk products, (4) pulses, (5) oils, (6) vegetables, (7) fruits, (8) fish-egg, etc., (9) sugar, etc. (10) spices, (11) beverages, (12) all-food, (13) tobacco, (14) fuel and light, and (15) services.

7.4 Analysis of occupationwise expenditure patterns:

In this section we propose to present the results of comparison of occupationwise engel functions for different items (relating item-specific per capita total expenditure (e) to all-items per capital total expenditure (E)). Before proceeding to the detailed analysis, it would be worthwhile to discuss briefly the general characteristics of the data.

Table 7.1 gives some general informations and engel ratios (i.e., expenditure on a particular item expressed as a proportion of total expenditure) for the 15 items separately for each of the four occupation groups. It is seen that the average per capita monthly total consumer expenditure figures display a wide range of variation between occupation groups. It is highest for the cultivators (Rs.35.65), followed by other agricultural occupations (Rs.24.39), non-agriculture (Rs.21.74) and with agricultural labourers (Rs.16.43) in the bottom. It is clear, therefore, that in terms of average per capita consumer expenditure, the cultivators are much better-off as compared to the rest of the rural population. The agricultural labourers, on the other hand, are the worst sufferers.

The items covered in the study account for roughly 80 per cent of total consumer expenditure for the two groups, other agriculture and non-agriculture, and about 87 per cent and 77 per cent respectively for agricultural labourers and cultivators. It is also seen that the engel ratio for food is highest (69.51 per cent) for agricultural labourers. The same is true of cereals (50.03 per cent).

7.4.1 Analysis of engel curve :

In the analysis of engel curves we have considered four two-parameter forms of engel curve, viz., linear (L), double-log (DL), semi-log (SL) and log-inverse (LI), and the three parameter log-log-inverse (LLI) form. All these forms have been fitted for each item and occupation group. In every case per capita item expenditure (e) or its logarithm has been regressed on per capita total consumer expenditure (E) and/or its transformations by the method of weighted least squares, the weights being the percentage of estimated population in different size classes of E.

Table 7.1 : Engel ratios and general characteristics of the households by occupation groups : NSS 18th round all-India rura, combined sample.

srl. no.	item	cultivators	agricultural labourers	other agriculture	non-agriculture	all-occupations
(1)	(2)	(3)	(4)	(5)	(6)	(7)
				engel ratios		
1.	cereals	40.82	50.03	35.68	38.13	41.42
2.	milk	4.80	2.25	4.47	4.05	4.33
3.	milk products	3.48	1.10	2.79	2.67	3.01
4.	pulses	4.76	4.38	4.47	4.05	4.56
5.	oils	2.93	2.74	3.08	3.17	2.97
6.	vegetables	2.93	3.04	2.99	2.85	3.01
7.	fruits	0.98	0.79	1.31	1.38	1.05
8.	fish-egg etc.	1.66	2.19	2.17	2.44	1.87
9.	sugar	3.65	2.43	3.36	3.13	3.38
10.	spices	2.80	3.65	3.04	2.99	2.97
11.	beverages	1.49	2.43	2.99	4.37	2.24
12.	all-food	65.80	69.51	63.70	65.59	66.20
13.	tobacco	1.95	2.62	2.05	2.25	2.10
14.	fuel & light	2.25	8.09	6.89	7.13	6.84
15.	services	3.14	1.64	3.94	2.76	2.87
no. of sample households		11784	4247	455	5055	21541
average monthly per capita total expenditure		35.65	16.43	24.39	21.74	22.36
proportion of estimated no. of persons		59.96	17.87	1.92	20.25	100.00

Table 7.2 : Coefficient of determinations (R^2) and squared correlation coefficient between observed and predicted item expenditure (R_y^2) associated with different engel curve forms by item and occupation groups : NSS 18th Round all-India rural, combined sample.

occupation group	linear	semi-log	double-log		log-inverse		log-log-inverse	
			R^2	R_y^2	R^2	R_y^2	R^2	R_y^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
			(a) cereals					
1	0.889	0.988	0.981	0.974	0.909	0.915	0.992	0.993
2	0.858	0.993	0.972	0.937	0.973	9.66	0.997	0.995
3	0.652	0.926	0.881	0.818	0.964	0.960	0.968	0.955
4	0.743	0.978	0.914	0.892	0.980	0.987	0.989	0.991
			(b) milk					
1	0.952	0.900	0.957	0.878	0.855	0.928	0.960	0.913
2	0.907	0.827	0.934	0.538	0.975	0.946	0.983	0.923
3	0.920	0.828	0.879	0.918	0.781	0.785	0.880	0.922
4	0.969	0.845	0.967	0.896	0.853	0.896	0.968	0.910
			(c) milk products					
1	0.975	0.829	0.924	0.910	0.736	0.868	0.929	0.871
2	0.854	0.678	0.938	0.533	0.904	0.840	0.947	0.715
3	0.918	0.611	0.741	0.940	0.414	0.507	0.927	0.968
4	0.978	0.803	0.922	0.917	0.979	0.861	0.927	0.877

Table 7.2 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(d) pulses				
1	0.932	0.969	0.980	0.972	0.926	0.908	0.997	0.996
2	0.951	0.899	0.971	0.957	0.958	0.850	0.989	0.96[illegible]
3	0.947	0.819	0.948	0.948	0.780	0.730	0.952	0.946
4	0.879	0.962	0.964	0.910	0.931	0.940	0.984	0.965
				(e) oils				
1	0.981	0.912	0.990	0.990	0.862	0.840	0.991	0.994
2	0.915	0.942	0.971	0.906	0.971	0.735	0.995	0.976
3	0.982	0.824	0.985	0.979	0.824	0.502	0.987	0.982
4	0.916	0.958	0.977	0.926	0.930	0.686	0.992	0.974
				(f) vegetables				
1	0.914	0.953	0.974	0.926	0.900	0.925	0.984	0.965
2	0.909	0.920	0.987	0.909	0.914	0.893	0.988	0.933
3	0.894	0.944	0.901	0.893	0.938	0.926	0.955	0.959
4	0.943	0.945	0.975	0.940	0.925	0.924	0.989	0.98[illegible]
				(g) fruits				
1	0.974	0.855	0.975	0.907	0.905	0.891	0.986	0.955
2	0.878	0.804	0.961	0.784	0.851	0.825	0.962	0.744
3	0.918	0.771	0.874	0.865	0.749	0.831	0.874	0.859
4	0.985	0.823	0.985	0.961	0.837	0.832	0.985	0.954

Table 7.2 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(h) fish, egg								
1	0.859	0.940	0.936	0.785	0.926	0.969	0.969	0.917
2	0.836	0.868	0.969	0.722	0.951	0.894	0.985	0.872
3	0.808	0.951	0.727	0.675	0.935	0.950	0.952	0.932
4	0.936	0.892	0.976	0.896	0.881	0.900	0.979	0.924
(i) sugar								
1	0.993	0.855	0.982	0.966	0.848	0.852	0.983	0.972
2	0.938	0.854	0.973	0.805	0.926	0.890	0.979	0.900
3	0.981	0.772	0.953	0.988	0.830	0.722	0.953	0.987
4	0.952	0.912	0.974	0.904	0.919	0.927	0.987	0.960
(j) spices								
1	0.992	0.833	0.987	0.973	0.795	0.687	0.991	0.984
2	0.784	0.451	0.962	0.741	0.821	0.355	0.970	0.823
3	0.900	0.780	0.796	0.879	0.600	0.620	0.820	0.900
4	0.923	0.975	0.971	0.972	0.940	0.915	0.992	0.993
(k) beverages								
1	0.984	0.854	0.973	0.933	0.922	0.884	0.990	0.980
2	0.908	0.750	0.899	0.855	0.737	0.753	0.919	0.698
3	0.973	0.904	0.893	0.889	0.892	0.950	0.925	0.972
4	0.956	0.715	0.966	0.961	0.793	0.733	0.970	0.946

Table 7.2 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(l) all-food				
1	0.978	0.920	0.994	0.992	0.863	0.843	0.995	0.995
2	0.953	0.947	0.994	0.971	0.937	0.900	0.998	0.993
3	0.970	0.936	0.989	0.990	0.901	0.855	0.993	0.995
4	0.940	0.963	0.986	0.968	0.925	0.913	0.997	0.992
				(m) tobacco				
1	0.942	0.923	0.983	0.976	0.802	0.822	0.985	0.968
2	0.719	0.379	0.963	0.744	0.830	0.310	0.968	0.820
3	0.336	0.632	0.699	0.466	0.803	0.720	0.803	0.718
4	0.970	0.916	0.985	0.980	0.885	0.854	0.987	0.987
				(n) fuel and light				
1	0.993	0.886	0.996	0.998	0.814	0.762	0.998	0.999
2	0.874	0.575	0.968	0.821	0.823	0.466	0.977	0.887
3	0.824	0.902	0.866	0.890	0.835	0.841	0.883	0.912
4	0.978	0.906	0.990	0.992	0.820	0.799	0.993	0.990
				(o) services				
1	0.942	0.628	0.979	0.991	0.762	0.686	0.989	0.974
2	0.840	0.733	0.974	0.621	0.894	0.819	0.975	0.659
3	0.902	0.599	0.927	0.971	0.794	0.714	0.927	0.970
4	0.902	0.578	0.981	0.994	0.790	0.622	0.988	0.995

While comparing the consumption patterns of different occupation groups, we decided not to base the comparison on a single form of engel curve. The reason is that for many items the best fitting from of engel curve is found to differ across occupation groups and the choice of a single form for all the occupation groups would involve some arbitrariness. We, therefore, preferred to have the comparisons, for each item, based separately on all the two-parameter forms which were found to give best-fit for at least one occupation group, as well as on the LLI form. To decide upon the best-fitting two-parameter form for each item-occupation pair we used the squared correlation coefficient (R_y^2) between the observed and predicted values of item expenditure for each of the forms mentioned above. The values of R^2 and R_y^2 are presented in Table 7.2. In this table we have underlined the R_y^2 corresponding to the best-fitting form for each item-occupation combination. It may be mentioned that LLI yielded maximum R^2 and R_y^2 for most of the item-occupation combinations thus justifying its inclusion and separate treatment in the study. In 30 out of 60 cases the LLI form turned out to be the best-fitting, while the linear form was seen to be best in 19 cases. Considering the second-best forms, it was seen that in 20 and 16 cases the DL and LLI turned out to be second-best forms respectively.

7.4.2 Engel elasticities

We next calculated the engel elasticity for each item-occupation combination. Precisely, in each case three estimates of engel elasticity were made, viz., the average elasticity ($\bar{\pi}$)[4], the elasticity at occupationwise average per capita total consumer expenditure ($\pi_{\bar{x}}$) and the elasticity at all-occupation average per capita total consumer expenditure ($\pi_{\bar{\bar{x}}}$). Table 7.3 and 7.4 present these estimates.

While $\bar{\pi}$ is a single measure of engel elasticity for the entire engel curve and takes into account the distribution of population among different per capita expenditure levels within a single occupation group, $\pi_{\bar{x}}$ gives the elasticity for the consumer with average per capita total expenditure within a particular occupation group. $\pi_{\bar{\bar{x}}}$ is perhaps most relevant from the point of view of inter-occupational comparison of engel elasticities, since this is free of any effect arising from inter-occupational differences in the level of average per capita total consumer expenditure. For each item-occupation pair $\bar{\pi}$, $\pi_{\bar{x}}$ and $\pi_{\bar{\bar{x}}}$ have been computed separately for the LLI curve and for the best-fitting two-parameter engel curve. Table 7.3 presents the elasticities for the two-parameter forms while Table 7.4 presents the elasticities for LLI curve.

A few comments regarding the relative magnitudes of $\bar{\pi}$ and $\pi_{\bar{x}}$ may be worthwhile. It is observed that in some cases these elasticities are similar in magnitude while in other cases they differ considerably. This is quite likely. For example, for the semi-log form, $\bar{\pi}$ is the elasticity computed at geometric mean of per capita total consumer expenditure and hence it is less than $\pi_{\bar{x}}$. In brief, while $\bar{\pi}$ is affected by the size distribution of per capita total consumer expenditure, $\pi_{\bar{x}}$ is dependent upon only the mean level of per capita total expenditure. As regards the relative magnitudes of $\pi_{\bar{x}}$ computed from the best-fitting two-parameter form and the LLI form, it is seen that in most of the cases where the LLI and the best-fitting from give equally good fit, the $\pi_{\bar{x}}$ for either shows close agreement.

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[4] *vide* Chapter 5 Section 6.2 *supra*.

Table 7.3 : Estimates of item elasticities *based on the* best fitting two-parameter engel curve form for each occupation group : NSS 18th Round, all-India rural, combined sample

srl. no.	item	cultivator				agricultural labour			
		form	$\bar{\pi}$	$\pi_{\bar{x}}$	$\pi_{\bar{\bar{x}}}$	form	$\bar{\pi}$	$\pi_{\bar{x}}$	$\pi_{\bar{\bar{x}}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	cereals	SL	0.551	0.508	0.528	SL	0.693	0.645	0.544
2.	milk	L	1.153	1.154	1.168	LI	1.530	1.822	1.366
3.	milk products	L	1.457	1.469	1.521	L	2.195	2.258	1.717
4.	pulses	DL	0.758	0.758	0.758	DL	0.938	0.938	0.938
5.	oils	DL	0.885	0.885	0.885	SL	1.013	0.913	0.723
6.	vegetables	SL	0.927	0.814	0.864	SL	1.038	0.935	0.736
7.	fruits	L	1.300	1.300	1.330	L	1.295	1.314	1.218
8.	fish, egg	LI	0.894	0.931	0.999	LI	1.035	1.094	0.820
9.	sugar	L	1.225	1.224	1.244	L	1.336	1.330	1.229
10.	spices	L	0.677	0.677	0.662	L	1.296	1.295	1.206
11.	beverages	L	1.282	1.739	1.839	L	1.466	1.465	1.312
12.	all-food	DL	0.844	0.844	0.844	DL	0.899	0.899	0.899
13.	tobacco	DL	0.705	0.705	0.705	DL	1.068	1.068	1.068
14.	fuel & light	DL	0.715	0.715	0.715	L	1.026	1.026	1.020
15.	services	DL	1.846	1.846	1.846	L	1.716	1.745	1.471

$\bar{\pi}$: average elasticity.

$\pi_{\bar{x}}$: elasticity at occupation-specitid average monthly per capita total expenditure.

$\pi_{\bar{\bar{x}}}$: elasticity at all-occupation averagemonthly per capita total expenditure (Rs.22.36).

Table 7.3 (contd.)

srl. no.	item	other agriculture				non-agriculture			
		form	$\bar{\pi}$	$\pi_{\bar{x}}$	$\pi_{\bar{\bar{x}}}$	form	$\bar{\pi}$	$\pi_{\bar{x}}$	$\pi_{\bar{\bar{x}}}$
(1)	(2)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1.	cereals	LI	0.475	0.395	0.440	LI	0.452	0.391	0.338
2.	milk	L	0.948	0.947	0.942	L	1.448	1.453	1.448
3.	milk products	DL	1.143	1.143	1.143	L	1.649	1.652	1.643
4.	pulses	L	0.888	0.886	0.875	SL	0.842	0.752	0.747
5.	oils	L	0.916	0.915	0.907	SL	0.943	0.832	0.826
6.	vegetables	SL	0.972	0.825	0.904	SL	1.014	0.886	0.879
7.	fruits	L	1.571	1.596	1.711	L	1.376	1.377	1.372
8.	fish, egg	SL	1.114	0.925	1.026	L	1.076	1.079	1.078
9.	sugar	DL	1.143	1.143	1.143	L	1.071	1.072	1.071
10.	spices	L	0.517	0.507	0.480	SL	0.685	0.624	0.620
11.	beverages	L	1.231	1.231	1.264	DL	1.506	1.506	1.506
12.	all-food	DL	0.765	0.765	0.765	DL	0.824	0.824	0.824
13.	tobacco	LI	0.573	0.497	0.553	DL	0.882	0.882	0.882
14.	fuel & light	DL	0.621	0.621	0.621	DL	0.714	0.714	0.714
15.	services	DL	2.054	2.054	2.054	DL	1.774	1.774	1.774

Table 7.4 : Estimates of item elasticities based on the log-log-inverse engel curve form for each occupation groups : NSS 18th Round, all-India rural, combined sample.

sl. no.	item	cultivator			agricultural labour			other agriculture			non-agriculture		
		$\bar{\pi}$	$\pi_{\bar{x}}$	$\pi_{\bar{\bar{x}}}$	$\bar{\pi}$	$\pi_{\bar{x}}$	$\pi_{\bar{\bar{x}}}$	$\bar{\pi}$	$\pi_{\bar{x}}$	$\pi_{\bar{\bar{x}}}$	$\bar{\pi}$	$\pi_{\bar{x}}$	$\pi_{\bar{\bar{x}}}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1.	cereals	0.540	0.524	0.532	0.685	0.664	0.588	0.487	0.422	0.458	0.476	0.431	0.428
2.	milk	1.359	1.373	1.385	1.746	1.960	1.628	1.037	1.037	1.045	1.556	1.568	1.567
3	milk products	1.666	1.634	1.617	2.061	2.200	2.047	1.539	1.375	1.237	1.804	1.760	1.762
4.	pulses	0.726	0.711	0.725	0.892	0.885	0.800	0.899	0.903	0.890	0.818	0.804	0.802
5.	oils	0.875	0.873	0.876	0.969	0.966	0.858	0.905	0.908	0.899	0.904	0.897	0.895
6.	vegetables	0.901	0.895	0.908	0.985	0.984	0.959	0.927	0.910	0.970	0.965	0.962	0.960
7.	fruits	1.387	1.421	1.443	1.417	1.408	1.437	1.694	1.684	1.678	1.399	1.393	1.394
8.	fish, egg	1.141	1.158	1.191	1.247	1.272	1.158	1.118	1.177	1.380	1.205	1.213	1.212
9.	sugar	1.308	1.311	1.315	1.456	1.486	1.404	1.140	1.140	1.142	1.202	1.219	1.217
10.	spices	0.679	0.690	0.684	0.908	0.909	0.961	0.532	0.568	0.546	0.662	0.642	0.640
11.	beverages	1.346	1.384	1.412	1.504	1.456	1.591	1.426	1.513	1.587	1.578	1.547	1.549
12.	all-food	0.836	0.834	0.837	0.879	0.874	0.835	0.755	0.745	0.757	0.797	0.786	0.784
13.	tobacco	0.715	0.721	0.716	1.110	1.101	1.152	0.574	0.499	0.554	0.866	0.862	0.862
14.	fuel & light	0.725	0.730	0.726	0.830	0.836	0.886	0.615	0.586	0.607	0.724	0.730	0.731
15.	services	2.032	1.937	1.911	1.767	1.785	1.757	2.092	2.067	2.060	1.922	1.842	1.845

$\bar{\pi}$: average elasticity;

$\pi_{\bar{x}}$: elasticity at occupation specific average monthly per capita total expenditure;

$\pi_{\bar{\bar{x}}}$: elasticity at all-occupation average monthly per capita total expenditure (Rs. 22.36).

We may now briefly indicate the pattern of differences of itemwise elasticities $\pi_{\overset{=}{x}}$ accross occupation groups. The variation is quite large for such items as milk, milk products, fruits, fish, egg etc., sugar, spices, tobacco, fuel and light and services. The elasticities computed from LLI form confirms the impressions based on the elasticities from two parameter forms.

In order to get a clear picture, the different items have been classified into luxury and necessity on the basis of $\bar{\pi}$ calculated from the best-fitting two-parameter form and the LLI form separately. The results are presented in Table 7.5. It is interesting to note that the classification based on the best-fitting two-parameter form exhibits considerable inter-occupational variation in consumptior pattern, specially for agricultural labourers(occupation 2) for which maximum number of items (12 out of 15) turn out to be luxuries, the only necessities being pulses, all-food and cereals. In terms of LLI form, however, the number as well as the list of items classified as luxury and necessity are, on the whole, the same for different occupation groups. This kind of classification is therefore seen to be sensitive to the choice of the engel curve form.

Table 7.5 : Occupationwise classification of items into luxuries ($\bar{\pi} \geq 1$) and necessities ($0 < \bar{\pi} < 1$) based on average engel elasticities of (i) best-fitting two parameter engel curves and (ii) log-log-inverse engel curves : NSS 18th round all-India rural combined sample.

occupation groups (1)		best-fitting two-parameter engel* curve (2)	log-log-inverse engel curve (3)
cultivators	$\bar{\pi} \geq 1$	services (1.84), milk products (1.45), fruits (1.30), beverages (1.28), sugar (1.22), milk (1.15)	services (2.03, milk products (1.67) fruits (1.39), milk (1.36), beverages (1.35), sugar (1.31), egg, fish etc. (1.14)
	$0 < \bar{\pi} < 1$	vegetables (0.92), fish, egg. etc. (0.89), oils (0.88), all-food (0.84), pulses (0.75), fuel & light (0.71), spices (0.67), cereals (0.55).	vegetables (0.90), oils (0.88), all-food (0.84), pulses (0.73), fuel & light (0.73), tobacco (0.72), spices (0.68), cereals (0.54).
agricultural labourers	$\bar{\pi} \geq 1$	milk products (2.19), services (1.71), milk (1.53), beverages (1.46), sugar (1.34), spices (1.30), egg, fish etc. (1.04), feul & light (1.03), oils (1.01).	milk products (2.06), services (1.77), milk (1.75), beverages (1.50), sugar (1.46), fruits (1.42), egg, fish etc. (1.25), tobacco (1.11).
	$0 < \bar{\pi} < 1$	pulses (0.94), all-food (0.90), cereals (0.69).	vegetables (0.99), oils (0.97), spices (0.91), pulses (0.89), all-food (0.88), fuel & light (0.83), ceresla (0.69).

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* figures in parentheses indicate the average elasticities.

Table 7.5 (contd.)

(1)		(2)	(3)
other agriculture	$\bar{\pi} \geq 1$	services (2.05), fruits (1.57), beverage (1.23), sugar (1.14), milk products (1.14), egg, fish etc. (1.11).	services (2.09), fruits (1.69), milk products (1.54), beverages (1.43), sugar (1.14), egg, fish etc. (1.12), milk (1.01).
	$0 < \bar{\pi} < 1$	vegetables (0.97), milk (0.95), oils (0.92), pulses (0.89), all-food (0.72), fuel & light (0.62), tobacco (0.57), spices (0.52), cereals (0.48).	vegetables (0.93), oils (0.91), pulses (0.90), all-food (0.76), fuel & light (0.62), tobacco (0.59), spices (0.53), cereals (0.49).
non-agriculture	$\bar{\pi} \geq 1$	services (1.77), milk products (1.65), beverages (1.51), milk (1.45), fruits (1.38), egg, fish etc. (1.08), sugar (1.07), vegetables (1.01).	services (1.92), milk products (1.80), beverages (1.58), milk (1.56), fruits (1.40), egg, fish etc. (1.21), sugar (1.20).
	$0 < \bar{\pi} < 1$	oils (0.94), tobacco (0.88), pulses (0.84), all-food (0.82), fuel & light (0.71), spices (0.69), cereals (0.45).	vegetables (0.97), oils (0.90), tobacco (0.87), pulses (0.82), all-food (0.80), fuel & light (0.72), spices (0.66), cereals (0.48).

7.4.3 Test of homogeneity of itemwise engel curves :

To examine the pattern of inter-occupational differences in item expenditure patterns, we applied the analysis of covariance technique and tested the homogeneity of itemwise engel curves across occupation groups. These tests have been carried out in three stages : In the first stage, we considered all the four occupation groups together and examined the homogeneity of the engel curves for all the four occupation groups; in the next stage, we dropped the non-agricultural occupation (group 4) and repeated the tests with three agricultural occupations; in the final stage, we have sought to identify occupation-pairs between which consumption patternsare clearly homogeneous or clearly distinct. In each of these three stages of analysis, we first examined the overall homogeneity of the itemwise engel curves among occupation groups taking those two-parameter forms which gave best-fit for at least one occupation group and also the LLI form. If the hypothesis of overall homogeneity is rejected for any item, we examined the homogeneity of slopes and intercepts of the best-fitting two-parameter form(s).

Table 7.6 summarises the results of the overall homogeneity tests for multi-group comparisons. The results indicate that when all the four occupation groups are taken together, the engel curves for vegetables, services and all food are homogeneous. In all other cases the null hypothesis of overall homogeneity has been rejected at 5 per cent level of significance. As regards the conformity of conclusions reached on the basis of different curve forms, it may be noted that only in case of spices, tobacco and services the alternative two-parameter forms indicate different results. These anomalies may largely be resolved if we check the goodness of fit of the competing curve forms accross occupation groups, since the form that fits relatively poorly for occupation groups, other than the one for which it gives best fit, often leads to such anomalous conclusions.

Table 7.6 : Computed values of F-ratios associated with the tests of overall homogeneity of itemwise engel curves across occupation groups : NSS 18th round, all-India rural, combined sample.

srl. no.	item	including occupation 4 form of engel curve					excluding occupation 4 form of engel curve				
		L	SL	LI	DL	LLI	L	SL	LI	DL	LLI
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1.	cereals	-	20.14	4.31	-	16.26	-	7.95	0.59	-	6.15
2.	milk	5.82	-	9.89	-	17.11	7.16	-	-	-	23.43
3.	milk products	11.00	-	-	19.99	14.07	12.43	-	-	27.50	19.96
4.	pulses	-	6.00	-	14.03	23.52	-	3.93	-	13.44	25.07
5.	oils	2.42	-	-	7.90	10.20	3.20	-	-	8.83	10.09
6.	vegetables	-	1.55	-	-	1.56	-	1.47	-	-	0.51
7.	fruits	14.20	-	-	-	9.13	3.54	-	-	-	1.19
8.	fish, egg etc.	6.80	7.92	6.16	-	11.47	2.18	4.91	-	-	8.59
9.	sugar	12.95	-	-	11.98	8.70	13.29	-	-	16.14	10.57
10.	spices	8.26	0.73	-	-	7.75	9.42	0.72	-	-	7.84
11.	beverages	82.98	-	-	49.11	49.09	29.23	-	-	20.25	24.27
12.	all-food	-	-	-	0.94	1.47	-	-	-	1.25	0.84
13.	tobacco	-	-	0.68	9.88	8.11	-	-	0.59	9.88	8.46
14.	fuel & light	8.44	-	-	7.11	7.00	9.93	-	-	7.30	7.57
15.	services	2.92	-	-	1.64	2.06	4.34	-	-	1.86	2.42
degrees of freedom		40,6	40,6	40,6	40,6	36,9	30,4	30,4	30,4	30,4	27,6
critical value of F:											
at 5% level		2.34	2.34	2.34	2.34	2.15	2.69	2.69	2.69	2.69	2.46
-do at 1 % level		3.29	3.29	3.29	3.29	2.94	4.02	4.02	4.02	4.02	3.56

The exclusion of occupation group 4 marginally alters the picture of heterogeneity described above. In this case, in addition to vegetables, all-food and services, the engel cruves for fruits also turn out to be similar across occupation groups.

The results of homogeneity of slopes and intercepts of two-parameter forms are presented in Table 7.7. In this Table, F_1 is associated with the null hypothesis that the slopes are same for different occupation groups, and F_2 is associated with the null hypothesis that the intercepts are same given the fact that slopes are homogeneous. The results based on DL and L forms are particularly interesting because the slope coefficients of these forms measure engel elasticity and marginal propensity to consume respectively. Thus, when occupation 4 is included in the comparison, the engel elasticity turns out to be similar for milk products, pulses, oils, sugar, beverages and fuel and light. Exclusion of occupation 4 does not alter this picture. Among the cases where the linear form has been used the marginal propensities are found to be similar for milk and oil[5]. Exclusion of occupation 4 leads to homogeneity of slopes for fish, egg etc., in addition. The overall picture that one gets from Tables7.6 and 7.7 is thus one of considerable heterogeneity of expenditure patterns across occupation groups. With this picture in view we next proceed to examine the results of pairwise comparisons of engel curves for different occupation groups.

5/ This list of items excluded the cases where overall homogeneity has been observed.

Table 7.7 : Itemwise computed values of F-ratios associated with the tests of (i) homogeneity of slopes (F_1) and of (ii) homogeneity of intercepts (when F_1 is not rejected) of best-fitting two parameter engel curves : NSS 18th round, all-India rural, combined sample.

srl. no.	item	form	including occupation 4		excluding occupation 4	
			F_1	F_2	F_1	F_2
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	cereals	SL	15.35	-	6.10	-
		LI	0.66	8.16	0.13	1.13
2.	milk	L	2.73	7.95	3.10	10.27
		LI	1.72	17.19	3.29	29.88
3.	milk products	L	9.23	-	11.17	-
		DL	3.64	30.67	5.20	40.60
4.	pulses	DL	3.45	21.03	4.83	18.37
		SL	2.64	8.40	3.79	4.07
5.	oils	L	0.54	4.45	1.06	5.49
		DL	2.61	11.87	3.87	12.09
6.	vegetables	SL	1.96	1.07	2.95	0.25
7.	fruits	L	14.88	-	5.77	-
8.	fish, egg, etc.	L	6.54	-	2.15	2.16
		SL	4.64	-	0.91	9.42
		LI	2.55	8.82	4.92	8.91
9.	sugar	L	13.58	-	10.73	-
		DL	2.36	19.75	3.05	26.66
10.	spices	L	15.08	-	17.32	-
		SL	0.79	0.68	0.68	0.83
11.	beverages	L	98.95	-	25.10	-
		DL	0.33	102.68	0.40	42.68
12.	all-food	DL	1.51	0.35	2.13	0.42
13.	tobacco	DL	13.68	-	15.71	-
		LI	0.71	0.66	0.61	0.59
14.	fuel & light	L	14.35	-	18.01	-
		DL	2.46	10.68	3.22	10.34
15.	services	L	5.72	-	8.73	-
		DL	0.35	3.08	0.29	3.69
degrees of freedom			40,3	43,3	30,2	32,2
critical value of F: at 5% level			2.84	2.82	3.32	3.30
-do- : at 1% level			4.31	4.28	5.39	5.34

Table 7.8 : Computed values of F-ratios associated with the tests of overall homogeneity of itemwise engel curves for each occupation pair : NSS 18th round, all-India rural, combined sample.

srl. no.	item	occupation pairs											
		1,2		1,3		1,4		2,3		2,4		3,4	
		form	F*	form	F	form	F	form	F	form	F	form	F
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(8)	(10)	(11)	(12)	(13)	(14)
1.	cereals	SL	2.59	SL	3.72	SL	28.74	SL	25.12	SL	65.20	SL	0.18
		-	-	LI	0.33	LI	3.38	LI	3.17	LI	14.23	LI	0.68
		LLI	5.84	LLI	3.27	LLI	20.75	LLI	19.06	LLI	43.08	LLI	0.40
2.	milk	L	9.67	L	0.51	L	1.45	L	9.53	L	15.33	L	2.91
		LI	16.30	-	-	-	-	LI	19.44	LI	11.41	-	-
		LLI	31.98	LLI	0.30	LLI	2.78	LLI	17.75	LLI	23.67	LLI	2.82
3.	milk products	L	18.81	L	0.58	L	4.36	L	13.03	L	23.30	L	0.56
		-	-	DL	0.56	-	-	DL	11.16	-	-	DL	1.13
		LLI	26.28	LLI	0.66	LLI	1.67	LLI	10.21	LLI	18.02	LLI	1.56
4.	pulses	DL	19.17	DL	1.23	DL	19.23	DL	0.47	DL	1.00	L	3.02
		-	-	L	0.88	SL	10.90	L	1.20	SL	0.33	SL	4.74
		LLI	43.23	LLI	4.22	LLI	39.91	LLI	2.31	LLI	0.55	LLI	2.39
5.	oils	DL	12.00	DL	0.20	DL	2.86	L	4.39	-	-	L	0.44
		SL	1.90	L	1.08	SL	0.42	SL	7.40	SL	12.14	SL	0.73
		LLI	13.48	LLI	0.24	LLI	3.88	LLI	14.19	LLI	30.95	LLI	1.71
6.	vegetables	SL	1.13	SL	0.14	SL	1.45	SL	2.63	SL	4.62	SL	0.07
		LLI	0.26	LLI	0.48	LLI	1.97	LLI	2.29	LLI	4.54	LLI	1.29
7.	fruits	L	1.07	L	4.65	L	25.46	L	11.87	L	30.75	L	0.69
		LLI	1.73	LLI	0.39	LLI	21.18	LLI	0.44	LLI	21.70	LLI	3.24

* The degrees of freedom associated with F are (20,2) for two parameter forms and (18,3) for the LLI form. The 5 % critical values of F are 3.49 and 3.16 respectively. Corresponding 1 % values are 5.85 and 5.09 respectively.

Table 7.8 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
8.	fish, egg etc.	LI	6.46	LI	1.23	LI	6.89	LI	7.97	LI	0.59	L	2.08
		–	–	SL	2.22	L	11.68	SL	–	L	0.48	SL	0.23
		LLI	10.23	LLI	2.29	LLI	13.19	LLI	12.19	LLI	0.72	LLI	10.40
9.	sugar	L	19.06	L	0.71	L	13.48	L	7.51	L	3.96	L	1.85
		–	–	DL	0.43	–	–	DL	7.22	–	–	DL	0.65
		LLI	14.51	LLI	0.25	LLI	2.37	LLI	4.95	LLI	11.81	LLI	0.83
10.	spices	L	12.82	L	2.41	L	2.49	L	5.40	L	11.10	L	0.32
		–	–	–	–	SL	0.26	–	–	SL	1.04	SL	0.73
		LLI	11.85	LLI	2.16	LLI	7.38	LLI	4.14	LLI	9.54	LLI	3.75
11.	beverages	L	29.18	L	39.85	L	145.06	L	0.38	L	18.30	L	10.59
		–	–	–	–	DL	108.64	–	–	DL	12.61	DL	5.32
		LLI	33.70	LLI	8.81	LLI	127.48	LLI	1.10	LLI	8.81	LLI	4.87
12.	all food	DL	1.23	DL	0.48	DL	0.24	DL	4.21	DL	1.76	DL	0.42
		LLI	0.80	LLI	0.35	LLI	1.69	LLI	2.43	LLI	1.37	LLI	0.70
13.	tobacco	DL	16.92	DL	0.88	DL	11.59	DL	5.34	DL	4.52	DL	3.01
		–	–	LI	0.10	–	–	LI	0.04	–	–	LI	0.10
		LLI	12.67	LLI	2.00	LLI	9.04	LLI	5.67	LLI	4.03	LLI	3.23
14.	fuel & light	DL	11.74	DL	3.41	DL	12.56	DL	1.59	DL	2.20	DL	1.02
		L	13.80	–	–	–	–	L	7.45	L	8.57	–	–
		LLI	12.56	LLI	4.08	LLI	13.30	LLI	2.68	LLI	3.09	LLI	1.78
15.	services	DL	2.73	DL	0.24	DL	0.14	DL	1.04	DL	4.95	DL	0.95
		L	5.20	–	–	–	–	L	26.66	L	7.66	–	–
		LLI	3.82	LLI	0.27	LLI	0.11	LLI	0.72	LLI	4.80	LLI	0.66

Table 7.9 : Itemwise computed values of F-ratios associated with the tests of (i) homogeneity of slopes (F_1) and of (ii) homogeneity of intercepts (when F_1 is not rejected) of best fitting from parameter engel curves for each occupation pair : NSS 18th round, all-India rural; combined sample.

srl. no.	item	occuparion pairs*								
		1,2			1,3			1,4		
		form	F_1	F_2	form	F_1	F_2	form	F_1	2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	cereals	-	-	-	SL	2.82	4.2	SL	21.71	-
		-	-	-	-	-	-	-	-	-
2.	milk	L	3.61	14.00	-	-	-	-	-	-
		LI	2.47	28.17	-	-	-	-	-	-
3.	milk products	L	16.63	-	-	-	-	L	2.45	5.87
		-	-	-	-	-	-	-	-	-
4.	pulses	DL	6.63	-	-	-	-	DL	2.43	33.74
		-	-	-	-	-	-	SL	1.72	19.42
5.	oils	DL	5.27	15.57	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-
6.	vegetables	-	-	-	-	-	-	-	-	-
7.	fruits	-	-	-	L	7.20	-	L	23.59	-
8.	fish, egg etc.	LI	1.74	10.79	-	-	-	LI	0.42	13.74
9.	sugar	L	15.03	-	-	-	-	L	18.57	-
		-	-	-	-	-	-	-	-	-
10.	spices	L	22.86	-	-	-	-	-	-	-
11.	beverages	L	24.22	-	L	34.45	-	L	174.85	-
		-	-	-	-	-	-	DL	0.04	227.64
12.	all-food	-	-	-	-	-	-	-	-	-
13.	tobacco	DL	26.07	-	-	-	-	DL	12.23	-
14.	fuel & light	DL	4.37	16.46	-	-	-	DL	0.001	26.37
		L	24.11	-	-	-	-	-	-	-
15.	services	-	-	-	-	-	-	-	-	-
		L	10.38	-	-	-	-	-	-	-

* The degrees of freedom associated with F_1 and F_2 are (20,1) and (21,1) respectively. Corresponding critical values at 5 per cent level are 4.35 and 4.32 respectively.

Table 7.9 : (contd.)

srl. no.	item	occupation pairs								
		2,3			2,4			5,4		
		form	F_1	F_2	form	F_1	F_2	form	F_1	F_2
(1)	(2)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1.	cereals	SL	5.44	10.11	SL	9.58	-	-	-	-
		-	-	-	LI	3.09	23.07	-	-	-
2.	milk	L	0.74	18.57	L	15.41	-	-	-	-
		-	-	-	LI	3.09	23.07	-	-	-
3.	milk products	L	19.20	-	L	25.34	-	-	-	-
		DL	9.20	-	-	-	-	-	-	-
4.	pulses	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	SL	6.62	-
5.	oils	L	3.75	4.45	-	-	-	-	-	-
		SL	10.03	-	SL	11.47	-	-	-	-
6.	vegetables	-	-	-	SL	7.11	-	-	-	-
7.	fruits	L	19.28	-	L	35.28	-	-	-	-
8.	fish, egg, etc.	LI	15.33	-	-	-	-	-	-	-
9.	sugar	L	7.78	-	L	0.22	7.39	-	-	-
		DL	6.07	-	-	-	-	-	-	-
10.	spices	L	9.73	-	L	20.83	-	-	-	-
11.	beverages	-	-	-	L	29.83	-	L	15.76	-
		-	-	-	DL	0.65	24.09	DL	0.31	10.70
12.	all-food	DL	8.32	-	-	-	-	-	-	-
13.	tobacco	DL	9.75	-	DL	6.79	-	-	-	-
14.	fuel & light	-	-	-	-	-	-	-	-	-
		L	14.13	-	L	16.30	-	-	-	-
15.	services	-	-	-	DL	0.06	10.29	-	-	-
		L	50.22	-	L	15.22	-	-	-	-

Tables 7.8 and 7.9 present the F-ratios associated with the null hypothesis of pairwise homogeneity of engel curves (of best-fitting two-parameter forms as also of LLI form). The following observations can be made on the basis of these results :

(i) Between occupation groups 1 and 2 (i.e., cultivators and agricultural labourers) engel curves differ for all items except vegetables, fruits and all-food items. For cereals and oils the SL form indicates homogeneity while other forms reject this. Similarly, for services the DL form suggests homogeneity at 5 per cent level while L and LLI forms indicate significant differences. In most of these cases while for one form F is just significant, for other forn(s) F is slightly smaller and non-significant.

(ii) Between groups 1 and 3 (i.e., cultivators and other agricultural occupations), significant differences are established only for cereals, beverages and fuel and light.

(iii) Engel curves for cereals, pulses, fruits, fish- egg etc., beverages, tobacco and fuel and light are seen to be significantly different between occupation groups 1 and 4 (i.e., cultivators and non-agricultural occupations). For sugar, while the LLI-based test indicates homogeneity, the L curves show clear differences. For milk products and oils, on the other hand, the opposite is true.

(iv) For the pair of occupations 2 and 3, complete homogeneity is obtained for pulses, vegetables and beverages. For fruits, fuel and light and services the LLI-based tests indicate homogeneity while the test based on L form suggests otherwise. In all other cases, the engel curves differ significantly.

(v) As between occupations 2 and 4, the engel curves for pulses, fish- egg etc., and all-food items are seen to be homogeneous. For sugar, the L form are homogeneous while the LLI curves are not so, and an opposite picture is observed for fuel and light and services.

(vi) The extent of homogeneity of itemwise engel curves is quite remarkable for the pair of occupations 3 and 4. For this pair, LLI engel curves for fish- egg etc., and L engel curves for beverages are seen to be significantly different. In all other cases, the engel curves are homogeneous.

7.5 Analysis of itemwise cash and kind expenditure functions :

Having observed significant inter-occupational differences in consumer expenditure patterns of rural households in India (as reflected through the engel curves relating item-specific e to E), it is a natural query as to whether a part of these differences could be explained through a detailed analysis of the cash (e_m) and kind (e_k) components of item expenditures (e). The question is pertinent because in a semi-monetized agricultural economy a part of household consumption generally comes from home-grown stocks or through barter exchange, and a household's cash and kind expenditure patterns for various items may be governed by altogether different factors. For example, Tendulkar (1969) examined the time series of cash and kind components of food and total consumer expenditure of rural households in Uttar Pradesh and observed that while cash expenditures followed an inventory-adjustment mechanism, the kind expenditures were governed by the habit-formation process. Now, assuming that the extent of non-monetized consumption vary across households depending, among other things, upon the level of living and type of agricultural activity of the household, it would be interesting to examine the inter-occupational differences in cash and kind expenditure patterns.

7.5.1 Comparison of rates of non-monetization across occupation groups :

To have an overall view of the extent of monetization in different occupation groups we calculated the itemwise rates of non-monetization $(\frac{e_k}{e})$ and the ratio of item-specific kind expenditure and total kind expenditure $(\frac{e_k}{E_k})$ separately for the four occupation groups and for all-occupation. Table 7.10 presents this ratios.

Table 7.10 : Rates of non-monetization ($\frac{e_k}{e}$) and proportion of specific kind expenditure to total kind expenditure ($\frac{e_k}{E_k}$); by selected items and occupation groups : NSS 18th Round rural, all-India, combined sample.

srl. no.	item	occupation 1		occupation 2		occupation 3		occupation 4		all occupations	
		$\frac{e_k}{e}$	$\frac{e_k}{E_k}$	$\frac{e_k}{e}$	$\frac{e_k}{E_k}$	$\frac{e_k}{e}$	$\frac{e_k}{E_k}$	$\frac{e_k}{e}$	$\frac{e_k}{E_k}$	$\frac{e_k}{e}$	$\frac{e_k}{E_k}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1.	cereals	0.748	0.629	0.383	0.601	0.397	0.472	0.256	0.510	0.592	0.612
2.	milk	0.841	0.083	0.568	0.040	0.798	0.120	0.455	0.096	0.737	0.080
3.	milk products	0.683	0.049	0.500	0.017	0.779	0.072	0.362	0.051	0.621	0.046
4.	pulses	0.554	0.054	0.264	0.036	0.349	0.052	0.171	0.036	0.440	0.050
5.	oils	0.145	0.008	0.022	0.019	0.107	0.011	0.029	0.004	0.108	0.008
6.	vegetables	0.333	0.020	0.260	0.025	0.247	0.025	0.114	0.019	0.273	0.020
7.	fruits	0.391	0.008	0.308	0.008	0.219	0.010	0.200	0.014	0.304	0.008
8.	fish, egg etc.	0.333	0.011	0.333	0.023	0.226	0.016	0.208	0.027	0.293	0.014
9.	sugar	0.174	0.013	0.100	0.008	0.134	0.015	0.044	0.007	0.135	0.011
10.	spices	0.152	0.008	0.067	0.008	0.122	0.012	0.062	0.009	0.123	0.009
11.	beverages	0.086	0.003	0.325	0.025	0.178	0.018	0.179	0.041	0.163	0.009
12.	all-food	0.615	0.834	0.345	0.752	0.375	0.797	0.227	0.779	0.495	0.820
13.	tobacco	0.044	0.002	0.093	0.008	0.020	0.001	0.020	0.002	0.044	0.002
14.	fuel & light	0.699	0.094	0.722	0.183	0.673	0.154	0.458	0.171	0.653	0.112
15.	services	0.243	0.016	0.111	0.006	0.208	0.027	0.033	0.005	0.191	0.040
16.	all items	0.663	1.000	0.319	1.000	0.300	1.000	0.192	1.000	0.392	1.000

Considering all items together the rate of non-monetization $(\frac{E_k}{E})$ is highest for cultivators (0.663). Agricultural labourers and other agriculture have similar magnitudes for this rate (0.319 and 0.300 respectively). Non-agricultural occupations have the lowest degree of non-monetization (0.192). As regards the item-wise ratios, $\frac{e_K}{e}$ for cereals is highest for cultivators (0.748), followed by other agriculture (0.397). agricultural labourers (0.383) and non-agricultural occupations (0.256). High rates of non-monetization are also observed for milk, milk products and fuel and light. For most of the items this ratio is highest for cultivators and lowest for non-agricultural occupations, agricultural labourers and other agricultural occupations holding intermediate positions.

As regards the break-down of E_k, kind expenditure on cereals accounts for the largest part of total kind expenditure for all the groups and $(\frac{e_k}{E_k})$ for cereals is highest for cultivators (0.629) followed by agricultural labourers (0.601), non-agricultural occupations (0.510) and other agricultural occupations (0.472).

7.5.2 Cash and kind expenditure functions — specification and estimation :

Actually, in examining item-specific cash and kind expenditure functions one would prefer to use the functional specifications $e_m = f_m(E_m, E_k)$ and $e_k = f_k(E_m, E_k)$ for individual items[6]. For comparing occupationwise cash and kind expenditure patterns one should therefore

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[6] The essential argument in favour of this type of specifications is that the effect of change in E_n on e_n or e_k is likely to be different from that of a change in E_k. Vide Mukherjee and Prasada Rao (1972).

consider the itemwise f_m and f_k functions. For the present study, we had only itemwise averages of per capita e_m, e_k and e and of per capita E_m, E_k and E classified separately by levels of per capita E_m, E_k and E for each occupation category. Such one-way classifications of the basic data could not however yield satisfactory estimates of the parameters of f_m and f_k functions.7/ We, therefore, considered the simpler functions viz., $e_m = f(E)$, $e_m = f(E_m)$, $e_m = f(E_k)$ and $e_k = f(e)$, $e_k = f(E_m)$ and $e_k = f(E_k)$. For each item-occupation combination we estimated these functions using the data classified by the respective regressor. Here also in each case we fitted the four two-parameter forms as also the LLI form as alternative algebraic specifications. It was seen that $e_m = f(E_m)$ and $e_k = f(E_k)$, estimated from E_m and E_k classification respectively, performed most satisfactorily in terms of correlation coefficient. We, therefore, have used estimates of $e_m = f(E_m)$ and $e_k = f(E_k)$ for comparing cash and kind expenditure patterns across occupation groups.

Tables 7.11A & B present the R^2 and R_y^2 for different algebraic forms of $e_m = f(E_m)$ and $e_k = f(E_k)$. It may be observed that for cash expenditure functions R^2 and R_y^2 are generally more satisfactory than those for kind expenditure functions. Specifically, e_k for such items as fruits, fish - egg, etc. and beverages are not satisfactorily explained by the regression equations (we, therefore, have dropped these items in subsequent analysis). As regards the comparative performances of alternative algebraic forms, the LLI form appears to be the best form in largest number of cases followed by linear and double-log forms.

7/ Haitovsky's (1968) procedure of estimating multiple regression equation from various one-way classifications of the basic data was not used because this procedure, we observed, is based on rather strange assumptions regarding the covariances of the random disturbances in different classifications.

Table 7.11-A: Coefficient of determination (R^2) and squared correlation coefficient between observed and predicted item expenditures (R_y^2) associated with alternative forms of $e_m = f(E_m)$ by item and occupation groups : NSS 18th round rural, all-India combined sample.

occupation groups	linear	semi-log	double-log R^2	double-log R_y^2	log-inverse R^2	log-inverse R_y^2	log-log-inverse R^2	log-log-inverse R_y^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(a) cereals				
1	0.624	0.947	0.929	0.440	0.993	0.973	0.994	0.958
2	0.889	0.976	0.962	0.793	0.996	0.966	0.998	0.988
3.	0.263	0.705	0.728	0.368	0.919	0.800	0.939	0.885
4	0.706	0.969	0.885	0.726	0.998	0.995	0.998	0.995
				(b) milk				
1	0.900	0.847	0.984	0.781	0.944	0.824	0.990	0.894
2	0.838	0.633	0.974	0.879	0.869	0.598	0.934	0.740
3	0.619	0.660	0.800	0.626	0.737	0.615	0.803	0.660
4	0.947	0.682	0.976	0.920	0.822	0.650	0.980	0.887
				(c) milk products				
1	0.933	0.732	0.994	0.950	0.937	0.669	0.996	0.973
2	0.855	0.530	0.929	0.876	0.785	0.498	0.970	0.581
3	0.915	0.715	0.627	0.881	0.442	0.624	0.683	0.665
4	0.952	0.650	0.947	0.947	0.751	0.598	0.965	0.884

Table 7.11-1 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(d) pulses				
1	0.887	0.951	0.984	0.953	0.965	0.870	0.997	0.992
2	0.950	0.871	0.990	0.640	0.939	0.707	0.990	0.968
3	0.900	0.550	0.891	0.828	0.789	0.389	0.891	0.827
4	0.876	0.909	0.973	0.936	0.851	0.804	0.973	0.933
				(e) oils				
1	0.944	0.855	0.988	0.975	0.869	0.698	0.992	0.980
2	0.956	0.847	0.976	0.959	0.868	0.732	0.989	0.964
3	0.862	0.774	0.916	0.890	0.825	0.643	0.916	0.891
4	0.935	0.860	0.966	0.970	0.773	0.697	0.981	0.951
				(f) vegetables				
1	0.851	0.939	0.992	0.961	0.928	0.833	0.994	0.972
2	0.959	0.824	0.972	0.961	0.849	0.707	0.992	0.942
3	0.830	0.916	0.930	0.891	0.929	0.841	0.958	0.945
4	0.948	0.854	0.968	0.974	0.791	0.713	0.977	0.952
				(g) fruits				
1	0.988	0.714	0.991	0.988	0.885	0.604	0.993	0.978
2	0.923	0.705	0.983	0.923	0.902	0.641	0.986	0.900
3	0.905	0.535	0.836	0.924	0.648	0.436	0.863	0.888
4	0.974	0.715	0.988	0.966	0.872	0.561	0.988	0.968

Table 7.11-A (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(h) fish, egg etc.				
1	0.852	0.917	0.985	0.918	0.941	0.830	0.989	0.939
2	0.935	0.785	0.979	0.926	0.885	0.713	0.935	0.861
3	0.662	0.87	0.920	0.531	0.943	0.882	0.961	0.852
4	0.910	0.75	0.970	0.905	0.799	0.669	0.978	0.862
				(i) sugar				
1	0.995	0.718	0.997	0.981	0.900	0.580	0.997	0.990
2	0.926	0.810	0.976	0.936	0.877	0.730	0.984	0.866
3	0.925	0.550	0.930	0.899	0.821	0.411	0.930	0.901
4	0.931	0.841	0.974	0.951	0.824	0.729	0.976	0.934
				(j) spices				
1	0.985	0.797	0.979	0.957	0.836	0.618	0.992	0.956
2	0.613	0.273	0.948	0.456	0.830	0.195	0.967	0.629
3	0.845	0.700	0.788	0.818	0.665	0.524	0.791	0.838
4	0.906	0.927	0.986	0.981	0.839	0.766	0.988	0.979
				(k) beverages				
1	0.923	0.852	0.990	0.942	0.905	0.752	0.990	0.938
2	0.948	0.750	0.995	0.918	0.935	0.714	0.995	0.915
3	0.866	0.652	0.895	0.838	0.689	0.565	0.926	0.700
4	0.938	0.584	0.990	0.966	0.828	0.530	0.994	0.955

Table 7.11-A (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(l) all-food				
1	0.960	0.877	0.994	0.969	0.948	0.786	0.998	0.965
2	0.973	0.904	0.993	0.963	0.969	0.858	0.998	0.993
3	0.843	0.942	0.941	0.886	0.974	0.878	0.989	0.960
4	0.922	0.939	0.981	0.939	0.951	0.870	0.999	0.993
				(m) tobacco				
1	0.167	0.137	0.059	0.914	0.018	0.669	0.181	0.954
2	0.961	0.723	0.929	0.888	0.768	0.575	0.987	0.959
3	0.439	0.767	0.779	0.627	0.832	0.781	0.837	0.781
4	0.990	0.762	0.958	0.957	0.732	0.580	0.990	0.991
				(n) fuel & light				
1	0.990	0.717	0.983	0.953	0.843	0.554	0.995	0.990
2	0.894	0.723	0.947	0.885	0.809	0.608	0.980	0.846
3	0.734	0.731	0.889	0.781	0.720	0.618	0.902	0.703
4	0.968	0.766	0.937	0.971	0.704	0.621	0.976	0.921
				(o) services				
1	0.933	0.531	0.982	0.961	0.846	0.445	0.993	0.933
2	0.772	0.549	0.948	0.773	0.820	0.481	0.973	0.636
3	0.868	0.483	0.909	0.880	0.743	0.446	0.920	0.833
4	0.849	0.416	0.931	0.930	0.673	0.330	0.990	0.998

Table 7.11-B : Coefficient of determination (R^2) and squared correlation coefficient between observed and predicted item expenditures (R_y^2) associated with alternative forms of $e_k = f(E_k)$ by item and occupation groups : NSS 18th round rural, All-India, combined sample.

occupation groups	linear	semi-log	double-log R^2	double-log R_y^2	log-inverse R^2	log-inverse R_y^2	log-log-inverse R^2	log-log-inverse R_y^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(1) cereals				
1	0.929	0.950	0.980	0.893	0.986	0.915	0.999	0.997
2	0.794	0.972	0.989	0.549	0.996	0.969	0.999	0.971
3	0.936	0.962	0.978	0.825	0.997	0.957	0.999	0.982
4	0.888	0.988	0.989	0.653	0.998	0.982	0.999	0.995
				(2) milk				
1	0.861	0.604	0.865	0.854	0.667	0.482	0.975	0.518
2	0.794	0.731	0.950	0.816	0.901	0.973	0.959	0.662
3	0.907	0.875	0.981	0.925	0.936	0.821	0.982	0.916
4	0.834	0.553	0.931	0.768	0.851	0.468	0.991	0.413
				(3) milk products				
1	0.854	0.530	0.894	0.863	0.706	0.444	0.982	0.463
2	0.720	0.452	0.806	0.686	0.746	0.385	0.829	0.615
3	0.510	0.298	0.952	0.537	0.900	0.257	0.955	0.584
4	0.781	0.497	0.935	0.759	0.861	0.428	0.982	0.361

Table 7.11-B: (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(4) pulses								
1	0.810	0.832	0.984	0.855	0.913	0.762	0.985	0.836
2	0.930	0.882	0.997	0.856	0.985	0.845	0.998	0.957
3	0.825	0.722	0.946	0.801	0.870	0.696	0.960	0.615
4	0.888	0.753	0.996	0.879	0.983	0.708	0.997	0.889
(5) oils								
1	0.899	0.678	0.984	0.714	0.966	0.694	0.992	0.894
2	0.823	0.792	0.979	0.773	0.982	0.803	0.983	0.820
3	0.234	0.198	0.766	0.234	0.723	0.177	0.768	0.233
4	0.857	0.677	0.978	0.853	0.957	0.622	0.978	0.858
(6) vegetables								
1	0.699	0.568	0.788	0.701	0.582	0.431	0.934	0.485
2	0.689	0.728	0.921	0.776	0.854	0.658	0.946	0.580
3	0.488	0.282	0.365	0.389	0.320	0.208	0.387	0.555
4	0.895	0.871	0.975	0.922	0.934	0.808	0.983	0.917
(7) fruits								
1	0.432	0.230	0.182	0.289	0.045	0.091	0.819	0.244
2	0.114	0.063	0.034	0.065	0.019	0.043	0.156	0.191
3	0.298	0.247	0.220	0.275	0.154	0.194	0.361	0.220
4	0.685	0.539	0.723	0.612	0.614	0.443	0.904	0.317

Table 7.11-B (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(8) fish, egg etc.				
1	0.606	0.506	0.649	0.625	0.444	0.576	0.852	0.253
2	0.462	0.343	0.825	0.407	0.726	0.272	0.914	0.394
3	0.386	0.240	0.308	0.296	0.265	0.175	0.333	0.420
4	0.279	0.199	0.132	0.208	0.102	0.151	0.226	0.334
				(9) sugar				
1	0.939	0.614	0.979	0.748	0.915	0.682	0.980	0.733
2	0.486	0.300	0.798	0.443	0.775	0.250	0.799	0.463
3	0.426	0.216	0.809	0.477	0.745	0.184	0.822	0.658
4	0.748	0.487	0.914	0.745	0.832	0.120	0.978	0.718
				(10) spices				
1	0.548	0.184	0.934	0.512	0.854	0.127	0.936	0.602
2	0.599	0.691	0.941	0.692	0.917	0.556	0.941	0.687
3	0.618	0.433	0.500	0.564	0.372	0.561	0.790	0.710
4	0.680	0.440	0.951	0.545	0.920	0.593	0.954	0.622
				(11) beverages				
1	0.501	0.201	0.524	0.401	0.447	0.141	0.541	0.619
2	0.378	0.224	0.744	0.342	0.726	0.189	0.744	0.380
3	0.189	0.172	0.506	0.164	0.444	0.164	0.586	0.125
4	0.394	0.216	0.939	0.395	0.882	0.178	0.960	0.192

Table 7.1[illegible]-B (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
				(12) <u>all-food</u>				
1	0.[illegible]96	0.8[illegible]3	0.999	0.983	0.948	0.751	0.999	0.995
2	0.[illegible]57	<u>0.912</u>	0.995	0.690	0.989	0.925	0.998	0.933
3	<u>0.990</u>	0.8[illegible]6	0.998	0.981	0.973	0.823	0.999	<u>0.999</u>
4	0.972	0.909	0.999	0.924	0.988	0.875	0.999	<u>0.983</u>
				(13) <u>tobacco</u>				
1	0.927	0.895	0.978	0.742	0.993	<u>0.942</u>	0.995	0.938
2	0.530	0.034	0.885	0.239	0.810	0.015	0.924	<u>0.910</u>
3	0.252	0.349	0.434	0.251	0.503	0.362	0.999	<u>0.475</u>
4	<u>0.673</u>	0.672	0.916	0.629	0.934	0.664	0.935	0.646
				(14) <u>fuel & light</u>				
1	0.914	0.558	0.746	0.707	0.509	0.363	0.984	<u>0.943</u>
2	0.487	0.704	0.653	0.142	0.518	0.055	0.921	<u>0.838</u>
3	0.554	0.481	0.520	0.503	0.411	0.381	0.646	<u>0.585</u>
4	0.854	0.682	0.939	0.736	0.876	0.601	0.971	<u>0.857</u>
				(15) <u>services</u>				
1	0.664	0.248	0.906	0.758	0.736	0.188	0.969	<u>0.966</u>
2	0.389	0.453	0.873	<u>0.462</u>	0.833	0.417	0.878	0.394
3	0.728	0.521	0.622	<u>0.770</u>	0.532	0.488	0.677	0.704
4	<u>0.604</u>	0.498	0.937	<u>0.604</u>	0.906	0.463	0.939	0.570

7.5.3 Test of homogeneity of itemwise cash and kind expenditure functions :

We now report briefly the results of covariance analysis applied to test the homogeneity of itemwise cash and kind expenditure functions across occupation groups. Here also we carried out these tests in three stages as mentioned in Section 7.4.3, but for the sake of brevity we present only the results of occupation-pairwise tests of overall homogeneity of itemwise cash and kind expenditure functions. Table 7.12 presents the computed F-values associated with the null hypothesis of overall homogeneity of itemwise cash expenditure functions, and Table 7.13 presents the corresponding F-values for kind expenditure functions.

For each occupation-pair-item combination we have presented the results obtained on the basis of best-fitting two-parameter form(s) as also the LLI form. The following observations can be made on the basis of these results :

(i) Between occupation groups 1 and 2 the cash expenditure functions differ for all items except milk and pulses. Only for fuel and light the test based on linear form indicates homogeneity while that based on LLI rejects it. As regards the kind expenditure functions the results of homogeneity test are not always unequivocal. The overall picture is one of heterogeneity. However, for some items, viz., oils, vegetables, spices, all-food and fuel and light, the test based on one form indicates homogeneity while the test based on other form rejects it.

Table 7.12 : Computed values of F-ratios associated with the test of overall homogeneity of itemwise cash expenditure functions for each occupation pair : NSS 18th round, all-India rural, combined sample.

srl. no.	item	occupation pairs											
		1,2		1,3		1,4		2,3		2,4		3, 4	
		form	F*	form	F	form	F	form	F	form	F	form	F
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1.	cereals	SL	62.57	-	-	-	-	LI	8.20	SL	15.39	-	-
		LI	136.22	LI	9.82	LI	101.60	SL	9.68	LI	30.20	LI	2.88
		LLI	141.11	LLI	7.62	LLI	72.25	LLI	12.95	LLI	38.55	LLI	3.70
2.	milk	L	1.07	L	0.74	L	33.87	L	5.64	L	10.05	L	13.98
		-	-	SL	0.28	-	-	SL	0.07	-	-	SL	1.37
		LLI	3.03	LLI	0.95	LLI	14.49	LLI	2.59	LLI	18.01	LLI	7.07
3.	milk products	L	23.36	L	16.13	L	4.05	DL	0.14	DL	28.31	L	12.84
		DL	110.12	-	-	-	-	L	1.48	L	13.78	-	-
		LLI	149.21	LLI	14.20	LLI	8.10	LLI	1.09	LLI	34.43	LLI	5.40
4.	pulses	L	3.43	L	1.34	-	-	L	0.13	L	3.10	L	1.30
		DL	2.19	DL	0.22	DL	1.88	-	-	DL	2.63	DL	0.06
		LLI	3.55	LLI	0.44	LLI	3.46	LLI	0.60	LLI	1.25	LLI	0.04
5.	oils	DL	64.67	DL	4.70	DL	12.15	DL	3.10	DL	9.04	DL	0.57
		LLI	65.39	LLI	3.41	LLI	10.13	LLI	2.16	LLI	10.83	LLI	0.81
6.	vegetables	DL	37.43	DL	3.71	DL	5.86	DL	1.43	DL	9.01	DL	0.64
		LLI	45.64	LLI	3.90	LLI	6.16	LLI	6.23	LLI	9.50	LLI	1.97
7.	fruits	DL	50.09	DL	1.01	DL	9.19	DL	3.22	DL	31.35	DL	0.32
		LLI	36.59	LLI	0.90	LLI	5.34	LLI	2.34	LLI	19.84	LLI	0.85

* The degrees of freedom associated with F are (20,2) for two-parameter forms and (18,3) for the LLI form. The 5 % critical values of F are 3.49 and 3.16 respectively, corresponding 1 % values are 5.85 and 5.09 respectively.

Table 7.12 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
8.	fish, egg etc.	DL	11.79	DL	3.15	DL	7.42	DL	1.33	DL	1.06	L	1.09
		-	-	LI	2.26	L	8.25	LI	2.61	L	0.58	LI	0.33
		LLI	11.65	LLI	4.31	LLI	8.39	LLI	3.76	LLI	0.72	LLI	2.25
9.	sugar	L	79.17	L	6.73	L	73.52	DL	5.67	DL	10.75	L	3.49
		DL	235.38	-	-	DL	93.80	L	6.47	-	-	DL	0.43
		LLI	198.12	LLI	11.08	LLI	62.67	LLI	4.93	LLI	9.25	LLI	0.31
10.	spices	L	5.41	L	0.76	L	10.39	L	2.27	L	6.70	L	0.60
		-	-	-	-	DL	10.30	-	-	DL	3.13	DL	1.07
		LLI	9.91	LLI	0.26	LLI	13.11	LLI	2.13	LLI	10.35	LLI	0.70
11.	all-food	DL	33.28	DL	3.49	DL	27.58	L	13.54	L	3.47	DL	0.52
		L	13.92	-	-	-	-	-	-	DL	3.15	-	-
		LLI	56.98	LLI	7.12	LLI	71.76	LLI	6.34	LLI	2.16	LLI	4.88
12.	tobacco	DL	9.65	DL	1.03	DL	13.42	L	11.06	L	10.43	LI	0.10
		L	5.95	LI	0.63	L	3.36	LI	0.53	-	-	L	6.50
		LLI	16.11	LLI	1.67	LLI	12.85	LLI	5.60	LLI	5.84	LLI	3.83
13.	fuel & light	L	3.05	L	0.94	L	41.79	L	0.36	L	19.67	DL	4.14
		-	-	DL	1.36	DL	12.11	DL	0.35	DL	19.49	-	-
		LLI	19.90	LLI	1.31	LLI	22.25	LLI	0.29	LLI	29.97	LLI	5.63
14.	services	DL	33.78	DL	3.62	DL	17.86	DL	3.50	DL	1.75	DL	0.47
		LLI	41.51	LLI	3.55	LLI	38.30	LLI	1.43	LLI	2.51	LLI	1.11

Table 7.13 Computed values of F-ratios associated with the tests of overall homogenieity of itemwise kind expenditure functions for each occupation pair :NSS 18th round, all-India rural, combined sample.

srl. no.	item	occupation pairs											
		1,2		1,3		1,4		2,3		2,4		3,4	
		form	F	form	F	form	F	form	F	form	F	form	F
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1.	cereals	SL	3.65*	SL	0.28	SL	14.26*	SL	2.30	SL	12.05*	SL	11.68*
		LLI	12.78*	LLI	102.90*	LLI	40.13*	LLI	112.75*	LLI	18.77*	LLI	199.72*
2.	milk	L	3.56*	L	0.30	L	0.34	DL	57.65*	L	12.30*	L	0.40
		DL	14.12*	DL	0.94	-	-	-	-	DL	60.16*	DL	3.53
		LLI	50.92*	LLI	1.35	LLI	19.64*	LLI	41.85*	LLI	20.07*	LLI	40.33*
3.	milk products	DL	14.63*	DL	0.47	DL	1.53	L	6.72*	L	9.96*	DL	1.05
		L	3.82*	-	-	L	1.06	DL	14.91*	-	-	L	1.37
		LLI	33.50*	LLI	1.24	LLI	15.30*	LLI	10.53*	LLI	10.06*	LLI	7.84*
4.	pulses	DL	120.72*	DL	11.42*	DL	110.92*	L	5.35*	L	0.13	L	3.22
		LLI	42.62*	LLI	7.82*	LLI	18.74*	LLI	4.34*	LLI	5.60*	LLI	3.16
5.	oils	L	2.12	-	-	L	2.48	-	-	L	5.41*	-	-
		LLI	60.21*	-	-	LLI	20.80*	-	-	LLI	34.08*	-	-
6.	vegetables	DL	0.11	DL	0.13	DL	2.66	DL	0.18	DL	11.30*	DL	0.43
		-	-	L	0.57	-	-	L	2.24	-	-	L	4.38*
		LLI	6.94*	LLI	1.24	LLI	17.65*	LLI	0.17	LLI	11.06*	LLI	0.65

* indicates significance at 5 per cent level.

Table 7.13 : (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
7.	sugar	L	5.18*	L	0.51	L	6.45*	L	2.27	L	0.08	DL	0.80
		LLI	5.35*	LLI	0.69	LLI	4.06*	LLI	0.45	LLI	5.22*	LLI	5.57*
8.	spices	L	0.97	L	0.07	L	1.00	L	4.41*	L	1.66	L	1.26
		DL	4.30*	-	-	-	-	DL	0.55	DL	8.34*	-	-
		LLI	0.83	LLI	1.08	LLI	0.52	LLI	3.71*	LLI	1.57	LLI	3.29
9.	all-food	L	1.81	L	0.11	L	0.21	L	0.54	L	0.63	L	0.27
		SL	1.03	-	-	-	-	SL	1.29	SL	0.77	-	-
		LLI	4.18*	LLI	1.75	LLI	7.79*	LLI	0.56	LLI	2.38	LLI	21.09*
10.	tobacco	LLI	50.03*	LLI	19.80*	LLI	11.44*	LLI	8.52*	LLI	50.26*	LLI	1.80
11.	fuel & light	L	3.16	L	1.84	L	0.18	L	0.85	L	1.45	L	4.62*
		LLI	9.20*	LLI	1.92	LLI	42.42*	LLI	6.58*	LLI	25.69*	LLI	15.25*
12.	services	DL	7.87*	DL	0.06	DL	5.62*	DL	4.25*	DL	5.85*	DL	3.16
		LLI	16.47*	LLI	0.52	LLI	15.15*	LLI	2.92	LLI	2.22	LLI	2.68

(ii) Between occupation groups 1 and 3, the cash expenditure functions show a good deal of homogeneity. In fact, these functions differ only for cereals, milk products and sugar. For this pair of occupations, the itemwise kind expenditure functions show a picture of overall homogeneity. In fact, for all items except cereals, pulses and tobacco the kind expenditure functions turned out to be homogeneous. For cereals, however, the conclusions reached on the basis of SL and LLI curves showed disagreement.

(iii) For the occupation pair 1 and 4, homogeneity of cash expenditure functions is established only for pulses. The picture about the homogeneity of kind expenditure functions, however, is not clear because for most items the results of homogeneity test appeared to be very much form-specific.

(iv) As between occupation groups 2 and 3, clear-cut picture of overall heterogeneity of cash expenditure functions is established for cereals, sugar and all-food items. For vegetables and tobacco the results based on different forms of the function do not agree. In all other cases, the cash expenditure functions appear to be homogeneous. Corresponding picture about kind expenditure functions is also one of overall heterogeneity. Here, only for vegetables, sugar and all-food the kind expenditure functions are homogeneous. For cereals, fuel and light and services there is disagreement of conclusions based on different forms.

(v) Cash expenditure functions for pulses, fish- egg etc., all-food and services are seen to be homogeneous between occupation groups 2 and 4. For this pair, cash expenditure functions for all other items turned out to be different. Corresponding results of kind expenditure functions also indicate considerable heterogeneity. Only for all-food item homogeneity of kind expenditure functions is established and for pulses, sugar, spices, fuel and light and services the results obtained from different forms differ. However, except fuel and light, in all other cases the differences are marginal in the sense that at 1 per cent level of significance homogeneity may be accepted.

(vi) The extent of homogeneity of cash expenditure patterns is quite remarkable for the occupation pair 3 and 4. For this pair, cash expenditure patterns for milk and milk product are seen to be different. In all other cases the homogeneity of expenditure pattern is acceptable. In this case also, the homogeneity tests of kind expenditure functions lead to numerous anomalous results and as such no conclusive picture could be obtained.

7.6 Conclusion :

The results of the above empirical exercises indicate considerable heterogeneity of expenditure patterns across occupational groups in rural India. Specifically, the analysis based on total expenditures (i.e., sum of cash and kind expenditures) on different items suggests that while cultivators and agricultural labourers have, by and large, distinct expenditure patterns, the expenditure patterns of households having other agricultural and non-agricultural occupations are more or less similar. These results also indicate that households of agricultural labourers have, on the whole, a pattern of expenditure which is different from that of other types of households.

We made an attempt to refine our analysis by examining the cash and kind components of item expenditures separately. Our results indicate that so far as the cash components of item expenditures are concerned, the pattern of expenditure is considerably influenced by occupational factors. Here it is observed that cultivators have a cash expenditure pattern different from those of agricultural labourers as well as of households with non-agricultural activities. The analysis of the kind expenditure patterns does not, however, reflect any clear picture primarily because of the fact that in most of the cases the itemwise kind expenditure functions could not be estimated satisfactorily. It may also be mentioned that the specifications of itemwise cash and kind expenditure functions employed here is not quite satisfactory. In fact, a detailed study is in progress in which the methodological issues on specification and estimation of expenditure functions and estimation of elasticities as also other aspects of the problem are being examined.

Appendix A

Consumption Patterns of Middle Class and Working Class Households in India : A Regional Comparison

The pattern of interregional variations of consumer expenditure has been examined in a number of Indian studies (e.g., Sinha, 1966; Kumar, 1967; Gupta, 1969, 1970; Maitra, 1970).[1] These studies mostly compared the expenditure patterns of households in different regions/ states of India. So far as only regional factors were considered as the source of differences of expenditure pattern, these studies indicated the over-all effects of regional variations on consumption pattern, such studies, though useful, have the essential limitation that they fail to bring out the 'separate effects' of regional factors on consumption. For measuring the 'separate effects' it is necessary to restrict other household characteristics that influence a household's consumption decisions. That is, it is necessary to compare the consumption patterns of households that may be regarded as homogeneous in respect of all the household characteristics except regional location. In actual practice, non-availability of elaborately cross-classified data on consumer expenditure by several household characteristics precludes the possibility of undertaking detailed studies on the impact of region on consumption pattern in India. In the present appendix we report some empirical results regarding the extent of interregional differences in consumer expenditure pattern of Indian middle class and working class households. In Chapter V we have examined the Engel curves for different items of expenditure

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[1] *Vide* Chapter I, Section 7.5.

separately for the middle class and working class households at four urban centres, viz., Ahmedabad, Calcutta, Kanpur and Madras. Here, we have examined the differences in expenditure pattern over these centres separately for the two social classes. The advantage of this type of analysis lies in the fact that by considering the two social classes separately, it is possible to eliminate the effect of social class/occupation, a household characteristic known to have significant influence on consumption pattern. This helps in obtaining a more clear picture of the regional differences in expenditure pattern.

Comparison of expenditure pattern is made in respect of the following categories of expenditures; (i) cereals and products, (ii) cereals and pulses, (iii) edible oil, (iv) meat, fish and egg, (v) milk and products, (vi) other food, including sugar, spices and condiments, prepared meals and refreshments, (vii) total food, (viii) pan, supari and tobacco, (ix) fuel and light, (x) clothing, (xi) housing and finally (xii) miscellaneous items composed of expenditure on transport and communication, education, medical and personal care and recreation. The comparisons are made through the analysis of covariances. That is, we have considered the DL engel curves, $\log y = \alpha + \beta \log x$, where y is per capita item expenditure and x is corresponding per capita total consumer expenditure for describing the expenditure pattern in respect of each of the items mentioned above, and have tested the inter-centre homogeneity of these DL engel curves for each item, separately for the two social classes. For each item and each class we have first tested the null hypothesis that the slopes (elasticities) are same for all the centres. If this is not rejected we have tested whether the intercepts of the DL curves are same for all the centres (assuming the slopes to be same). If this is also not rejected, we, finally, have tested whether for any item a single DL curve would explain the expenditure pattern for all the centres.[2/]

Table A below presents the results of analysis of covariance for testing inter-centre homogeneity of expenditure patterns.

Table A : Values of F-ratio associated with different null hypotheses underlying the analysis of covariance applied to test interregional homogeneity of expenditure patters : Working class and Middle class FLS 1958-59.

item	working class			middle class		
	F_1	F_2	F_3	F_1	F_2	F_3
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. cereals and products	3.00	0.37	1.75	2.75	5.00	-
2. cereals and pulses	2.57	0.64	1.66	1.93	1.01	1.53
3. edible oil	0.35	11.58	-	0.33	14.06	-
4. meat, fish and egg	1.15	56.22	-	1.13	110.36	-
5. milk and products	2.88	29.44	-	0.23	19.90	-
6. other food	2.55	16.39	-	1.21	29.63	-
7. food - total	3.64	7.67	-	1.45	7.26	-
8. pan, supari, tobacco	5.06	-	-	2.40	16.63	-
9. fuel and light	1.30	1.94	1.65	0.08	46.37	-
10. housing	1.65	16.49	-	1.18	43.46	-
11. clothing	0.16	15.23	-	0.20	24.23	-
12. miscellaneous	6.48	-	-	0.42	12.69	-
degree of freedom	(3,24)	(3,27)	(6,24)	(3,20)	(3,23)	(6,20)
critical F-values 5 %	3.01	2.96	2.51	3.10	3.03	2.60

[2/] Vide Appendix C for the procedure of analysis of covariance that we have actually adopted.

In Table A, F_1 is associated with the null hypothesis that the slopes (elasticity) of the DL curves are same for all centres; F_2 is associated with the null hypothesis that the intercepts are also same, and finally F_3 is used to test the null hypothesis that both the slope and intercept are same for all the four centres. It is seen from Table A *that for the working class at different centres, the engel elasticities* are similar for all the items excepting pan, supari and tobacco and miscellaneous items. Only for cereals and products, cereals and pulses and fuel and light the engel curves are homogeneous over the centres. In all other cases, the DL engel curves differ as a result of significant differences in the intercepts. For the middle class households the results of analysis of covariance suggest that the slopes (elasticities) are homogeneous over centres for all the items. Only for cereals and pulses the complete homogeneity of engel curves is established. In all other cases the intercepts differ significantly over centres.

The results of analysis of covariance reported above indicate significant inter-centre differences in the levels of consumption of different items for both the social classes. Since inter-centre differences in household size are usually small, it may be concluded that the analysis of covariance based on per capita formulation of DL engel curves do not vitiate the true picture of underlying differences to any significant extent (vide Tables 5.3 and 5.4 for the inter-centre differences in household size over classes of per capita monthly income for the working class and middle class respectively). However, it must be mentioned that inter-centre differences in price levels may have considerable influence on the differences in expenditure pattern for various items. Thus, if prices could be brought in explicitly, a part of the differences would have been removed. In the present analysis, we have ignored the role of prices altogether, and this may be considered a limitation of the present analysis.

Appendix B

Choice of Classificatory Character in Engel Curve Analysis

In Chapter V we have analysed the item-wise engel curves for the two social classes at different centres by using estimates of per capita item expenditure and per capita total consumer expenditure classified by levels of per capita income. It may be argued that expenditure data classified by per capita total expenditure would have been more appropriate in this context. Here, we report some results of comparison of constant elasticity engel curves estimated from the data classified by per capita income with those estimated from the data classified by per capita total consumer expenditure. In both the cases logarithm of per capita total consumer expenditure is used as the regressor and the weighted least squares method has been followed. These results are based on the estimates thrown up by the Middle class FLS at different centres. Since for working class at different centres only per capita income classification of expenditure estimates are available, no such comparison could be done for this class.

The pragmatic justification for preferring per capita total consumer expenditure, as the regressor and hence as the classificatory variable (in case of grouped expenditure data) is that this is often recorded more accurately than per capita income. This apart, actual income may have a relatively large transitory component than total consumer expenditure. Thus, per capita item expenditure would be a stable function of per capita total expenditure. On the other hand, following Liviatan (1961), it may be argued that since item expenditures are stochastically related to permanent income, total expenditure would usually have a random component. Moreover, the errors in item expenditure and total expenditure would be correlated, the errors in total expenditure being a function of errors in item expenditures. In such a case, least squares estimates of the parameters of engel curve relating item expenditure to total expenditure would be inconsistent. This problem of inconsistency may be avoided by using the instrumental variable estimation procedure, and recorded income should be chosen as the instrumental variable. An equivalent procedure would be to use expenditure data classified by recorded income for estimating the engel curve relating item expenditure to total expenditure. The implicit assumption is that recorded income is highly correlated with permanent income, because if this is so the errors in item expenditure will have a negligible correlation with recorded income and thus the instrumental variable estimators of the engel parameters would be consistent.

Apart from this theoretical arguement, the practice of classifying expenditure data by total expenditure may be questionable on a more practical ground (Bhattacharya, 1967). Frequently, in consumer expenditure surveys a moving reference period is used for collecting informations about expenditure from sample households. Thus, households interviewed on different dates furnish accounts for different reference periods. As the interviews are spread over the survey period, of a few months or one year, seasonal variation is superimposed on the true variation between different households. Thus it is likely that there would be transitory elements in item expenditures and therefore in total expenditure as well. In such a case, the engel curves might get distorted as a result of using total expenditure as the classificatory variable unless unusual item expenditures are excluded from recorded total consumer expenditure.

An examination of the movement of average per capita total consumer expenditure over classes of per capita monthly income for the Middle class at different centres show that total consumer expenditure often exceeds income (vide Table B 1 below). Since such a divergence can never be a permanent phenomenon, it appears that actual income in these surveys are either under-reported or contain seasonal or other types of transitory element.

Table B 1: Average per capita total consumer expenditure by levels of per capita monthly income: Middle class FLS, 1958-59.

centre	per capita income (Rs.)								
	0-10	10-20	20-30	30-40	40-60	60-100	100-150	150 & above	all
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ahmedabad	22.64	30.33	36.89	42.24	57.08	79.57	110.51	183.22	52.80
Calcutta	--	20.54	30.83	38.17	51.13	76.15	108.89	212.39	71.72
Kanpur	12.52.	23.70	31.87	39.56	50.72	81.97	128.88	212.98	46.69
Madras	13.13	23.72	34.94	44.72	58.08	77.73	112.79	228.02	71.09

In so far as total consumer expenditure appears to be stable and more accurately reported in the present surveys, it seems reasonable to accept logarithm of per capita total consumer expenditure ($\log \frac{X}{n}$) as the regressor for the constant elasticity engel curve $\log (\frac{Y}{n}) = \alpha + \beta \log (\frac{X}{n})$, where $\log (\frac{Y}{n})$ is the logarithm of per capita item expenditure. We have estimated this curve in three alternative ways. First of all, we have use estimates of $(\frac{Y}{n})$ and $(\frac{X}{n})$ grouped by levels of $(\frac{X}{n})$ and have applied the weighted least squares procedure for obtaining estimates of α and β. Here, the weights chosen are number of sample households in each class of $(\frac{X}{n})$. Next, a similar procedure has been adopted for the data grouped by levels of per capita income $(\frac{Z}{n})$. Finally, we have applied the instrumental variable technique to obtain estimates of α and β from the income classification. In this case logarithm of mid-point of per capita income class has been used as the instrument. Table B 2 presents the alternative estimates of α and β and associated R^2 for different items of expenditure. Specifically, the items/item-groups considered here include, (i) cereals and products, (ii) cereals and pulses, (iii) edible oil, (iv) meat, fish and egg, (v) milk and products, (vi) other food, (vii) food-total, (viii) pan, supari, tobacco, (ix) fuel and light, (x) housing, (xi) clothing, and (xii) miscellaneous.

applied to expenditure classification and income classification of expenditure data and through (ii) instrumental variable technique applied to income classification : Middle class FLS, 1958-59.

item	by WLS applied to expenditure classification			by WLS applied to income classification			by instrumental variable technique applied to income classification		
	α	β	R^2	α	β	R^2	α	β	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				(i) Ahmedabad					
1. cereals & products	1.002	0.214	0.857	0.972	0.219	0.636	0.881	0.242	0.629
2. cereals & pulses	1.110	0.235	0.906	1.231	0.201	0.550	1.128	0.228	0.541
3. edible oil	-0.353	0.291	0.939	-0.324	0.280	0.743	-0.327	0.281	0.743
4. meat, fish & egg	-3.600	0.594	0.724	-4.648	0.826	0.362	-4.168	0.703	0.354
5. milk & products	-1.388	0.791	0.943	-2.105	0.966	0.928	-2.272	1.009	0.926
6. other food	-1.132	0.772	0.987	-1.745	0.921	0.986	-1.734	0.918	0.986
7. food-total	0.997	0.541	0.989	0.565	0.645	0.984	0.524	0.655	0.984
8. pan, supari & tobacco	-4.597	1.071	0.925	-4.381	1.009	0.862	-4.226	0.969	0.861
9. fuel & light	-1.153	0.571	0.963	-1.591	0.677	0.943	-1.660	0.695	0.942
10. housing	-2.193	1.042	0.981	-3.553	1.378	0.990	-3.543	1.375	0.990
11. clothing	-4.844	1.711	0.946	-2.555	1.158	0.961	-2.593	1.166	0.961
12. miscellaneous	-4.547	1.729	0.980	-2.960	1.360	0.982	-2.903	1.345	0.982

Table B 2 : (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				(ii) Calcutta					
1. cereals & products	1.494	0.129	0.506	1.542	0.119	0.543	1.548	0.117	0.543
2. cereals & pulses	1.589	0.130	0.512	1.633	0.120	0.545	1.639	0.119	0.545
3. edible oil	-1.079	0.393	0.828	-1.205	0.422	0.842	-1.214	0.425	0.842
4. meat, fish & egg	-1.838	0.782	0.919	-2.015	0.822	0.917	-2.020	0.823	0.917
5. milk & products	-2.833	0.999	0.909	-2.942	1.023	0.929	-2.948	1.024	0.929
6. other food	-1.614	0.923	0.990	-1.825	0.973	0.988	-1.814	0.970	0.988
7. food-total	0.657	0.644	0.995	0.557	0.667	0.995	0.558	0.667	0.995
8. pan, supari & tobacco	-5.013	1.238	0.992	-5.033	1.244	0.977	-5.077	1.250	0.977
9. fuel & light	-1.687	0.631	0.993	-1.791	0.654	0.989	-1.796	0.655	0.989
10. housing	-2.656	1.220	0.992	-2.827	1.257	0.991	-2.823	1.256	0.991
11. clothing	-3.653	1.275	0.982	-2.494	1.121	0.952	-2.966	1.126	0.952
12. miscellaneous	-3.333	1.438	0.998	-3.199	1.412	0.999	-3.197	1.411	0.999

Table B 2 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				(iii) Kanpur					
1. cereals & products	0.733	0.314	0.930	0.688	0.332	0.774	0.654	0.331	0.773
2. cereals & pulses	0.931	0.304	0.938	0.872	0.316	0.777	0.838	0.325	0.776
3. edible oil	-1.088	0.389	0.897	-1.158	0.401	0.639	-1.271	0.431	0.635
4. meat, fish & egg	-5.269	1.253	0.888	-5.649	1.330	0.835	-5.720	1.355	0.835
5. milk & products	-2.427	1.044	0.901	-2.001	0.935	0.927	-2.112	0.964	0.926
6. other food	-2.101	1.024	0.992	-2.332	1.078	0.996	-2.327	1.077	0.996
7. food-total	0.397	0.701	0.994	0.190	0.750	0.984	0.162	0.758	0.984
8. pan, supari & tobacco	-4.090	0.979	0.968	-4.151	0.991	0.933	-4.163	0.995	0.933
9. fuel & light	-1.729	0.657	0.989	-1.804	0.674	0.981	-1.824	0.679	0.982
10. housing	-2.329	1.027	0.969	-2.977	1.189	0.983	-2.960	1.184	0.983
11. clothing	-2.945	1.191	0.873	-2.140	1.021	0.974	-2.117	1.014	0.974
12. miscellaneous	-3.630	1.544	0.994	-2.942	1.382	0.999	-2.936	1.380	0.993

Table B 2 (contd.)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				(iv) Madras					
1. cereals & products	1.181	0.183	0.548	1.650	0.067	0.221	1.634	0.071	0.221
2. cereals & pulses	1.249	0.208	0.570	1.702	0.096	0.321	1.677	0.103	0.320
3. edible oil	-1.427	0.454	0.815	-1.042	0.359	0.798	-1.099	0.373	0.797
4. meat, fish & egg	-3.315	0.901	0.935	-2.740	0.765	0.946	-2.682	0.751	0.946
5. milk & products	-2.165	0.937	0.848	-1.988	0.890	0.85	-2.111	0.921	0.850
6. other food	-1.328	0.898	0.993	-1.690	0.980	0.992	-1.725	0.989	0.992
7. food-total	0.561	0.675	0.973	0.593	0.662	0.989	0.567	0.669	0.989
8. pan, supari & tobacco	-4.293	0.922	0.968	-4.251	0.912	0.927	-4.199	0.899	0.927
9. fuel & light	-1.618	0.665	0.974	-1.595	0.655	0.934	-1.612	0.659	0.984
10. housing	-2.332	1.085	0.995	-3.139	1.272	0.998	-3.157	1.276	0.998
11. clothing	-4.248	1.476	0.974	-2.594	1.107	0.967	-2.639	1.118	0.967
12. miscellaneous	-3.549	1.484	0.998	-3.353	1.448	0.996	-3.354	1.448	0.996

It is clear that the pattern of divergence of the elasticities (β) estimated from the expenditure classification and income classification through weighted least squares (i.e., col. (3) and col. (6) of Table B 2) is not similar for all the centres. For Ahmedabad the discripancy of the two estimates of β is large for all the items excepting cereals and products, cereals and pulses and edible oil. For the other three centres, the corresponding discripancies are usually less serious. As regards the goodness of fit, R^2's corresponding to expenditure classification are generally higher for Ahmedabad. The R^2's for cereals and pulses, edible oil and meat, fish and egg obtained from expenditure classification are remarkably higher than those obtained from income classification. For Calcutta, the R^2's obtained from the two classifications are more or less comparable. For Kanpur and Madras, marked difference in R^2 is observed for cereals and products, cereals and pulses and edible oil. In other cases, the divergence in R^2 is relatively small. As regards the estimates obtained through instrumental variable technique, it may be noted that the estimates obtained through this technique are often very close to those obtained from income classification through weighted least squares method. This is expected in view of the fact that the estimated average per capita total expenditure and the corresponding mid-points of per capita income class are usually highly correlated. It can, therefore, be concluded that barring a few aberrant cases the engel curves estimated from expenditure classification and income classification are more or less comparable.

Appendix C

Analysis of Covariance

The analysis of covariance technique has been applied in Chapter V and also in Appendix A to expenditure data grouped by levels of per capita monthly income. The basic data is thus $(y_j^i, x_j^i, w_j^i\ ;\ i=1,\ldots,p;\ j=1,\ldots,n_i)$ where y_j^i, x_j^i and w_j^i are per capita item expenditure, per capita total consumer expenditure and number of sample households respectively in the jth per capita income class for the ith group. The basic data being grouped in nature, it is desirable that different regressions underlying the analysis of covariance be estimated through weighted least squares procedure using w_j^i's as weights. In case of the DL engel curve, $\log y = \beta_0 + \beta_1 \log x$, the weighted least squares procedure is equivalent to applying ordinary least squares to $\log y \sqrt{w} = \beta_0 \sqrt{w} + \beta_1 \log x \sqrt{w}$, where w is the number of sample households. In this case, the null hypotheses underlying the analysis of covariance are related to (i) testing the homogeneity of β_1 over groups, (ii) testing the homogeneity of β_0 when β_1 are assumed to be same over groups, and (iii) testing the homogeneity of the overall regression, i.e., both of β_0 and β_1 over groups.

For DL curves, different specifications correspending to the null hypotheses mentioned above are, first

$$\log y_j^i \sqrt{w_j^i} = \beta_{oi} \sqrt{w_j^i} + \beta_{1i} \log x_j^i \sqrt{w_j^i} + \varepsilon_j^i \qquad \ldots(C\text{-}1)$$

the unrestricted model, the corresponding residual sum of square being

$$r^2 = \sum_{i=1}^{p} \left[\sum_j (\log y_j^i)^2 \, w_j^i - \beta_{0i} \sum_j \log y_j^i w_j^i - \beta_{1i} \sum_j \log y_j^i \log x_j^i w_j^i \right] \quad ..(C-2)$$

where β_{0i}, β_{1i} are the ordinary least squares estimators from (C-1). The degrees of freedom associated with (C-2) is $(\Sigma n_i - 2p)$.

Next we have

$$\log y_j^i \sqrt{w_j^i} = \beta_0 \sqrt{w_j^i} + \sum_{s=2}^{p} \alpha_i \, d_j^s + \beta_1 \log x_j^i \sqrt{w_j^i} + \varepsilon_j^i \quad \ldots (C-3)$$

where β_1 is assumed same over all groups, but β_0 is allowed to vary. Here d_j^s ($= \sqrt{w_j^i}$ for $i = s$ and $d_j^s = 0$ otherwise) is the dummy variable introduced for allowing variations in intercepts over groups. The residual sum of squares is

$$e^2 = \sum_{i=1}^{p} \sum_j (\log y_j^i)^2 \, w_j^i - \sum_{i=2}^{p} \alpha_i \sum_j w_j^i \log y_j^i - \beta_0 \sum_{i=1}^{p} \sum_j \log y_j^i \, w_j^i$$

$$- \beta_1 \sum_{i=1}^{p} \sum_i \log y_j^i \log x_j^i \, w_j^i \quad \ldots (C-4)$$

with $\sum_{i=1}^{p} n_i - 2 - (p - 1)$ degrees of freedom, where α_i , β_0 and β_1 are again ordinary least squares estimators.

Finally, we have

$$\log y_j^i \sqrt{w_j^i} = \beta_0 \sqrt{w_j^i} + \beta_1 \log x_j^i \sqrt{w_j^i} + \varepsilon_j^i \quad \ldots (C-5)$$

where β_0 and β_1 are same for all groups. Here the residual sum of squares is

$$s^2 = \sum_{i=1}^{p} \left[\sum_j (\log y_j^i)^2 \, w_j^i - \beta_0 \sum_j \log y_j^i \, w_j^i \right.$$

$$\left. - \beta_1 \sum_j \log y_j^i \log x_j^i \, w_j^i \right] \quad \ldots (C-6)$$

with $\sum_{i=1}^{p} n_i - 2$ degrees of freedom.

Now, the rest of the procedure is standard (*vide* Johnston, 1972, pp. 192-207). For testing the null hypothesis β_1 are same for all groups we have used

$$F_1 = \frac{e^2 - r^2 / (p-1)}{r^2 / \left(\sum_{i=1}^{p} n_i - 2p \right)} \qquad \ldots \text{(C-7)}$$

with $\left((p-1), \left(\sum_{i=1}^{p} n_i - 2p \right) \right)$ degrees of freedom. Next, for testing the homogeneity of β_0 (assuming β_1 to be homogeneous over groups).

$$F_2 = \frac{s^2 - e^2 / (p-1)}{c^2 / \left(\sum_{i=1}^{p} n_i - 2 - (p-1) \right)} \qquad \ldots \text{(C-8)}$$

with $\left((p-1), \left(\Sigma n_i - 2 - (p-1) \right) \right)$ degrees of freedom is used. Finally, for testing overall homogeneity of engel curves

$$F_3 = \frac{s^2 - r^2 / 2(p-1)}{r^2 / \left(\sum_{i=1}^{p} n_i - 2p \right)} \qquad \ldots \text{(C-9)}$$

with $\left(2(p-1), \left(\Sigma n_i - 2p \right) \right)$ degrees of freedom is used.

For testing the overall homogeneity of the LLI engel curves $\log y = \beta_0 + \beta_1 \log x + \beta_2 \cdot$, we have followed essentially the same procedure and have computed (C-9). Here, we have

$$\log y \sqrt{w} = \beta_0 \sqrt{w} + \beta_1 \log x \sqrt{w} + \beta_2 \frac{\sqrt{w}}{x} .$$

Thus,

$$s^2 = \sum_{i=1}^{p} \left[\sum_{j} (\log y_j^i)^2 \; w_j^i - \beta_0 \sum_{j} \log y_j^i \, w_j^i - \beta_1 \sum_{j} \log y_j^i \log x_j^i \, w_j^i - \beta_2 \sum \frac{\log y_j^i}{x_j^i} \, w_j^i \right] \quad \ldots. \; (C\text{-}10)$$

with $\sum_{i=1}^{p} n_i - 3$ degrees of freedom, and

$$r^2 = \sum_{i=1}^{p} \left[\sum_{j} (\log y_j^i)^2 \, w_j^i - \beta_{0i} \sum_{j} \log y_j^i \, w_j^i - \beta_{1i} \sum_{j} \log y_j^i \log x_j^i \, w_j^i - \beta_{2i} \sum_{j} \frac{\log y_j^i}{x_j^i} \, w_j^i \right] \quad \ldots \; (C\text{-}11)$$

with $\Sigma \, n_i - 3p$ degrees of freedom.

Appendix D

Estimation of Sampling Errors of Engel Parameters from Grouped Survey Data

Introduction :

Household budget enquiries usually cover samples of households drawn according to complicated sampling designs, often involving stratification, multi-stage selection etc. This is true of the budget enquiries conducted in different rounds of the National Sample Survey (NSS). This makes if difficult, if not impossible, to estimate the standard errors of the estimated parameters of engel curves fitted to the data and hence of estimated engel elasticities. Standard statistical procedures, like t- and F-tests, cannot also be applied. Some analysts seem to have completely overlooked these difficulties and proceeded as though the samples were simple random (vide Iyengar, Jain and Srinivasan, 1969).

One additional complication is that the data are often available only in a grouped form. Le x denote the classificatory variate viz., per capita household income or total consumer expenditure. Then for each of a number of intervals of x, one has, from the survey tabulations, (i) p_i, the estimated population (or proportion of population) in the i-th interval of x, $i = 1, 2, \ldots, k$, and (ii) $\bar{x}_i$, the estimated average of x, and (iii)· $\bar{y}_i$, the estimated average of y, the consumption of the item under consideration*.

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* It may be noted that unless the micro engel relation is linear, aggregation over individuals in a particular x-interval leads to some distortion of the engel relation. This point has generally been ignored in empirical research.

Faced with such problems, some researchers have approached the problem of estimating sampling variances in the following way (Jain and Tendulkar, 1973). The appraoch treats the group averages $(\bar{x}_i, \bar{y}_i)$, $i = 1, 2, \ldots, k$ as primary observations and applies weighted least squares method, making a <u>rough</u> correction for heteroscedasticity. Assuming a linear form of the engel relation, for example, one specifics the model as

$$\bar{y}_i = \alpha + \beta\,\bar{x}_i + \varepsilon_i \qquad i = 1, 2, \ldots, k \qquad \ldots (D\ 1)$$

when $E(\varepsilon_i) = 0$; $V(\varepsilon_i) = \dfrac{\sigma^2}{p_i}$, $i = 1, 2, \ldots, k$; $\mathrm{Cov.}(\varepsilon_i, \varepsilon_j) = 0$, $i \neq j$; and so on.** It follows that one may write

$$\sqrt{p_i}\,\bar{y}_i = \alpha\sqrt{p_i} + \beta\,\bar{x}_i\sqrt{p_i} + \varepsilon_i\sqrt{p_i} \qquad i = 1, 2, \ldots k \qquad \ldots (D\ 2)$$

and apply classical least squares (CLS) method of estimation to (D 2). The sampling variance of the CLS estimate $\wedge$ would then be estimated by

$$\hat{V}_i(\hat{\beta}) = \frac{\hat{\sigma}^2}{S_{\bar{x}_i}} \qquad \ldots (D\ 3)$$

where $$S_{\bar{x}_i} = \sum_i (\bar{x}_i - \bar{x})^2\, p_i$$

and $$\bar{x} = \sum_i x_i p_i \,/\, \Sigma p_i$$

and $\hat{\sigma}^2$ is the CLS estimate of the variance of $\varepsilon_i\sqrt{p_i}$.

In the NSS, the sample is drawn in the form of two or more independent and interpenetrating subsamples, each providing independent and equally valid estimates of population characteristics. This enables us to compute separate subsamplewise estimates of engel parameters in addition to

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** It should be appreciated that the assumption $V(\varepsilon_i) = \sigma^2/p_i$ is only a rough approximation to reality.

the estimates based on the 'combined' sample; the divergence among the subsample estimates of any parameter would give a measure of uncertainty associated with the corresponding combined sample estimate. Half-samplewise estimates of engel elasticities computed by some researchers (vide Biswas 1963; Saha 1973) may therefore be utilized for estimating the sampling variance. Thus, if $\hat{\beta}_1$, and $\hat{\beta}_2$ be the estimate of β in (D 1) from half-samples 1 and 2 of the NSS sample, and $\hat{\beta}$ the combined sample estimate, then, this approach gives

$$\hat{V}_2(\hat{\beta}) = \frac{1}{4}(\hat{\beta}_1 - \hat{\beta}_2)^2 \qquad \ldots \quad (D\ 4)$$

as the estimated sampling variance of $\hat{\beta}$.

In this Appendix are reported the results of an empirical study on the comparative magnitudes of $\hat{V}_1(\hat{\beta})$ and $\hat{V}_2(\hat{\beta})$. It appears that the two methods sometimes yield significantly different estimates of sampling variance. The sign and magnitude of the discrepancies are found to depend on the algebraic form of the engel curve, presumably, on the goodness of fit provided by it. However, the results are curious in certain respects and could not be satisfactorily explained in terms of known results of econometric theory.

Comparative Study of $\hat{V}_1(\hat{\beta})$ and $\hat{V}_2(\hat{\beta})$:

The following is the reasoning leading to the F-test applied for comparing $\hat{V}_1(\beta)$ and $\hat{V}_2(\hat{\beta})$. If one assumes that the half-samplewise estimates $\hat{\beta}_1$ and $\hat{\beta}_2 \sim N(\beta, 2\sigma_\beta^2)$ then it follows that

$$\hat{V}_2(\hat{\beta}) \sim \sigma_\beta^2\, \chi_1^2$$

where χ_r^2 denotes a chi-square variate with r d.f. (Note that σ_β^2 is the true sampling Variance of $\hat{\beta}$). On the other hand, it can be easily shown, making the usual assumptions, including normality of ε's

$$\hat{V}_2(\hat{\beta}) \sim \sigma_\beta^2 \frac{\chi^2_{k-2}}{k-2}$$

If, more generally, the engel relation is linear in parameters and includes p parameters, this result would become

$$\hat{V}_1(\hat{\beta}) \sim \sigma_\beta^2 \frac{\chi^2_{k-p}}{k-p}$$

where $\hat{V}_1(\hat{\beta})$ is the estimated sampling variance of any estimated parameter $\hat{\beta}$ obtained by the standard CLS procedure. One may now assume the combined sample estimates of average y for the different x-intervals to be statistically independent of the differences between the corresponding half-sample estimates; this is indeed quite plausible as all the estimates are approximately normally distributed. Under this assumption, $\hat{V}_1(\hat{\beta})$ and $\hat{V}_2(\hat{\beta})$ are statistically independent and we get

$$F = \frac{\hat{V}_2(\hat{\beta})}{\hat{V}_1(\hat{\beta})} \sim F_{1,\, k-p} \qquad \text{... (D 5)}$$

Of course, the above tacitly assumes that both procedures estimate the same true sampling variance.

The statistic F in (D 5) was computed in each of 290 cases of engel curves and the frequency distributions of the computed F-values are set out in Tables D 1 and D 2. To be precise, these results were based on the Bhattacharya and Maitra (1969) study of engel curves for 15 different items of consumption separately for rural and urban India and for

14 rounds of NSS covering the period from the 7th (Oct. 1953- March 1954) to 22nd (July 1967 - June 1968) rounds. For purposes of this study, we used (i) the half-samplewise and combined sample estimates of parameters of engel of four algebraic forms — double-log (DL), semi-log (SL), hyperbola (HP) and log-log-inverse (LLI), and (ii) the estimated sampling variances, of the nature of $\hat{V}_1(\hat{\beta})$, of the combined sample estimates of all the parameters, excluding the intercept parameters.

Table D 1: Frequency distribution of computed F-values (1 and 10 degrees of freedom) : slope coefficients of hyperbola, double-log and semi-log engel curves.

class-interval		number of cases		
value of F	upper tail probability	hyperbola	double-log	semi-log
(1)	(2)	(3)	(4)	(5)
less than 0.1650×10^{-5}	1.000 - 0.999	2	-	1
0.1650×10^{-5} - 0.4120×10^{-4}	0.999 - 0.995	7	-	1
0.4120×10^{-4} - 0.1650×10^{-3}	0.995 - 0.990	5	-	6
0.1650×10^{-3} - 0.00103	0.990 - 0.975	17	1	8
0.00103 - 0.00412	0.975 - 0.950	25	5	10
0.00412 - 0.0166	0.950 - 0.900	46	4	29
0.0166 - 0.107	0.900 - 0.750	96	11	60
0.107 - 1.49	0.750 - 0.250	90	50	144
1.49 - 3.29	0.250 - 0.100	2	39	18
3.29 - 4.96	0.100 - 0.050	-	20	-
4.96 - 6.94	0.050 - 0.025	-	20	4
6.94 - 10.04	0.025 - 0.010	-	26	5
10.04 - 12.83	0.010 - 0.005	-	20	2
12.83 - 21.04	0.005 - 0.001	-	27	-
21.04 and above	0.001 -	-	67	2
all		290	290	290

Table D 2: Frequency distribution of computed F values (1 and 9 degrees of freedom) : slope coefficients of log-log-inverse engel curve.

class-interval		number of cases	
value of F	upper tail probability	β	γ
	(2)	(3)	(4)
less than 0.1660×10^{-5}	1.000 - 0.999	-	-
0.1660×10^{-5} - 0.4151×10^{-4}	0.999 - 0.995	-	1
0.4151×10^{-4} - 0.1660×10^{-3}	0.995 - 0.990	2	1
0.1660×10^{-3} - 0.00104	0.990 - 0.975	3	6
0.00104 - 0.00415	0.975 - 0.950	11	3
0.00415 - 0.01671	0.950 - 0.900	13	18
0.01671 - 0.108	0.900 - 0.750	37	38
0.108 - 1.51	0.750 - 0.250	149	143
1.51 - 3.36	0.250 - 0.100	42	38
3.36 - 5.12	0.100 - 0.050	16	14
5.12 - 7.21	0.050 - 0.025	1	14
7.21 - 10.56	0.025 - 0.010	7	7
10.56 - 13.61	0.010 - 0.005	3	-
13.61 - 22.86	0.005 - 0.001	3	2
22.86 and above	0.001 -	3	5
all		290	290

Discussion of results :

Attempts were made to explain the results reported above in terms of known results of econometric theory, but these attempts were only partially successful. Presumably, errors in the algebraic specification of the engel relation were largely responsible for such striking results. We give below some results from the work of Maitreyi Mukherjee (1974) who has examined at depth the consequences of misspecification on the CLS estimation of Sampling Variance of estimated regression coefficients.

Consider the usual regression model written $y = X\beta + \varepsilon$, $E(\varepsilon) = 0$, $E(\varepsilon\varepsilon') = \sigma^2 I_n$, where X is a fixed nonstochastic matrix with full column rank. If now some regressors are omitted from the regression equation, and y regressed on a subset of the regressors, say, X^+, then the CLS estimators ($\hat{\beta}^+$) of the corresponding coefficients β^+ are known to be biased (Theil, 1971, Chap. 11). Mukherjee (1974) suggested that in this case one may define $E(\hat{\beta}^+)$ to be the true regression coefficients of the subset of regressors. She then showed that if the CLS procedure is followed for estimating the sampling variances of the elements of β^+ then overestimates are obtained, even though the omission of regressors may lead to some sort of positive autocorrelation in the disturbance term of the misspecified regression equation.

Mukherjee (1974) also considered the case where the disturbances in the true model are autocorrelated, say, due to autocorrelated errors of observation, and follow the Markov scheme. In this case the two effects act in opposite directions. If the effect of misspecification is larger $V(\hat{\beta}_i^+)$ (i = 1, 2, ...,) will be overestimated by the CLS procedures, but if the effect of autocorrelated disturbances is more powerful, $V(\hat{\beta}_i^+)$ will be underestimated.

Assuming that $\hat{V}_2(.)$ is a more or less safe estimator, $\hat{V}_1(.)$ appears to be alright for both parameters of the log-log-inverse curve. Bhattacharya and Maitra (1969) seem to have demonstrated the suitability of this curve form in a convincing manner. Not only are the R^2-values highest among the four curve forms and very high, in the absolute sense, in almost every single case, but in addition, the residuals from this type of curve seem to be nearly random, on the whole, as judged by durbin-watson and other criteria. In the light of these results, one might rule out the possibility of serious algebraic misspecification for the LLI form. That $\hat{V}_1(.)$ and $\hat{V}_2(.)$ are of the same order of magnitude therefore suggests that autocorrelation of the disturbance term is by no means important in the present case.

The results for the hyperbola are the easiest to understand. This curve-form generally gave a poor fit to the empirical data (vide Bhattacharya and Maitra, 1969). There were clearly large specification errors. The theoretical result stated in the context of simple misspecification (Theil, 1971) seems to explain the finding that $\hat{V}_1(.)$ overestimates the true sampling variances in this case.

The results for the remaining curve-forms-DL and SL- do appear to be perplexing. We may first take up the DL curve. If in every case the LLI were perfectly suitable and further the disturbances were non-autocorrelated, fitting the DL would involve specification errors and one would expect the opposite kind of departure of the computed F's from the theoretical distribution*. As regards the SL, its fit was also usually inferior to that of the LLI and one should have expected the observed F-distribution to resemble that obtained for the hyperbola, at least to some extent. In both these cases, then, the observed F-distribution suggests that there was some effect like autocorrelated disturbances, imparting an upward bias to the F-values.

Actually, autocorrelation among the disturbances is not inconceivable in the present case. It is well-known that household budget data, relating to short and moving reference periods like the last month, are affected by seasonality and other short-run movements influencing both x and y values included in the analysis. These transitory components can be treated like errors of observation — and here the errors in x - and y- observations can be correlated. It is easy to see that if the group averages of x and y are numbered in increasing order of x-values, then the component of the disturbance term arising out of these errors in observation could be positively autocorrelated. It is possible that this tended to raise the F-values for all the curve-forms, but that the misspecification errors were far too big for the hyperbola, just counteracting for the SL and smaller in consequence for the DL. This line of thinking completely fails with the results for the LLI.

It is possible that other complications like heteroscedasticity of the disturbance term can provide partial explanations of the results. However, it may be mentioned that in the present case heterscedasticity would be small in case of DL and LLI curves since they use log y as the dependent variable.

Before concluding we may state that the problems discussed in this Appendix would seem to arise even when the sampling is simple and ungrouped observations were available.

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* It may be added here that in a good proportion of cases the DL was nearly adequate and the LLI fit was hardly superior.

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