ON MEASURING THE COST OF CHILDREN : THE CASE OF RURAL MAHARASHTRA

MANISHA CHAKRABARTY

Indian Statistical Institute
Calcutta, 1998

(Revision)

ON MEASURING THE COST OF CHILDREN : THE CASE OF RURAL MAHARASHTRA

MANISHA CHAKRABARTY

A Dissertation Submitted to the
Indian Statistical Institute
in Partial Fulfilment of the Requirement for
the Award of the Degree of
Doctor of Philosophy

Indian Statistical Institute
Calcutta, 1998

Preface

The subject matter of this dissertation is measurement of the *cost of children* which is an issue of central importance in policy related matters like poverty, income distribution, income-maintenance programs, child benefit programs etc.

We know children are not born with cash supplements, but they must be fed, clothed, and therefore, parents have to adjust their expenditure pattern in order to meet this extra burden. This adjustment is a measure of the cost of a 'new born baby'. The cost can be represented in terms of two types of indices, viz., the *relative cost of children* index and the *absolute cost of children* index. The *relative cost of children* index is given by the ratio of the expenditure of a comparison household (with children) to that of the childless reference household and is equivalent to the *general equivalence scale*. The *absolute cost of children* index is given by the difference in the expenditure rather than the ratio. In other words, *relative cost* measures the amount by which household income could be deflated if children were not present, without changing the level of parental well-being, and *absolute cost* measures the amount by which household income could be reduced if children were not present, without affecting parental well-being.

Two well-known methods of estimating *cost of children* are the iso-prop method [which was originated by Engel (1857)] and Rothbarth's method [Rothbarth (1943)]. The iso-prop method looks at the expenditure share on a subset of commodities, often chosen to be necessities (*food* in case of Engel's method). This expenditure share is assumed to be inversely related to the welfare level of the household and different types of households are considered to be at the same welfare level whenever the shares are equal. The cost of a child is measured by the amount of compensation that is required to be paid to the parents to restore this share to its prenatal level. The Rothbarth measure, on the other hand, regards households with the same outlay on a selected subset of commodities (*adult goods*) to have the same welfare level. The cost of a child in this case is defined as the compensation to be paid to a household to restore its expenditure on *adult goods* to its prenatal level as adult welfare is assumed to be correctly indicated by *adult good* expenditure level. It may be mentioned here that the *relative cost* is related to the iso-prop method whereas the *absolute cost* relates to the Rothbarth method.

This dissertation is partly empirical and partly theoretical in nature. It uses the 38th round National Sample Survey (NSS) household level consumption expenditure data for rural Maharashtra. Information on the demographic and socioeconomic aspects of each household is also used in this analysis. The empirical part starts with identification of *adult goods* and an exploratory nonparametric analysis of the engel curve forms of some selected commodities including *adult goods*. Having determined the shapes of engel curves, the rank of the underlying demand system is estimated using a nonparametric procedure. Based on this information theoretically plausible systems of demand equations that incorporate household demographic characteristics are proposed and estimated. The *relative cost of children* is then measured using the above mentioned methods in the single equation framework and using the iso-prop method in the systems framework.

The layout of this dissertation is as follows: chapter 1 gives a brief survey of the relevant literature, chapter 2 describes the NSS data, chapter 3 deals with the identification of *adult goods*, chapter 4 provides the nonparametric exploratory analysis of engel curves, chapter 5 measures the cost of children in a single equation framework and addresses the issue of gender bias, chapter 6 determines the rank of the demand system, chapter 7 proposes the demand systems and measures the *cost of children* from the systems and finally chapter 8 gives the concluding remarks. Appendices A, B and C are supplementary to chapters 3, 4 and 5 respectively.

This dissertation was prepared under the supervision of Dr. Amita Majumder. I am extremely indebted to Dr. Majumder who guided me through every step in the preparation of this dissertation. Without her kind guidance this work could never have been completed. I express my sincerest gratitude to her for her excellent guidance at every stage of my research career.

I convey my profound gratitude to Professor Nikhilesh Bhattacharya for his valuable suggestions. I also fondly recall the help provided by Professor Dipankor Coondoo. I am grateful to him for his invaluable suggestions and for taking time off his busy schedule to read an earlier draft of the entire manuscript and suggest substantial improvement in presentation. I sincerely thank Dr. Probal Choudhuri for his active help in solving a tricky problem that came in the way of better exposition of the problem I had to tackle. I thank Professor Robin Mukherjee, Professor S.R.Chakravarty, Dr. S. Chakrabarti and Dr. C.Neogi for various kinds of help and encouragement throughout the period of my work.

I am especially thankful to Professor Arthur Lewbel for providing me with the relevant computer program package which was extensively used in one part of the empirical analysis presented in this dissertation. I am also grateful to two anonymous reviewers for their invaluable comments and suggestions on an earlier draft of the thesis.

My friend Mrs. Suchismita Ghosh helped me a lot with my computer work and introduced me to some very useful computer packages. My friends Miss Rajlakshmi

Mallick and Mr. Samarjit Das were also of great help in understanding various problems and completing this dissertation. It was their labour of love for me. I express my sincere thanks to Dr. S. Chakrabarti, Mrs. A. Dutta, Mrs. G. Ghosh and to my research fellow friends Mr. D. Mukherjee, Mr. B.S. Chakrabarty and Mr. A. Mukherjee of Economic Research Unit(ERU) for their various kinds of help and encouragement. My sincere thanks are due to Mr.G.Poduval, Mr.D. Ghosh and Mr.P. Raha of CSSC for various kinds of technical help and to the library staffs and to the nonacademic members of ERU for various types of help.

Research is a sequence of alternative hope and tension that I had to undergo from time to time. It is needless to acknowledge the most needed support and encouragement given to me by my parents, though farely advanced in age, to relieve me from all psychological hazards and physical weariness. Without their sustenance provided to me at the homefront, this stupendous task I had undertaken, could never have been completed.

Calcutta, November 1998 *Manisha Chakrabarty*

Contents

Chapter 1

Applied Demand Analysis - A Brief Survey of Literature

1.1 Introduction

The empirical analysis of consumer behaviour has been a major area of applied econometric research since the pioneering work by Ernst Engel (1857). Applied demand analysis is the area of applied econometrics which integrates consumer behaviour theory with the empirical analysis of household consumption expenditure data. The central objectives of all these studies are related with the measurement of consumer response to changes in factors affecting the demand and also with the empirical validation of the theoretical postulates regarding consumer behaviour.

According to the nature of data used, these studies may be classified into three groups- viz., analysis of cross-sectional household budget data, analysis of time-series data on aggregate/average consumption of goods obtained from national accounts sources or from repetitive household budget surveys, and finally, analysis of continuous cross-sectional or panel data on household budget.

Of these, the tradition of analysis of cross-sectional budget data is the oldest, initiated by Engel (1857). Classical examples of such studies are Allen and Bowley (1935), Wold and Jureen (1953), Prais and Houthakker (1955) and Friend and Jones (1960) (see survey by Brown and Deaton(1972), Deaton (1986)). Typically, these studies are concerned primarily with the estimation of income responses, i.e., the engel curves, through eliminating the effects of demographic and other socioeconomic factors that are known to have considerable effects on household consumption decisions. This is possible because large variation of prices across sample households is normally absent as the data relate to a specified time period.

Analysis based on time-series or continuous cross-sectional data are required for measuring consumer responses to price changes and also to examine the dynamic aspects of consumer behaviour. Broadly speaking, there are two alternative approaches to the time-series data based demand analysis. The first one may be called the single-equation approach which tries to analyse the pattern of demand for a specific commodity by relating the consumption of that commodity to the factors likely to affect its demand. The other approach which is known as the complete demand systems approach, on the other hand, recognises the essentially interrelated nature of consumer demand for various commodities and estimates the demand functions for individual commodities as a single system of demand functions. The early statistical works on demand analysis based on time-series data mostly followed the single-equation approach (e.g., Schultz(1938), Stone(1954a)). Interest in complete demand systems was stimulated by Stone (1954b) and later by Barten (1967), Theil (1965), Christensen, Jorgenson and Lau (1975), Pollak and Wales (1978), Deaton and Muellbauer (1980b), Coondoo and Majumder (1987), Lewbel (1987a), Ray (1989) and Banks, Blundell and Lewbel (1996,1997), to name a few.

Considerable use of utility and demand theory has been made in the specification and measurement of *equivalence scale*. The *cost of a child* or the *general equivalence scale*, as it is more commonly known, is a concept that is of considerable importance in issues relating to public policy and welfare. Calculation of the scales from observed expenditure pattern of households was pioneered by Engel (1895) and was later extended by Sydenstricker and King (1921), Nicholson (1949) and Prais and Houthakker (1955) in a single equation framework (see Browning (1992) and Nelson (1993) for a review of this literature). Barten (1964) pioneered the estimation of *equivalence scale* in a complete system framework and the literature has, since then, grown to a large extent (see Cramer (1969), Muellbauer (1977), Pollak and Wales (1981), Ray (1983b,1993)). In the following sections we briefly discuss each of these issues.

The layout of this chapter is as follows: section 1.2 discusses the cross-sectional demand analysis; section 1.3 discusses the systems approach to demand analysis; section 1.4 presents a discussion on the incorporation of demographic variables in demand systems; and finally, section 1.5 gives an account of the literature on *equivalence scale* or *cost of children*.

1.2 Cross-sectional Demand analysis: Engel Curves

The mainstay of cross-sectional engel curve analysis is the postulate that, on an average, difference in consumption patterns of households can be ascribed to the difference in their current income positions. There are some advantages of such analysis; firstly, household expenditure data provide the quasi-experimental conditions under which the income-expenditure relationships may be studied in isolation from the phenomenon of price change, and finally, due to large sample size there are ample opportunities for studying the effect of the household attributes on household expenditure pattern.

It is well-known that in a static framework the demand for each commodity by a single consumer can be expressed as a function of the consumer's income and market prices, given the consumer's preference (u) which is governed by his needs and taste ,i.e.,

$$q_i = f_i(y, p_1, p_2, ..., p_n; u) \;\; for\ i = 1, 2, .., n, \tag{1.1}$$

where q_i is the quantity demanded for commodity i , y is total income/expenditure of the consumer, $(p_1, p_2, ..., p_n)$ represents the price vector for the n commodities, u is the utility level. Equation (1.1) is known as Marshallian demand function. Now the type of preferences a consumer will have is largely conditioned by his physical and psychological needs and taste, and these, in turn, are mostly determined by the consumer's characteristics. Thus, if $d_1, d_2, ..., d_K$ are such demographic and socioeconomic factors which can affect consumer's preference, the demand function can be written as

$$q_i = f_i(y, p_1, p_2, ..., p_n, d_1, d_2, .., d_K). \tag{1.2}$$

The family budget analysis starts with the assumption of constant prices which is quite plausible in a cross-sectional study for a given time period. If further the d's are restricted, then equation (1.2) becomes

$$q_i = f_i(y | p_1, p_2, ..., p_n, d_1, d_2, ..., d_K). \tag{1.3}$$

This relation is generally known as the engel equation. In a cross-sectional study we ignore the effect of household's past income and for the sake of simplicity we also ignore the problem of saving altogether and treat income variable as identical with total expenditure on consumer goods and services which is particularly relevant in case of developing/ underdeveloped countries.

1.2.1 Parametric Analysis of Engel Curves

To begin with, an engel curve analysis starts with a group of households in which there is as little variation as possible in factors which might affect preferences, such as, the age and sex composition of the household, educational and cultural background and occupational status etc.

There are a number of equation forms which are generally used in engel curve analysis to describe consumer expenditure pattern for individual item/ item-group. Traditionally, engel curves have been formulated based on a number of economic theoretic criteria. These include (a) the curve should have a threshold level of total expenditure below which the consumption of an item is zero (this is particularly applicable for luxury items), (b) for a necessary item physical consumption should approach a saturation level as the level of total expenditure rises, (c) the functional form should be flexible enough to allow for realistic variation of Engel elasticity along the engel curve, and (d) the parameters of the engel curve should have simple economic interpretations.

Prais and Houthakker (1955), in their pioneering work on engel curve analysis, considered five simple two-parameter forms of engel curves, viz.,

$$
\begin{aligned}
Log - linear/constatnt - elasticity\ form:\ \ln(p_i q_i) &= \alpha_i + \beta_i \ln y \\
log - inverse\ form:\ \ln(p_i q_i) &= \alpha_i - \frac{\beta_i}{y} \\
semi - log\ form:\ p_i q_i &= \alpha_i + \beta_i \ln y \qquad (1.4) \\
linear\ form:\ p_i q_i &= \alpha_i + \beta_i y \\
hyperbola\ form:\ p_i q_i &= \alpha_i - \frac{\beta_i}{y}
\end{aligned}
$$

where q_i is the quantity of the i-th commodity consumed and p_i is the price of i-th commodity. These forms, however, do not have any theoretical basis. One restriction on the functional form of engel curves that the theory provides is that of adding-up, which requires that if the same functional form of engel curve is fitted to a set of item expenditures (which add up to the total expenditure) the functional form should be such that for every level of total expenditure, the sum of item expenditures should add up to the total expenditure. Except the linear form, none of the other forms above satisfy the adding-up property. The major statistical criteria governing the choice of functional form of engel curve are (a) goodness of fit, (b) ease of estimation, and (c) homoscedasticity of the residuals, i.e., the variables should be so transformed as to yield homoscedastic regression residuals. Criterion (c) was considered to be of utmost importance by Leser (1963) and he recommended the following forms of engel curves in terms of budget share($w_i = \frac{p_i q_i}{y}$) :

$$\begin{aligned} w_i &= \alpha_i + \beta_i y \\ w_i &= \alpha_i + \frac{\beta_i}{y} \\ \ln w_i &= \alpha_i + \beta_i \ln y - \ln \sum e^{\alpha_j + \beta_j \ln y} \\ w_i &= \alpha_i + \beta_i \ln y. \end{aligned} \tag{1.5}$$

The form $w_i = \alpha_i + \beta_i \ln y$ was originally suggested by Working (1943) and is popularly known as the Working-Leser form[1]. This form meets the adding-up requirement and gives reasonably good statistical fit for different types of items. A quadratic extension of the Working-leser form considered by Deaton and Muellbauer (1986) and Lancaster and Ray (1996) has now become popular in view of its satisfactory performance on several data.

1.2.2 Nonparametric Analysis of The Form of Engel Curves

The parametric approach to the estimation of household demand functions or engel functions has a major drawback, namely that, the functional form of the equation is specified without a priori knowledge of the true functional form. Misspecification of the functional form of household expenditure function may have serious consequences for the econometric results. The usual cure is to try several alternatives, but this hardly rules out the possibility of misspecification. We can specify the functional form of a model as flexible as we wish by introducing new parameters, but there is a limit to it both theoretically and econometrically(see Gorman (1981), Russel (1983)). This problem of misspecification is avoided if the nonparametric regression technique is used to estimate engel curves. The nonparametric regression technique allows consistent estimation of a regression model without specifying in advance its functional form.

The main strength of nonparametric over parametric regression technique is the fact that the former allows the data to choose the shape of the curve itself. The price of this flexibility is a much greater data requirement of the nonparametric method, the difficulties of handling high-dimensional problems, simultaneity, measurement error, and so forth, and also failure to calculate conditional expectations (which is actually the regression function) for zero values of the dependent variable and also

[1]Although this formulation is based on a purely statistical criterion, it is directly rooted in utility theory. The underlying cost function is the Price Independent Generalised Log-linear (PIGLOG) class of Muellbauer (1975)[to be discussed in section 1.3].

failure to predict for out-of-sample behaviour, and to a lesser extent, computational costs.

There are several nonparametric regression techniques which include the k-nearest neighbour(k-nn) [Loftsgaader and Quesenberry (1965)], spline smoothing and Kernel regression [Härdle(1990)]. However, the most commonly used technique, especially in estimating econometric functionals, is the Kernel regression technique[2].

Though nonparametric regression technique is becoming more and more popular in economics, it has found fewer applications than it merits. The initiation of this approach, however, goes back to Samuelson's(1938) introduction of revealed preference analysis. Later this technique to estimate unknown functional form has been advocated by Diewert(1971), Diewert and Parkar(1978). A limited number of econometric applications of this technique are there- viz., estimating average benefit ratio at each level of living for rice farmers by estimating the relationship between food price change and welfare [Deaton (1997)] and estimating the relationship between calorie consumed and per-capita outlay [Subramanian and Deaton (1994)]. The use of nonparametric technique to explore the form of engel curves has been popularised by Bierens and Pott-Buter(1990). This technique to estimate demand functions has been later used by Nicol(1993) to estimate income elasticity, by McMillan, Ullah and Vinod(1989) to estimate the shape of demand curves and to establish Marshall's law of the elasticity of demand, by Burgess and Ping Ping (1995) to examine the pattern and determinants of consumption behaviour of Chinese rural households and by Banks, Blundell and Lewbel(1997) in order to determine the rank of the demand system.

1.3 Systems Approach to Demand Analysis

It has been mentioned earlier that the systems approach to consumer demand analysis is primarily concerned with the interdependency of demand for various goods. This approach can supply the empirical basis for forecasting and planning of the demand bundle, for the construction of certain price index, for designing an optimal tax structure and for expenditure inequality measurement. The approach is essentially an empirical one, in the sense that one aims at the formulation of a system to be estimated using actual data. In view of data limitations, one makes use of restrictions, which are of a theoretical nature.

The pioneering work of demand system estimation is by Stone (1954b), where

[2]See Nadaraya(1964), Watson(1964), Bierens(1983,1987).

he proposed the simplest version of the Linear Expenditure System - a system of commodity-specific linear demand equations incorporating several theoretical postulates of consumer behaviour as consistency requirements. Subsequently research on consumer behaviour based on complete demand systems has proceeded in three directions[3], viz.,

- (i) testing the empirical validity of the different theoretical restrictions on consumer behaviour in a pragmatic framework of linear or linearised system of demand equations [e.g., Theil (1965), Barten (1967) and Byron (1968,1970a,1970b)];
- (ii) development of complete demand systems based on specific forms of well-behaved preference structure [e.g., Houthakker (1960)]; and finally,
- (iii) development of demand systems corresponding to fairly general forms of preference structure that may be supposed to represent preferences through suitable parametric restrictions [e.g., Christensen, Jorgenson and Lau (1975), Howe, Pollak and Wales (1979), Ray (1983a) and Lewbel (1987a)].

Application of demand systems has found its way mostly in developed countries. Analysis based on Indian data is available in Murty (1980), Radhakrishna and Murty (1980), Coondoo and Majumder (1987) ,Ray (1980,1982) and Majumder (1992) (see Ray(1991) for a survey on application of complete demand systems in India).

The theoretical restrictions which are posed by the static theory of consumer behaviour are the following:

1. The adding-up property which implies that the reallocations of the budget due to income or a price change must exhaust total income;
2. The demand functions are homogeneous of degree zero in prices and income;
3. Symmetry of the substitution effects; and finally,
4. Negative semidefiniteness of the substitution matrix, i.e., quasi-concavity of the utility function underlying the Marshallian demand function.

We now discuss some issues relating to application of demand systems.

[3]Here we concentrate on the static theory of consumer behaviour. Analysis of the dynamic aspects of consumer behaviour has also made rapid strides since 1960's in both their methodological and substantive aspects (for surveys on consumer behaviour see Brown and Deaton (1972), Barten (1979), Deaton and Muellbauer (1980a), Deaton (1986), Blundell (1988)).

1.3.1 Aggregation

Commodity aggregation is one of the most important issues involved in the empirical implementation of the theory. The basis of the notion of commodity aggregation is purely empirical. In the analysis of demand using actual data a problem of manageability arises due to the presence of a large number of commodities which are actually consumed by consumers. The demand functions corresponding to these large number of commodities are often aggregated into functions corresponding to commodity-groups which can be justified under the theoretical assumption of separable preferences. This concept was introduced by Leontief (1947) and Sono (1960). According to them commodities may be partitioned into any number of groups, and preferences for commodities within each group can be described independently of commodities in other groups. The implications of separability in the context of consumer budgeting and preference structure have been studied by Strotz (1957, 1959), Gorman (1959, 1968), Pollak (1969), Lau (1969), Blackorby, Primont and Russel (1978)[4].

The other type of aggregation in empirical demand analysis is concerned with aggregation over consumers. The theory of consumer behaviour formalises the behaviour of an optimizing rational consumer. The applicability of this theory to empirical analysis of observed aggregate consumption data, however, is not automatically guaranteed. Indeed, it is only under appropriate theoretical restrictions that a set of micro-demand functions would aggregate over consumers without giving rise to any aggregation bias. Although the problem of aggregation is theoretical in nature, the conditions under which such aggregation is possible have important bearings on empirical analysis. In fact, such conditions impose specific restrictions on the form of the demand functions and the underlying preference structure.

The results on aggregation of demand functions can be classified into two groups-one relating to exact aggregation and the other relating to consistent aggregation. Under exact aggregation, the form of micro-demand functions should be such that these, when aggregated over consumers, would give an aggregate demand function relating aggregate demand to aggregate income/total expenditure. Gorman (1953, 1961) gave conditions for exact linear aggregation for which cost functions must be of the form

$$C(u,p) = a(p) + b(p)u \tag{1.6}$$

where $C(u,p)$ is the cost function with utility level u and price vector p, $a(p)$ and $b(p)$ are linear homogeneous price index functions.

[4]See also Deaton and Muellbauer (1980a).

Form (1.6) is commonly known as the Gorman-Polar form. However, the requirements for exact aggregation are rather stringent. Muellbauer (1975, 1976) introduced the notion of consistent aggregation to generate a much wider class of demand functions under which the aggregate budget share of each good can be expressed as a function of prices and a single indicator of y, not necessarily the mean, called the representative income level. The representative income level depends on the income distribution as also on given prices. The special case in which the representative income level is independent of prices has been called 'Price Independent Generalized Linearity(PIGL)' form. PIGL has been shown to be equivalent to the cost function being of the form

$$C^{-\mu}(u,p) = A(p)^{-\mu} + \{B(p)\}^{-\mu}u \quad \mu \neq 0 \tag{1.7}$$

$$C(u,p) = \{b(p)\}^{u}a(p), \qquad \mu = 0 \tag{1.8}$$

where $A(p), B(p)$ and $a(p)$ are linear homogeneous functions and $b(p)$ is a homogeneous function of degree zero in prices. The form corresponding to $\mu = 0$ has been called the 'Price Independent Generalised Log-Linear' (PIGLOG) form. It may be noted that the Gorman Polar form is a special case of Muellbauer's more general form and is obtained as a special case when $\mu = -1$.

Muellbauer's approach to consistent aggregation described above is based on the representative consumer approach where the representative consumer is defined to be one whose budget shares for different commodities are the average budget shares assuming that such a consumer exists. In this approach, individual consumers are assumed to possess identical preferences. Lau(1977) and also Jorgenson, Lau and Stoker (1982) developed a theory of exact aggregation that can incorporate differences in individual preferences arising out of differences in individual attributes. An aggregate demand function, according to Lau's definition, is expressible as a function of prices and k independent index functions dependent on individuals' income and attributes. The results in Gorman (1953) and Muellbauer (1975) may be obtained as special cases of Lau's aggregation results.

1.3.2 Rank of a Demand System

Gorman (1981) considered a general flexible functional form of engel curves given by

$$w_i = \sum_{\omega \in \Omega} \phi_{i\omega} f_{\omega}(\ln y) \tag{1.9}$$

where Ω is some finite set and $f()$'s are a series of functions. If Gorman's generalisation is to be consistent with theory then there must exist a cost function $C(u,p)$ such that

$$\frac{\partial \ln C(u,p)}{\partial \ln p_i} = \sum_{\omega \in \Omega} \phi_{i\omega}(p) f_\omega\{\ln C(u,p)\}. \tag{1.10}$$

Gorman shows that for these partial differential equations to have a solution (i)the rank of the matrix formed from the coefficients $\phi_{i\omega}(p)$ can be no larger than three and (ii) the function $f_\omega()$ must take specific restricted forms. Russel (1983) gave three specific forms of f_ω when $\text{rank}[\phi_{i\omega}(p)] = 3$.

Full rank demand systems are parametrically parsimonious; they maximize the degree of income flexibility of demands with the smallest number of parameters. The rank of any demand system is the maximum dimension of the function space spanned by the engel curves of the demand system. Lewbel (1987b) extended Gorman's result by characterizing every possible demand system of the form $q_i = \alpha_i + \beta_i y + e_i f$. This class encompasses virtually all utility derived demand systems. Muellbauer's(1975) PIGL and PIGLOG demand systems, Howe, Pollak and Wales' (1979) Quadratic Expenditure System (QES), the log-quadratic form applied by Deaton (1981), the TRANSLOG model of Jorgenson, Lau and Stoker (1982) and the polynomial Integrable Almost Generalised Linear (IAGL) model of Lewbel (1986) fall under Gorman's generic form. Lewbel's (1987b) characterization also encompasses two new utility theory consistent demand systems where f equals to $\ln y$ and $y \ln y$ with $\phi_i \neq 0$[5].

A rank one demand system is homothetic, i.e., budget shares are independent of the level of income. Rank two demand models include AIDS, TRANSLOG, LES, PIGL, PIGLOG and Fractional demand system. Banks, Blundell and Lewbel (1997) characterised the indirect utility function of a rank three system[6]. They also estimated a rank three demand model called the Integrable Quadratic Almost Ideal Demand System (IQAIDS) (1996,1997). Based on the Almost Ideal Quadratic Logarithmic (AIQL) model proposed by Fry and Pashardes(1992), Pashardes(1995) also estimated a rank-three demand system incorporating demographic variables to estimate *equivalence scales*. Lancaster and Ray (1996) estimated a rank-three Price Scaled demographically extended demand system to estimate *equivalence scales*.

[5]Leser (1963) also found this type of specification of engel curves to be superior to all other specifications.

[6]Described in detail in chapter 7.

1.4 Demographic Variables in Complete Demand Systems

An important feature of recent demand studies is the introduction of demographic and economic variables in the specification and estimation of demand equations. These variables are incorporated either through a direct approach which specifies the utility function u as a function of commodity vector q and a vector $a^h = a(d^h) = a(d^h{}_1, ..., d^h{}_K)$ of h-th household characteristics, or through an indirect approach which specifies either the cost function $C(u, p, a^h)$ or the Marshallian demand functions $q_i(y, p, a^h)$. The direct approach and the indirect one via the cost functions are equivalent as by invoking the Shephard-Uzawa duality theorem one can recover $u(q/a^h)$ from $C(u, p, a^h)$, provided the cost function possesses the theoretical properties. Similarly, the indirect approach via the Marshallian demand function is equivalent to the direct approach, provided the demand functions posses the theoretical properties.

The treatment of demographic effects in the framework of theoretically plausible demand systems dates from Barten (1964). In his framework, for each commodity, he defined effective household size that depends on the household composition vector, i.e., $a_i = a_i(d_1, d_2, ..., d_K)$, $i = 1, 2, .., n$, where d_k: number of members of the k-th type (age-sex category) in the household (subscript h is omitted here), and i is the commodity subscript. The effective per-capita consumption is then obtained by scaling the household consumption q_i by the corresponding effective household size a_i, viz., $q_i^* = \frac{q_i}{a_i}$, where q_i^* represents effective per-capita consumption of commodity i. The household's direct utility function is defined in terms of q_i^*'s as $u = u(q_1^*, q_2^*, ..., q_n^*)$. In view of these adjusted quantities, the budget constraint is modified as $y = \sum_i p_i^* q_i^*$, where $p_i^* = p_i a_i$. Thus, in this set-up, the effect of variation in household composition is supposed to work exclusively through the prices, as a change in household composition results in an alteration in the relative price structure and thus affects the consumption basket. The resulting demand function corresponding to this demographic scaling are of the form

$$q_i^* = f_i(p_1^*, p_2^*, ..., p_n^*, y). \tag{1.11}$$

Gorman (1976) noted the limitation of the Barten model, where the household composition works through price effects exclusively. He proposed the following generalisation of the Barten model of demographic scaling. Consider the cost function underlying Barten's approach, viz., $C = C(u^*, p_1^*, p_2^*, ..., p_n^*)$ where C is the minimum cost of attaining a stipulated utility level u^*. Gorman suggested that a fixed cost component, exclusively dependent on prices and household composition should be added to the cost function. Thus, if $\sum_i p_i a_i$ is the fixed cost component then the cost function would be

$$C = \sum_i p_i a_i + C(u^*, p_1^*, p_2^*, .., p_n^*). \tag{1.12}$$

Given a specification of the variable cost component $C(u^*, p_1^*, p_2^*, ..., p_n^*)$ of Gorman's cost function, one would obtain the corresponding system of demand equations.

The concept of fixed cost referred to above has been later called 'demographic translation'. Pollak and Wales (1980) demonstrated the feasibility of generating theoretically consistent systems of demand equations that incorporate household composition through 'demographic translation'. In fact, they have shown that corresponding to any theoretically consistent demand system $q_i = f_i(p_1, p_2, ..., p_n, y)$ there exists a corresponding theoretically consistent system of the form

$$q_i = a_i + f_i^*(p_1, p_2, .., p_n, y - \sum p_j a_j)^7. \tag{1.13}$$

There have been a number of generalisation of the models described above (see Ray (1993) for an account of the models). An alternative demographic procedure is the 'Price Scaling (PS)' model of Ray (1983b), which rests on the definition of the *general equivalence scale*. In PS, the original cost function is written as

$$C(u, p, a(d)) = a_0(p, d) C^R(u, p_1, ..., p_n), \tag{1.14}$$

where the general equivalence scale a_0 is dependent on prices and household composition, C^R being the cost function of reference household.[8].

Lewbel (1985) suggested a general method under which introduction of demographic effects into an otherwise legitimate cost function without demographic variables will yield a modified cost function which is also theory consistent.

1.5 Equivalence Scale/Cost of Children

Within a household individual members differ in their age-sex characteristics and they have different needs. In a family children consume some special goods and require less of the other goods generally consumed by adults. It is also possible that there are economies of scale in consumption perhaps because family members benefit from each other, or because there are goods that can be jointly used by all

[7]See also Pollak and Wales (1981), Muellbauer (1977).

[8]For generalisations of PS model see Ray (1993).

family members at no additional cost. In this situation considering only household expenditure per capita to measure welfare may not be appropriate. The obvious solution is to use a system of weights, whereby a child is counted as some fraction of an adult, the fraction being dependent on the age and sex of the child, so that total household size is measured in number of adult equivalents. The *equivalence scale* helps to compare welfare across households which differ in size and composition. Use of such a scale is essential in major policy exercises, e.g., in the measurement of inequality and poverty, in studying the effect of tax-changes on the welfare levels of different households, and in calculating the compensation for the additional *cost of a child.* Thus *equivalence scales* serve as deflators using which the budget of different household types can be corrected for needs.

The calculation of household *equivalence scales*, i.e., measuring household size by a weighted sum which recognises different needs of adults and children has a long history originating with the study of Engel (1895). Engel's *equivalence scale* measure assumes that the welfare of two households is equal if they spend the same proportion of their income on *food* and the welfare of adults is inversely related to the share of the household budget spent on *food.* The Engel *equivalence scale* of a comparison household is the ratio of the expenditure of this comparison household to that of a reference household (e.g., a household with two adults) having identical budget share for *food.*

To be specific, by Engel's model

$$\frac{q^h{}_i}{a^h} = f_i(\frac{y^h}{a^h}, p), \tag{1.15}$$

where i stands for *food*, which in budget share form becomes

$$\frac{p_i q^h{}_i}{y^h} = \frac{p_i f_i(\frac{y^h}{a^h}, p)}{\frac{y^h}{a^h}}. \tag{1.16}$$

This is a function of $\frac{y^h}{a^h}$ and not of y^h and a^h separately. If R is the reference household for which $a^R = 1$, and if h and R have the same budget share, then

$$\frac{y^h}{a^h} = \frac{y^R}{a^R} = y^R,$$

so that

$$a^h = \frac{y^h}{y^R}.$$

This, however, assumes that the needs of children relative to adults and the economies of scale in consumption are the same for every commodity. This was recognised by Sydenstricker and King (1921) whose approach was later taken up by Prais and Houthakker (1955). The engel curve corresponding to (1.15) is generalised to

$$\frac{q^h{}_i}{a^h{}_i} = f_i(\frac{y^h}{a^h}). \qquad (1.17)$$

Forsyth (1960) and Cramer (1969) showed that it is impossible to estimate the complete set of specific *equivalence scales* on the basis of a single cross-section budget survey. The basic reason for lack of identification is that, because of the budget identity, with n goods there are n functions to be estimated but only $n-1$ engel curves from which to do so. This model has also been criticized by Muellbauer (1980) who gave a formal demonstration of identification problem due to zero substitution between commodities. In the subsequent periods, it is the overall scale that has received wide attention and consequently, the literature has developed along this line.

Rothbarth (1943) model, on the other hand, assumes that adult welfare is directly related to the level of household expenditure on *adult goods*. The *equivalence scale* of a household is the ratio of the household's expenditure to that of the reference household having identical level of expenditure on *adult goods*. It has, however, been argued in Deaton and Muellbauer (1986) that the Engel procedure gives an overestimate and Rothbarth's procedure an underestimate of the true scale [see also Nelson (1992)].

The Engel and Rothbarth models, the two single equation approaches, do not consider the role of prices. Barten's (1964) approach in a complete system framework is the pioneering attempt to take into account the interaction between prices and household composition variables. The cost function underlying the Barten model is given by

$$C(u, p, a) = C(u, p_1 a_1(d), .., p_n a_n(d)) \qquad (1.18)$$

where $a_i(.)$'s are interpreted by Muellbauer (1977) as commodity specific *equivalence scales.*

In this form a change in demographic composition has a direct effect through the change in needs and an indirect effect through the induced change in the effective price. It is this recognition of the quasi-price substitution effects of demographic change that is the crucial contribution of Barten's model. However, in Barten's model normalising $a_i = 1$ for the childless couple household, implies that the basic utility function is defined over adult consumption only, and demand for exclusively children item cannot be analysed in this framework.

Later Gorman (1976) modified and generalised Barten's model by introducing a term measuring the fixed cost of children into the cost function (discussed in the previous section) to overcome the restrictive implications of Barten's model. The cost function is thus given by

$$C(u,p,d) = \sum p_i a_i(d) + C(u, p_1 a_1(d), .., p_n a_n(d))$$

which provides a formulation for testing the Barten model. Now if the scaling terms are dropped, and if it is recognised that the child cost term is likely to be zero for certain *adult goods*, then for an *adult good* we have the Hicksian demand function independent of d. For all such goods, an additional child exerts only income-effects, a proposition that can be tested by comparing the ratios of demand derivatives with respect to income across goods, while families with the same outlay on *adult goods* can be identified as having the same welfare level. This provides a justification for the Rothbarth model in a utilitarian framework.

An alternative approach, which is based on the definition of general *equivalence scale*, is the Price Scaling technique of Ray (1983b), which we have discussed earlier.

The *equivalence scale* exercise is often converted into an exploration of the *cost of children*. An *equivalence scale* seeks to quantify and represent in one summary measure the changing needs of a family as it expands and changes its compositions. This enables one to measure the additional amount of expenditure required by a family with one child in order to be as well off as it would be with no children.

There are several theoretical and statistical problems in calculating equivalence scales [see Nicholson (1976)]. This has generated controversy over the interpretation and use of *equivalence scales*, as conventionally calculated, in welfare comparisons across households. There is no consensus on what such welfare comparisons mean or on what information is required to make them. Pollak and Wales (1979) distinguished between *conditional* and *unconditional* scales. *Unconditional* scales are based on a household's decision on having children, treated endogenously, similar to its expenditure decision. *Conditional* scales, on the other hand, assumes exogeneity of children. Thus, traditional budget data allows us to calculate *conditional* scales only. There are, however, some problems. In general, *adult equivalence scale* depends on the utility level at which two households with different compositions are being compared. Thus, *equivalence scale* measure requires an identifying assumption in order to be estimable using only demand data. On the theoretical side, the identifiability of household *equivalence scale* has been analysed by Muellbauer (1974), Pollak and Wales (1979), Deaton and Muellbauer (1986), Fisher (1987), Lewbel (1989c), Blundell and Lewbel (1991), Dickens, Fry and Pashardes (1993), Blackorby and Donaldson (1993) and Nicol (1994). This literature highlights some models that include identifying restrictions for household *equivalence scales*. The empirical literature, on the other hand, has presented a variety of estimated household *equivalence scales* [see, e.g., Deaton and Muellbauer (1986), Jorgenson and Slensnick (1987), Buhmann, Rainwater, Schmaus and Smeeding (1988), Deaton, Ruiz-castillo and Thomas (1989), Blundell and Lewbel (1991), Pashardes (1991), Dickens, Fry and Pashardes (1993), Murthi (1994) and Ray and Lancaster (1996)].

Blundell and Lewbel (1991) argue that demand equations alone provide no information about *equivalence scales* in any one price regime, but that if *equivalence scales* in any one price regime were known, demand data then could identify the unique true *equivalence scales* in all other price regimes.

A necessary and sufficient condition for adult *equivalence scale* to be independent of the utility level of the household members has been given by Blackorby and Donaldson (1993) and they call it *Equivalence Scale Exactness* (ESE). A similar characterisation was independently given by Lewbel (1989c), who called it *Independence of Base* (IB). Blackorby and Donaldson (1994) gave similar exactness conditions in the context of *cost of children*. These will be discussed in detail in chapter 7.

Chapter 2

The Indian National Sample Survey Data: A Discussion in the Context of the Present Study

2.1 Introduction

The present study is based on the disaggregated household level budget data collected by the Indian National Sample Survey Organisation(NSSO)[1], in their 38th round survey operations relating to the period from January to December, 1983. More specifically, the study is based on a retabulation of the NSS 38th round data from the 'Central Sample'(canvassed by the Central Government staff- which excludes the 'State sample' canvassed by the staff of different State/Union Territory Governments) for the rural sector of the state of Maharashtra. The delimitation of the geographical coverage of the study is determined by our access to NSS data and computational tractability[2]. Also, Maharashtra is the only state for which the person-specific information on demographic characteristics (such as age, sex, etc.)

[1]NSSO was set up in 1950 as a part of the Indian Statistical Institute for the collection of various kinds of socioeconomic data for the country as a whole through field surveys for national accounting, planning and other policy purposes. In 1972 it was taken over by the Government of India. It was placed under the Department of Statistics of the Ministry of Planning and was renamed as the National Sample Survey Organisation (NSSO).

[2]The 38th round disaggregated data are the latest that are available to us in the form of updated tapes at the Computer and Statistical Service Center (CSSC) of Indian Statistical Institute, Calcutta.

is available to us from the Employment Schedule (Schedule 10).

The National Sample Survey (NSS) is a multipurpose socioeconomic enquiry of all-India coverage carried out on a continuing basis in the form of successive rounds. The duration of a round has varied in the past from few months to a complete year. The enquiry on consumer expenditure was a regular feature of the NSS beginning with the first round conducted during October, 1950- March,1951 upto the 28th round carried out during October, 1973-June, 1974. Thereafter, for some time, this enquiry was conducted at an interval of 4 to 5 years. In 1986-87, the NSS reverted to the earlier practice of conducting the consumer expenditure enquiry every year. However, one now has quinquennial enquiries on a larger scale (i.e. with a large sample size) and annual enquiries on a smaller scale (i.e. with a small sample size).

Below, section 2.2 provides a brief discussion on the sampling design and survey coverage of the 38th round household budget data and section 2.3 gives a brief description of the definitions and concepts adopted in the NSS 38th round survey operation. Finally, section 2.4 describes some features specific to the state of Maharashtra.

2.2 Sample Design and Survey Coverage

Over the years, the survey design adopted by the NSSO has undergone many changes[3]. The survey design, even now, may change from round to round depending upon the nature of enquiry.

The sampling design adopted for the 38th round survey was a stratified two-stage one. For the rural areas census villages were taken as the first-stage units (fsu's). Households were defined as the second stage units (ssu's). In the rural areas, sample villages were selected with probability proportional to size and with replacement (PPSWR) in the form of two independent and interpenetrating subsamples (IPNS). The ssu's , i.e., households were selected circular systematically in a number of ten in each of the selected fsu's.

All the states of India were first divided into some agroclimatic regions by grouping contiguous districts, similar in respect of population density and cropping pattern. Within each region the basic strata were formed such that they did not cut across districts. Each district with less than 1.8 million rural population, according to 1981 census, formed a basic stratum itself. A district with more than 1.8 million population was divided into two or more basic strata by grouping contiguous

[3]See Murthy and Ray(1975) for a brief history of the developments of the design adopted by the NSSO.

tehsils that are broadly homogeneous in respect of the population density and crop pattern. The basic strata thus formed served as the ultimate strata for sampling in the rural areas.

The total sample of about 13,170 fsu's were first allocated to each state or union territory considering the relative size of its rural and urban population. All state-sector allocations were rounded off to multiples of eight, in order to have equal sample size in each of the four subrounds[4] for either of the two sub-samples into which the total sample was divided. The rural allocations at state level were reallocated to strata in proportion to their rural population ensuring that the region level allocations were multiples of eight.

It should be clear from the above account that the sampling design adopted by NSSO was not self-weighting. Each sample household represents a different number of households in the population. Since these numbers, or probability weights which are called multipliers, are different for different sample households, estimates of any population aggregate should be a weighted sum of the sample observations, the weights being the multipliers[5].

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

The data contained information on certain household characteristics used as classificatory variables such as location/residence of the household - state or union territory, sector, etc. to which a household belonged, household's size and composition, principal occupation etc., along with information on the household's expenditure on various items of domestic consumption[6].

[4]The field work for the 38th round survey started in January, 1983 and was completed in December, 1983. The entire survey period of one year was divided into four subround periods of three months' duration coinciding approximately with the four agricultural seasons. The subround periods were January to March, 1983(subround 1), April to June, 1983(subround 2), July to September, 1983(subround 3) and October to December, 1983(subround 4). The sample villages and blocks were distributed over the four subrounds in a manner so that valid estimates for each of the subrounds can be obtained separately.

[5]The parameters in chapter 3 have been estimated by using suitable multipliers as weights, but it turns out, as will be seen later, that the difference between the weighted and unweighted estimates is nonsignificant.

[6]A summary of the consumption expenditure data collected in the NSS 38th round survey is available in NSS report number 332, 'Pattern of Consumption Expenditure of SC and ST Households' (January-December, 1983), Government of India, Department of Statistics, New Delhi.

2.3 Some Definitions and Concepts Adopted in The NSS Enquiry

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

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

Household Size : The total number of members of a household is considered to be the size of the household.

Reference Period : The reference period for the collection of data on all items of consumer expenditure was the 'last 30 days'('last month'), ending on the day preceding the date of enquiry. In addition to this, for items like clothing, durable goods and also for expenses on medical care and education, data were collected for a reference period of 'last 365 days'('last year') from 32nd round(1977-78) onwards. This was done in view of the seasonal nature of expenditure on these items and the fact that large amounts are spent on them at relatively long intervals of time. In this dissertation, for such items, the reference period of 'last 365 days' has been considered and the expenditures are adjusted and converted to '30 days' expenditure.

Household Consumption expenditure : Household Consumption expenditure, in Indian rupees(Rs.), comprises all expenditures incurred by the household exclusively on the domestic account. This includes domestic consumption of goods and services out of (1)monetary purchases (cash or credit), (2) receipts in exchange of goods and services, (3)home-grown stock and (4)transfer receipts like gifts, loans etc. and free collections. Non-monetised consumption was imputed at producer's/local retail prices. Any expenditure on household enterprises like animal husbandry was excluded from the consumer expenditure. While consumption out of transfer receipts was included, transfer payments of all kinds were excluded. The imputed rental of owner-occupied houses or of free/subsidized quarters provided by employers was excluded from consumer expenditure data. Expenditure on purchase and construction of residential houses was excluded, but expenditure incurred towards maintenance of residential buildings was included. Monetary value of food articles consumed during the reference period was taken to represent expenditure on food. For semi-durable and durable goods, the actual expenditure incurred towards purchase of these articles acquired during the reference period was considered as the expenditure on such items. However, for clothing, the monetary value of the articles acquired and brought into first use during the reference period was considered. In case of miscellaneous goods and services, durable goods and taxes, expenditure both in cash and in kind were taken into account. In case of food, intoxicants, fuel and light and clothing both total quantity and total monetary value of expenditure were recorded. In case of medical expenditure item expenditure on medicine of different types and on different clinical tests and medical services were recorded.

Household type : At the time of enquiry for the 38th round survey operation, each sample household was assigned a one digit household code. Out of the following five different household type codes the one appropriate for the sample household was chosen on the basis of the main source of income of the household for the past 365 days prior to the date of survey :

Nonagricultural Self Employed Households(NASE)	1
Agricultural Labourer Households(AL)	2
Other labourer Households(OL)	3
Agricultural Self Employed Households(ASE)	4
Other Households(OH)	9

Household Group : A one digit code was assigned to each sample household to identify the group to which a particular household belonged. The codes are as follows:

Scheduled Tribe(ST)	1
Scheduled Caste(SC)	2
Neo-Buddhists(NB)	3
Other	9

For our purpose we form two broad groups from the above four groups. They are: SC-ST (combined) and OTHER consisting of NB and others which includes all religious groups excluding the SC and ST households from each religious community.

The above definitions relate to the household level. At the individual level for each household member NSS provides the following information:

Sex : The sex of each household member is recorded in a one-digit code number, viz., Male (1) and Female (2).

Age in Completed Years : The age of each member is recorded in terms of completed years on the date of survey and thus related to the last birthday.

2.4 Break-up of Various Regions of Maharashtra

In NSS data states are first divided into agro-climatic regions which are groups of contiguous districts, similar with respect to population density and crop pattern. NSSO divides Maharashtra into six regions. The regions are :

1. Coastal: The Coastal region consists of Greater Bombay and also the districts of Thane, Kolaba, Ratnagiri and Sindhudurg of Maharashtra[7].

2. Inland Western: The Inland Western region of Maharashtra consists of the districts of Ahmednagar, Pune, Satara, Sangli, Solapur and Kolhapur.

3. Inland Northern: The Inland Northern part is formed with only three districts, viz., Nasik, Dhule and Jalgaon.

4. Inland Central: The region of Maharashtra roughly coincides with the Marathawada region. It consists of the districts of Aurangabad, Parabhani, Beed, Nanded, Usmanabad and Jalna.

5. Inland Eastern: This region of Maharashtra is formed with the districts of Nagpur, Wardha, Yavatmal, Amaravati, Buldana and Akola.

[7]Here we use the 1983 definitions of the districts. After 1983, some of the districts of Maharashtra were divided into smaller districts because of administrative reasons.

6. Eastern: This region is formed with only two districts, viz., Chandrapur and Bhandara.

   The Inland Eastern and the Eastern regions of Maharashtra form a part of what is more popularly known as the Vidarbha region of India.

Although Maharashtra is considered to be one of the most developed states in India in terms of several conventional indicators of development, the aggregate indices hide enormous regional differences that exist within the state. While the neighbourhood of Bombay and the Western part of Maharashtra are highly developed the rest of the state is grossly underdeveloped relative to these parts [Dev, 1992]. Within the underdeveloped part the regions differ widely among themselves with respect to employment, irrigation infrastructure etc. [Bhattacharya, 1995].

Chapter 3

Identification of Adult Goods[1]

3.1 Introduction

We have mentioned earlier that measurement of *child cost* is one of the major concerns in policy making, and the dissertation focuses particularly on this aspect. Since a child does not bring additional income, parents have to give up their own consumption in order to provide the resources required by the child. This effect of arrival of a child into a household is likely to spread over a wide range of goods, but in case of *adult goods* this effect can be isolated as children do not consume *adult goods* and have needs of their own. This isolation is not possible in case of other goods, for which the reduction in adult consumption is offset by an increase in child consumption.

This chapter deals with the identification of *adult goods*, and tests for their *demographic separability* using the central sample data of rural Maharashtra (described in chapter 2). The methodology used here is based on that proposed in Deaton, Castillo and Thomas(1989), with a modification suggested herein.

This chapter is organised as follows: section 3.2 briefly describes the methodology, section 3.3 presents the data and results, and finally, section 3.4 draws the conclusions.

3.2 Methodology

The notion of '*adult goods*' is based on the assumption that the effect of an additional child on '*adult goods*' is similar to that of a reduction in income. This effect

[1]This chapter is based on Chakrabarty(1995).

can be expressed in terms of the outlay-equivalent ratio, π_{ik} which is given by

$$\pi_{ik} = \frac{\partial p_i q_i / \partial d_k}{\partial p_i q_i / \partial y} \frac{N}{y} \tag{3.1}$$

where y is the income/total expenditure, i refers to a commodity group, d_k is number of persons in kth demographic (i.e., age-sex) category and N is total household size. Each π_{ik} gives the effect of an additional person of type k on the demand for good i, measured as the amount of additional outlay that would have been necessary to produce the same effect on demand, that additional outlay expressed as a fraction of total household expenditure per household member. If i is an *adult good* and k a child category, π_{ik} should be negative, i.e., an additional child acts like a decrease in the budget.

An *adult good* group, G is said to be *demographically separable* from O, a demographic (i.e., age-sex) group, if changes in the demographic structure within O exert only income-like effects on the goods in G. Formally, demographic separability can be expressed as

$$\frac{\partial q_g}{\partial d_o} = \theta_o \frac{\partial q_g}{\partial y} \tag{3.2}$$

for all $g \in G$ and $o \in O$. θ_o, which is the factor of proportionality, is independent of commodity index g. So, if the effect of a child on the level of consumption of a good is divided by the income effect of the good, the ratio should be the same across all the *adult goods*, which is a testable restriction, given the demand functions. π_{ik} values should then be same for all i in the *adult good* group. It may be noted that there must be at least two goods in the *adult goods* group for testing equality of θ_o [See Deaton, Castillo and Thomas (1989)].

To identify *adult goods* and to test *demographic separability* in terms of π_{ik}, following Deaton, Castillo and Thomas (1989), we take the commonly used Working-Leser(WL) form of engel curves, containing a set of demographic variables. This form provides a simple framework for testing the hypothesis. The equation is as follows:

$$w_i = \alpha_i + \beta_i \ln \frac{y}{N} + \eta_i \ln N + \sum_{k=1}^{K-1} \nu_{ik}\left(\frac{d_k}{N}\right) + \delta_i z + \epsilon_i \tag{3.3}$$

where w_i is the budget share of commodity group i, k is a demographic category, and z is a vector of socioeconomic determinants of consumer behaviour. The household size is accommodated to allow household scales to have a separate effect on the pattern of demand[2]. ν_{ik} coefficients give an idea of how allocations within the

[2]Though $\ln(y/N)$ and $\ln N$ are likely to be correlated in the microeconomic data, the correlation in our case is -.26, which is unlikely to lead to any serious problem of collinearity.

household budget will change with differing household composition. With both household expenditure and household size controlled for they allow us to isolate, for a given expenditure category, the pure demographic effect (on a given budget share) of adding a new household member of type k relative to that of adding a member of the reference group (i.e., the Kth omitted demographic category). Given the above form of engel curves, π_{ik} can be calculated as

$$\pi_{ik} = \frac{\eta_i - \beta_i + \nu_{ik} - \sum_{k=1}^{K} \nu_{ik} \frac{d_k}{N}}{\beta_i + w_i} \tag{3.4}$$

where $k = 1, 2, ..., K$ and ν_{iK} is defined to be zero.

Demographic separability is tested using the following hypothesis

$$H_0 : \Delta_{ik} = \pi_{ik} - \sum_{v=1}^{V} \frac{\pi_{vk}}{V}, \tag{3.5}$$

where V is the number of goods in the demographically separable group of goods. Δ_{ik} actually measures deviation around the mean. In matrix notation, the above equation can be written as

$$\Delta_k = M\Pi_k = 0, \tag{3.6}$$

where Δ_k is the V-vector of discrepancies for the demographic category k, and Π_k is the vector of corresponding π ratios. M is the matrix $I - (\frac{ll'}{V})$ for identity matrix I and vector of units l. Then the variance-covariance matrix of Δ_k is

$$Var(\Delta_k) = MVar(\Pi_k)M'.$$

But note that, by construction, the matrix M and hence $Var(\Delta_k)$ becomes singular. Deaton, Castillo and Thomas (1989), however, obtained their results based on the above formulation. Here, to correct for the singularity, we modify the procedure by dropping one equation from (3.6). Thus in our case, M is the matrix $P - (\frac{sl'}{V})$ where P is a $V - 1 \times V$ matrix with 1 corresponding to each Δ_{ik} and 0 elsewhere, s is a $V - 1$ unit vector and l is a V unit vector. For the overall test for separability, if the true Δ_k's are zero, we can use Wald test statistic of the following form

$$(W)_k = \hat{\Pi}_k{}' M'(MVar(\hat{\pi}_k)M')^{-1} M\hat{\Pi}_k, \tag{3.7}$$

where

$$Var(\hat{\pi}_k)_{ij} = J_{ik}(X'X)^{-1} J'_{jk} \hat{\sigma}_{ij},$$

and $\hat{\sigma}_{ij} = (H - \mathrm{r}\ )^{-1} \epsilon'_i \epsilon_j$, ϵ_i being the vector of Ordinary Least Square(OLS) residuals from equation (3.3), J being the $1 \times \mathrm{r}$ Jacobian matrix of transformation from the

OLS parameter into the scaler π_{ik} and X the matrix of explanatory variables [see Deaton, Castillo and Thomas(1989)]. $(W)_k$ is asymptotically distributed as χ^2 with $V-1$ degrees of freedom. If the value of $(W)_k$ is less than the critical value of χ^2, then group k is *demographically separable* from the commodity groups taken together.

3.3 Data and Results

3.3.1 Data

As already mentioned the data used in this analysis are the NSS-38th round (1983) central sample data for the rural sector of Maharashtra. We use the detailed consumption expenditure and demographic and socioeconomic data. Combining the expenditure data and household characteristics data, which are available from the employment schedule, the sample size turns out to be 5020, of which 197 single-person households are excluded as their consumption pattern may not be comparable with those of the rest in the sample. Thus the final sample size is 4823.

To start with, we consider the following commodity groups: (1)*tea-coffee*, (2)*pan*, (3)*tobacco*, (4)*intoxicants*, (5)*adult cloth*, (6)*adult personal care*, (7)*food*, (8)*other beverages*, (9)*clothing*, (10)*miscellaneous*, (11)*unclassified*, (12)*durable good*, and (13)*medical*[3].

For *durable goods, clothing* and *adult cloth* items, the data with last 365 days reference period have been used and converted to monthly figures. For these items the data collected on 30 day reference period was not used because that might lead to many zero observations.

Out of the above 13 goods, six goods can possibly be regarded as *adult goods* based on intuitive reasoning. These are (a)*tea-coffee*, (b)*pan*, (c)*tobacco*, (d)*intoxicants*, (e) *adult cloth*, and (f)*adult personal care*. The NSS data are not particularly well-endowed with potential *adult goods*. Commodities like *adult cloth, adult personal care* are not measured separately. We have, however, formed these groups by aggregating the individual items that might possibly belong to these groups.

The demographic effect on the budget is captured by the ratios d_k/N. The four demographic categories considered here are the age-groups 0-5 years, 6-10 years, 11-14 years and the adult age-group 15 years and above. Differentiation of age is important, because otherwise scales obtained solely from the size of the house-

[3]See appendix A for the list of items included in each group.

hold would be biased upwards [Nicholson (1976)]. In the z vector we have included dummies for relevant household characteristics. Four of them are for the occupational group of household head, viz., (a)self-employed in non-agricultural activity (NASE), (397) (b)agricultural labourer (AL) (1875), (c)Other labourer (OL) (330), and(d)self-employed in agriculture (ASE) (1868)[4]. Dummies for social groups are constructed by suitably combining caste and religion. Since in India the scheduled caste and scheduled tribe households are, in general, economically backward, their pattern of consumption and attitudes towards children are likely to be different. So we form the first group as (a) scheduled tribe and scheduled caste combined(SC-ST) (1157). The second group OTHER (3631) is formed according to religion, excluding SC and ST from each religious community and it includes (i)other Hindu, (ii)other Muslim and (iii)other households which includes neo-Buddhists, Jains, Christians etc. In the occupational category the omitted residual category includes OH(Other households) and in the social category it includes OTHER.

3.3.2 Results

Equation (3.3) has been estimated using OLS method[5]. Table 3.1 presents the estimates of the regression coefficients ($\nu_{ik},\ k = 1, 2, 3$) along with the mean budget shares and percentage of households reporting positive item expenditure for all 13 goods. It is clear from the table that the variables relating to number of children in the three children categories have significant negative effect on most of the possible *adult good* categories.

Table 3.2 presents the outlay-equivalent ratios along with their asymptotic t-values for all the 13 goods. The results broadly corroborate our initial identification of the *adult goods* based on intuitive judgment. The estimated outlay- equivalent ratios show, for most of these goods, the children categories have negative values and the adult category has a positive value for π_{ik}, as should be expected for *adult goods*. There are, however, some discrepancies. A possible reason for positive ratios for the 0-5 years age-group for *tea* and *tobacco* could be the increase in tension created by having a child. It is also possible that in rural India in a household where *tea* is taken at home, children are also given to drink *tea*.

[4]Figures in parentheses are the sample sizes.

[5]To account for the heteroskedasticity in such cross-section data we have estimated the equation also using Weighted Least Square (WLS) by taking the probability weights. Except for food, unclassified and pan all other F-statistics for the differences in the two estimates are nonsignificant. In view of this and for ease of estimation of the variance-covariance matrix to be used for testing demographic separability we confine our attention to the OLS estimates.

In case of *adult cloth*, π_{ik} for the age-group 11-14 years is positive. This can be justified by the fact that in rural areas boys and girls in this age group normally start to wear *adult cloth.* The negative value of π_{ik} for the adult age-group in case of *intoxicants* may be attributed to data problem, like under-reporting or a very low percentage of households consuming the item. Other goods can be called general goods as for them either all π_{ik}'s are positive or all are negative. Combining all the individual *adult goods* into a commodity group called '*all adult goods*' and all *adult goods* excluding *adult personal care* into a composite commodity group *adult good*, the outlay-equivalent ratios presented in table 3.2 indicate that these two groups can be treated as a single commodity which is called *adult good.*

Table 3.3 presents that values of Δ_{ik} together with their absolute value of asymptotic t-statistic. The last row of the table shows the corresponding Wald-test (W) statistic. The W statistic is non-significant at 5% level only for the age group 6-10 years indicating that the six-goods as a group is *demographically separable* from the children category of 6-10 years[6].

Using state-sample data of rural Maharashtra, Subramanian and Deaton(1991) tried to identify the *adult goods* starting with eight commodity groups, viz., (a)*pan and tobacco*, (b)*alcohol*, (c)*meat, eggs and fish*, (d) *male clothing*, (e)*female clothing*, (f)*leather shoes and boots*, (g)*amusements*, (h)*personal care and toiletries.* They considered males and females separately and were able to identify only *pan and tobacco* as the *adult goods* for both sexes. Male and female *clothing* separately are not *adult goods* according to them, while in our case the combined *adult cloth* turns out to be an *adult good* based on the outlay-equivalent ratio. Subramanian and Deaton(1991) did not find any *demographically separable* group of goods based on Wald test statistic, but here we have found a *demographically separable* four-commodity group consisting of *tea-coffee*, *tobacco*, *intoxicants* and *adult-personal care.*

A close look at table 3.1 reveals that for some *adult goods* the percentage of reporting is rather low, thus yielding many zero observations for these cases. This may call for estimating the equations taking into consideration the zero observations, viz., using a Tobit type model. However, we have omitted the Tobit estimation

[6]To identify a set of *adult goods* that is *demographically separable* from all children categories, we consider all possible five-goods groupings. None of these groups turn out to be *demographically separable* from the children categories. We, however, have been able to identify a *demographically separable* four-commodity group consisting of *tea-coffee*, *tobacco*, *intoxicants* and *adult personal care.* The results are presented in table 3.4, where all the W statistics for the three children age-group turn out to be non-significant. A number of possible combinations of commodities is also possible.

because of the following reasons: (i) OLS applied to all types of households (including those reporting zero purchase) gives us total influence of demographics on expenditures, i.e., the effect on whether to purchase at all as well as the effect on the amount of consumption once the prior decision has been taken [Subramanian and Deaton (1991)], (ii)in presence of heteroskedasticity, which is endemic in survey data, Tobit may not give better estimates than OLS [Deaton (1995)], (iii) in the Tobit regression model it is not possible to compute variance-covariance matrix for testing demographic separability, and finally, (iv) eventually we work with the composite commodity *adult good*, where separate identity of the individual adult commodities become irrelevant.

3.4 Conclusion

This chapter identifies six items, viz., *tea-coffee, pan, tobacco, intoxicants, adult cloth* and *adult personal care*, that can be called *adult goods.* It is also found that a combination of all these goods as well the one excluding *adult personal care* can be treated as an *adult good.* In the subsequent chapters we treat the latter combination as a single commodity and call it *adult good.*

It may be pointed out that the analysis here is based on the Working-Leser form. Since our aim was only to identify the *adult goods*, we have not examined the issue of sensitivity of the results to alternative engel curve forms.

Table 3.1: Mean budget share, percentage of reporting and regression coefficients of $\frac{d_k}{N}$ for different commodities.

Commodity	Mean budget share	Percentage of reporting	Regression coefficient of children categories(years)		
			(0-5)	(6-10)	(11-14)
(1)	(2)	(3)	(4)	(5)	(6)
Tea-coffee	.025	98	-.003 (.150)	-.006 (3.926)	-.001 (.478)
Pan	.012	62	-.006 (4.031)	-.003 (2.213)	-.004 (2.059)
Tobacco	.016	81	-.004 (1.803)	-.010 (4.857)	-.011 (4.474)
Intoxicants	.007	15	.001 (.525)	-.003 (1.215)	.001 (.404)
Adult cloth	.092	99.900	-.050 (9.720)	-.057 (10.685)	-.025 (3.809)
Adult personal care	.001	20	-.0002 (.326)	-.0004 (.627)	-.0010 (1.186)
All adult goods	.154	99.900	-.036 (5.815)	-.068 (10.912)	-.041 (5.381)
Adult good (excluding adult personal care)	.153	99.900	-.036 (5.881)	-.068 (10.950)	-.040 (5.318)
Food	.620	99.9	-.121 (10.520)	-.033 (3.222)	.022 (1.549)
Other beverages	.011	60	.017 (4.782)	.005 (1.395)	.00002 (.006)
Clothing	.017	90	.009 (2.662)	.005 (1.592)	.007 (1.667)
Miscellaneous	.120	100	.049 (5.953)	-.003 (.343)	-.018 (1.752)
Unclassified	.004	11	.009 (4.859)	.002 (.838)	.003 (1.246)
Medical	.031	98	.0007 (.152)	-.005 (1.153)	-.002 (.395)
Durable good	.028	48	.014 (1.547)	.005 (.571)	-.008 (.675)

Figures in parentheses are the absolute t-values

Table 3.2: Outlay-equivalent ratios (π_{ik}) for different commodities

commodity	age-group(years)			
	0-5	6-10	11-14	15 and above
(1)	(2)	(3)	(4)	(5)
Tea-coffee	.020 (.309)	-.254 (3.426)	-.018 (.195)	.033 (.610)
Pan	-.523 (4.092)	-.230 (1.582)	-.282 (1.562)	.148 (1.344)
Tobacco	.162 (1.083)	-.443 (2.674)	-.561 (2.737)	.504 (3.621)
Intoxicants	-.192 (.947)	-.659 (2.857)	-.197 (.685)	-.330 (2.121)
Adult cloth	.090 (.957)	-.061 (.576)	.683 (4.861)	1.258 (11.364)
Adult personal care	-.093 (.315)	-.215 (.640)	-.539 (1.301)	.032 (.130)
All adult goods	-.061 (1.906)	-.281 (7.827)	-.096 (2.133)	.181 (6.033)
Adult good (excluding adult personal care)	-.060 (1.897)	-.281 (8.886)	-.090 (1.178)	.186 (5.880)
Food	.094 (4.862)	.273 (12.131)	.307 (11.002)	.355 (20.432)
Other beverages	.589 (2.968)	-.203 (.980)	-.541 (2.114)	-.543 (4.000)
clothing	.749 (3.131)	.465 (1.804)	.591 (1.641)	.012 (.065)
Miscellaneous	.004 (.111)	-.309 (7.118)	-.400 (7.451)	-.291 (9.857)
Unclassified	.298 (1.381)	-.776 (3.285)	-.588 (2.025)	-1.007 (6.611)
Medical	-.120 (1.042)	-.320 (2.451)	-.217 (1.334)	-.143 (1.558)
Durable good	-.211 (1.335)	-.409 (2.277)	-.704 (3.164)	-.530 (4.484)

Figures in parentheses are the asymptotic absolute t-values

Table 3.3: Outlay-equivalent ratios: Deviations from mean (Δ_{ik}) for *adult goods*

Commodity	Age-group(Years)			
	0-5	6-10	11-14	15 and above
(1)	(2)	(3)	(4)	(5)
Tea-coffee	.110	.057	.134	-.241
	(1.312)	(.600)	(1.145)	(3.443)
Pan	-.433	.080	-.130	-.126
	(3.456)	(.562)	(.734)	(1.176)
Tobacco	.251	-.132	-.409	.230
	(1.837)	(.871)	(2.171)	(1.838)
Intoxicants	-.103	-.349	-.045	-.604
	(.579)	(1.730)	(.178)	(4.362)
Adult cloth	.179	.249	.836	.984
	(1.745)	(2.152)	(5.593)	(9.170)
Adult personal care	-.004	.095	-.387	-.242
	(.017)	(.334)	(1.101)	(1.161)
Wald test statistic*	19.503	7.109	36.929	120.462

Figures in parentheses are the asymptotic absolute t-values.
*Critical value of χ^2_5 at 5% level of significance is 11.071.

Table 3.4: Outlay-equivalent ratios: Deviations from mean (Δ_{ik}) for *demographically separable* group of goods

Commodity	Age-group(Years)			
	0-5	6-10	11-14	15 and above
(1)	(2)	(3)	(4)	(5)
Tea-coffee	.046	.139	.311	-.027
	(.423)	(.942)	(2.042)	(.297)
Tobacco	.188	-.050	-.232	.445
	(1.348)	(.316)	(1.207)	(3.593)
Intoxicants	-.166	-.266	.132	-.390
	(.971)	(1.357)	(.546)	(2.892)
Adult personal care	-.068	.178	-.210	-.028
	(.291)	(.670)	(.646)	(.145)
Wald test statistic*	2.343	2.737	7.344	18.364

Figures in parentheses are the asymptotic absolute t-values.
*Critical value of χ^2_3 at 5% level of significance is 7.815.

Chapter 4

An Exploratory Analysis of The Form of Engel Curves: A Nonparametric Approach [1]

4.1 Introduction

In this chapter we determine the shape of the engel curves for some selected items including the *adult good* using the nonparametric approach. We use the nonparametric Kernel regression technique which enables one to determine the functional form from the data and allows consistent estimation of a regression model for a given set of data without specifying a functional form a priori. We also make a comparison of the estimates of the nonparametric and two commonly used parametric engel curve forms. In this cross-section data based study, where prices may be taken to be fixed, we examine the shape of engel curves separately for groups of households homogeneous in respect of household demographic and socioeconomic characteristics. This is done so, because it is expected to facilitate the identification of the shape of engel curves for different items when the noneconomic determinants of consumption pattern like household demographic and socioeconomic characteristics are held fixed.

The plan of this chapter is as follows: section 4.2 briefly describes the nonparametric Kernel method; section 4.3 presents the specific data used for the analysis reported in this chapter and the results, and finally, section 4.4 draws some conclusions.

[1] This chapter is based on Majumder and Chakrabarty (1998).

4.2 The Nonparametric Kernel Method

Most of the studies on engel curve analysis that use nonparametric estimation of an unknown regression function use the Kernel method [e.g., McMillan, Ullah and Vinod (1989), Bierens and Pott-Buter(1990), Burgess and Ping Ping (1995), Nicol (1993) and Banks, Blundell and Lewbel (1997)]. It is basically a smoothing technique in which smoothing of a data set, say, $\{(X_h, Y_h)\}_{h=1}^{H}$, involves approximation of the mean response curve m in the regression relationship

$$Y_h = m(X_h) + \epsilon_h, \ h = 1, 2, \ldots.., H, \tag{4.1}$$

where m is the unknown regression function and ϵ_h's are the random disturbances. A reasonable approximation to the regression curve $m(x)$ is the mean of the response variables near a point x. Formally, the procedure can be defined as

$$\hat{m}(x) = \frac{1}{H} \sum_{h=1}^{H} W_{Hh}(x) Y_h, \tag{4.2}$$

where $\{W_{Hh}(x)\}_{h=1}^{H}$ denotes a sequence of weights, which may depend on the whole vector $\{X_h\}_{h=1}^{H}$, and controls the amount of averaging.

In Kernel smoothing the shape of the weight function $W_{Hh}(x)$ is described by a density function with a scale parameter that adjusts the size and the form of the weights near x. The shape function is referred to as Kernel Kl, which is a continuous, bounded and symmetric real function with

$$\int Kl(U)dU = 1.$$

Using the form of Kernel weights proposed by Nadaraya(1964) and Watson(1964), i.e.,

$$W_{Hh}(x) = Kl_{\tau_H}(x - X_h)/\hat{f_{\tau_H}}(x),$$

where

$$\hat{f_{\tau_H}}(x) = H^{-1} \sum_{h=1}^{H} Kl_{\tau_H}(x - X_h),$$

$$Kl_{\tau_H}(U) = {\tau_H}^{-1} Kl(U/\tau_H),$$

where τ_H is the scale factor, the mean response function is obtained as

$$\hat{m}(x) = [\frac{1}{H\tau} \sum Y_h Kl(\frac{x - X_h}{\tau})] \div [\frac{1}{H\tau} \sum Kl(\frac{x - X_h}{\tau})], \tag{4.3}$$

suppressing the dependence of $\tau = \tau_H$ on the sample size H. The shape of the Kernel weights is determined by Kl, whereas the size of the weights is parametrized by τ, which is called the bandwidth. The accuracy of Kernel smoothers as estimates of m depends mainly on the smoothing parameter τ [Härdle,1990]. The optimum bandwidth is the one that minimises a quadratic error measure (distance function) for the regression curve and optimally trades-off bias and variance. There are several distance functions, which are determined by a variance component (decreasing in τ) and a $(bias)^2$ component (increasing in τ), minimisation of which gives the optimal bandwidth. One such function is the average squared error, expressed as

$$ASE(\tau) = H^{-1}\sum_{h=1}^{H}[\hat{m}_\tau(X_h) - m(X_h)]^2 \tag{4.4}$$

This is a discrete approximation to the integrated squared error given by

$$ISE = \int [\hat{m}(x) - m(x)]^2 f(x)\, dx. \tag{4.5}$$

In order to choose the optimal bandwidth, we adopt the technique of *cross-validation leave-one out method.* The *leave-one out* method is based on regression smoothers in which one, say the j-th, observation is left out, so the estimator is

$$\hat{m}_{\tau j}(X_j) = H^{-1}\sum_{h\neq j} W_{\tau h}(X_j)Y_h. \tag{4.6}$$

With these modified smoothers, the *cross-validation function*, which validates the ability to predict $\{Y_j\}_{j=1}^{H}$ across the subsamples $\{(X_h, Y_h)\}_{h\neq j}$, given by

$$CV(\tau) = H^{-1}\sum_{j=1}^{H}[Y_j - \hat{m}_{\tau j}(X_j)]^2 \tag{4.7}$$

is formed. The optimal bandwidth is the one which minimises (4.7), which in turn minimises (4.4). For computational simplicity we choose Kl to be the quartic Kernel, which is differentiable everywhere and is given by

$$Kl(U) = (1 - U^2)^2 I(\mid U \mid \leq 1) \tag{4.8}$$

with indicator function I. It may also be noted that a particular choice of Kernel does not appear to be of great importance so far as asymptotic results are concerned [Silverman,1986].

To explore the engel curve relationship, we approximate the mean response curve m in the regression relationship

$$w_{ih} = m_i[\ln y_h] + \epsilon_{ih},\ i = 1, ..., n,\ h = 1, 2, ..., H \tag{4.9}$$

where w_i, the budget share of the i-th commodity, is a function of logarithm of total expenditure $\ln y$ and n is the number of commodities under study for each homogeneous demographic group[2].

4.3 Data and results

4.3.1 Data

The basic data set is the same as that used in chapter 3. To place emphasis on the sensitivity of the shape of the engel curves to demographic characteristics we divide each occupational group/ social class into homogeneous subgroups having identical household composition. Thus, for each occupation group/ social class the first group consists of households with only 2 adults (denoted as A), the second one consists of households with 2 adults and 1 child (denoted as B), the third group consists of households with 2 adults and 2 children (denoted as C), and in the fourth and fifth groups we have households with 2 adults and 3 children (denoted as D) and 2 adults and 4 children (denoted as E), respectively. As this grouping within NASE, OL and OH household types does not give adequate sample size required for the nonparametric method, we consider only two occupational groups, viz., AL and ASE and two social classes, viz., SC-ST and OTHER mentioned in chapter 3.

Engel curve forms have been examined for the following commodities: (1) *cereals*, (2) *other food*, (3) *adult good* (identified in chapter 3) (4)*fuel and light* and (7)*clothing*(excluding the adult clothing items) [3].

4.3.2 Results

For each commodity we have first estimated the budget share curve nonparametrically separately for homogeneous subgroups having identical household compositions within each occupational/ social class. Then for comparison with the nonparametric curve, two most commonly used parametric engel curve forms, viz., the

[2]Instead of running a separate regression of the form (4.9) for each demographic group one could run only one nonparametric regression incorporating the household characteristic variable along with total expenditure in equation (4.9), using a mixed continuous-discrete Kernel regression approach. However, this is computationally very heavy. Also, these estimates and the estimates from the present approach turn out to be asymptotically the same [Bierens and Pott-Buter (1990)].

[3]See Appendix A for the list of items included in each group. The items for which the corresponding quantity values are not available, have been excluded because calculation of *unit values* is required in later chapters.

Working-Leser (WL) form and the Quadratic Logarithmic(QL) form given by

$$w = \alpha + \beta \ln y + \epsilon \tag{4.10}$$

and

$$w = \alpha + \beta_1 \ln y + \beta_2 (\ln y)^2 + \epsilon \tag{4.11}$$

respectively, have also been estimated on the same data set. It may be noted that since (4.10) and (4.11) have been estimated separately for each homogeneous demographic group and not on the pooled data, the interaction effects between number of children and household expenditure is taken care of by the varying parameter estimates for different groups. We have plotted the budget share against $\ln(y)$ for all commodities for both household occupation groups and social classes. Figures 4.1-4.5 present the nonparametric Kernel regression for the five commodities for the occupation groups ASE and AL and for the social classes SC-ST and OTHER by demographic groups[4]. As an illustration the nonparametric fit (along with the 95% confidence bands), the WL and the QL fit (evaluated at decile points) of the budget share curves for the five commodities, for the demographic groups A, B and C in the occupation and the social categories are presented in figures B.1 - B.15 in Appendix B. In most cases the parametric curves are quite close to the nonparametric one and lie within the confidence band for all cases.

Table 4.1 presents the correlation coefficient ($cr_{w\hat{w}}$) between the observed and estimated budget shares for the nonparametric and parametric engel curves for the occupation groups AL and ASE, and household composition groups A,B,C,D and E. It also presents the percentage of households not reporting purchase of these commodities. Table 4.2 presents the correlation coefficients for the household demographic groups A, B, C, D and E of the two social classes. The findings from the tables and the plots can be summarised as follows:

For *cereals*, an overall downward sloping budget share curve is observed for all demographic categories and occupation groups although the slopes and intercepts differ. For both occupation groups, in most cases the performance of the QL form is marginally better than that of the WL form. A similar result holds for the two social classes. This is evident from the correlation coefficients in Tables 4.1 and 4.2.

Generally the budget share curve shifts upwards monotonically with the increase in the number of children. This is possibly indicative of the fact that in the rural

[4]The flatness of the nonparametric curves may seem to be a result of oversmoothness due to large bandwidth. However, in our case, the choice of optimum bandwidth is governed by minimisation of (4.4).

sector children are, by and large, *cereals*-consuming units. But this monotonicity is not strictly observed in case of groups ASE-C, AL-D. In case of SC-ST curves for the two groups C and D almost coincide. In some cases, e.g., ASE-B, AL-A, B and C, the budget share curve is almost flat indicating small variation in budget share for change in $\ln y$.

In case of *other food* an upward sloping curve is observed for all demographic categories in the occupation groups and social classes. The downward shift of the budget share curve with the increase in the number of children is observed for both social groups, but this feature is not clearly observed for the occupation groups. *Other food*, being a luxury item (the budget share curves are upward rising) households are expected to reduce their share of expenditure on other food as more and more children appear in the family. Here in most cases the QL form is closer to the nonparametric curve in terms of correlation coefficients presented in tables 4.1 and 4.2. In some cases (e.g., AL-C) the nonparametric curves tend to show a shape with break points which may induce one to use a change-point model[5]. In this case too QL is a better approximation as compared to WL as is evident from the correlation coefficients in table 4.1.

The budget share curve for *adult good* is downward sloping in most of the cases for both occupational groups and social classes indicating that this item can be treated as a necessary item[6]. Exceptions are the cases for ASE-C (upward sloping), SC-ST-B and E and OTHER-E. For the occupation group as well as the social groups generally a downward shift in the curves is observed with increase in the number of children. This shift is self explanatory in view of the item being *adult good*. Here also like *other food* break points occur in the groups AL-C and E. The values of the correlation coefficient in tables 4.1 and 4.2 indicate that QL provides a better explanation than the WL model especially for the social classes.

For *fuel and light* a downward slope is observed for all demographic compositions for both occupation groups and social classes excepting, SC-ST-C, although the slope and intercept differ. Here in all cases the QL form is marginally better than the WL form (see also Tables 4.1 and 4.2). The effect of increase in the number of children on the consumption of *fuel and light* is not clear. Given the nature of the commodity the result is not unexpected.

In case of *clothing* nothing can be said clearly about the nature of the commodity. The budget share curve shows an upward slope in some groups and a downward

[5]We have, however, not pursued this here.

[6]This is corroborated by the estimates of the coefficients in table 4.3 (for the range of income we are considering here).

slope in some other groups. In many cases the curves tend to be flat, indicating little change with changes in the level of $\ln y$. In most of the cases QL gives a better fit than the WL form. The peculiar behaviour of this commodity can be partly explained by the composition of the commodity (adult clothing items are not included here). It may also be pointed out that the percentage of people not purchasing this commodity is rather high (see tables 4.1 and 4.2) compared to the other commodities.

Table 4.3 presents the regression coefficients of $\ln y$ and $(\ln y)^2$ for pooled regression of WL and QL forms of engel equations incorporating dummies for occupation and social categories. Both the Chow-test and likelihood-ratio test indicate that QL gives a significantly better fit than WL for *cereals*, *other food* and *fuel and light*. For *adult good* and *clothing* the performances are similar.

4.4 Conclusion

In this chapter we have explored the forms of the budget share curves of some selected commodities for rural Maharashtra using the nonparametric kernel smoothing technique. Dividing the overall sample into homogeneous subsamples in terms of demographic characteristics, occupational groups and social classes, it turns out that the Quadratic logarithmic (QL) form of the budget share curve performs statistically better than WL form in most cases and provides a very close approximation to the nonparametric curves. The results of this analysis may briefly be summarised as follows:

1. In majority of the cases *cereals, fuel and light* and *adult goods* turn out to be necessary items, while *other food* is a luxury item. The nature of *clothing*, in some cases varies with the groups. Given the composition of this particular commodity, the result is not unexpected.

2. Given income, as the number of children increases the budget share increases for *cereals* and decreases for *adult good* and for *other food*. The effect of children on *fuel and light* and *clothing* is not so evident.

We have noted earlier that both the WL and the QL form are quite close to the nonparametric engel curves. In view of this the subsequent analysis is based on both of these forms of engel curves.

Table 4.1: $cr_{w\hat{w}}$ (Correlation coefficient between observed and estimated budget shares, estimated parametrically and non-parametrically) for *Cereals, Other food, Adult good, Fuel and Light* and *Clothing* by demographic groups within occupational categories.

Demographic group	Sample size	Cereals				Other food			
		Budget share type			% of households not purchasing	Budget share type			% of households not purchasing
		NP*	WL	QL		NP*	WL	QL	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Agricultural Labourer(AL)									
A	138	.10	.10	.10	.72	.42	.40	.41	0.00
B	174	.18	.04	.08	.57	.29	.13	.20	0.00
C	226	.05	.05	.06	0.00	.29	.04	.11	0.00
D	185	.24	.19	.22	0.00	.43	.40	.40	0.00
E	110	.22	.22	.22	0.00	.36	.36	.36	0.00
Agricultural Self Employed(ASE)									
A	110	.27	.18	.22	0.00	.55	.48	.50	0.00
B	78	.16	.14	.17	0.00	.22	.22	.22	0.00
C	107	.40	.36	.38	.93	.50	.47	.50	0.00
D	118	.34	.27	.29	0.00	.48	.46	.47	0.00
E	67	.42	.37	.37	0.00	.53	.45	.45	0.00

Demographic group	Sample size	Adult good				Fuel and light			
		Budget share type			% of households not purchasing	Budget share type			% of households not purchasing
		NP*	WL	QL		NP*	WL	QL	
(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Agricultural Labourer(AL)									
A	138	.36	.30	.31	0.00	.25	.25	.25	0.00
B	174	.17	.14	.16	0.00	.17	.14	.17	0.00
C	226	.36	.18	.18	0.00	.07	.02	.09	0.00
D	185	.31	.16	.26	0.00	.17	.12	.14	0.00
E	110	.40	.12	.22	0.00	.16	.14	.15	.91
Agricultural Self Employed(ASE)									
A	110	.15	.12	.12	0.00	.36	.36	.36	0.00
B	78	.19	.19	.19	0.00	.26	.21	.21	0.00
C	107	.22	.09	.11	0.00	.35	.34	.36	0.00
D	118	.08	.07	.12	0.00	.21	.20	.22	0.00
E	67	.40	.12	.19	0.00	.21	.21	.21	0.00

*NP: Non-parametric.

Table 4.1: Continued

Demographic group	Sample size	Clothing			
		Budget share type			% of households not purchasing
		NP*	WL	QL	
(1)	(2)	(19)	(20)	(21)	(22)
Agricultural Labourer(AL)					
A	138	.31	.12	.16	21.60
B	174	.07	.08	.11	14.90
C	226	.07	.07	.11	8.40
D	185	.23	.13	.15	10.80
E	110	.05	.03	.11	15.50
Agricultural Self Employed(ASE)					
A	110	.25	.09	.09	21.80
B	78	.20	.19	.22	12.80
C	107	.13	.11	.14	4.70
D	118	.19	.17	.18	10.20
E	67	.08	.04	.08	9.00

*NP: Non-parametric.

Table 4.2: $cr_{w\hat{w}}$ (Correlation coefficient between observed and estimated budget shares, estimated parametrically and non-parametrically) for *Cereals, Other food, Adult good, Fuel and light* and *Clothing* by demographic groups within social classes.

Demographic group	Sample size	Cereals				Other food			
		Budget share type			% of households not purchasing	Budget share type			% of households not purchasing
		NP*	WL	QL		NP*	WL	QL	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Scheduled Caste and Scheduled Tribe(SC-ST)									
A	100	.16	.16	.16	0.00	.36	.31	.34	0.00
B	101	.33	.32	.33	0.00	.35	.15	.31	0.00
C	111	.32	.23	.23	0.00	.26	.26	.26	0.00
D	102	.25	.25	.25	0.00	.45	.44	.44	0.00
E	65	.40	.40	.40	0.00	.55	.54	.55	0.00
Others(OTHER)									
A	230	.35	.33	.35	.87	.56	.55	.55	0.00
B	229	.18	.05	.18	.44	.42	.31	.37	0.00
C	316	.34	.24	.32	.32	.45	.41	.43	0.00
D	316	.30	.25	.27	0.00	.45	.43	.43	0.00
E	181	.31	.30	.30	0.00	.43	.41	.41	0.00

Demographic group	Sample size	Adult good				Fuel and light			
		Budget share type			% of households not purchasing	Budget share type			% of households not purchasing
		NP*	WL	QL		NP*	WL	QL	
(1)	(2)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Scheduled Caste and Scheduled Tribe(SC-ST)									
A	100	.16	.01	.18	0.00	.35	.28	.29	0.00
B	101	.51	.27	.49	0.00	.31	.30	.31	0.00
C	111	.29	.12	.20	0.00	.16	.02	.06	0.00
D	102	.04	.04	.04	0.00	.35	.20	.21	0.00
E	65	.32	.09	.29	0.00	.19	.18	.19	0.00
Others(OTHER)									
A	230	.29	.16	.20	0.00	.35	.31	.32	0.00
B	229	.31	.26	.26	0.00	.22	.18	.21	0.00
C	316	.23	.02	.19	0.00	.25	.23	.25	0.00
D	316	.31	.08	.19	0.00	.23	.23	.24	0.00
E	181	.33	.02	.26	0.00	.29	.27	.28	.55

*NP: Non-parametric.

Table 4.2: Continued

Demographic group	Sample size	Clothing			
		Budget share type			% of households *not purchasing*
		NP*	WL	QL	
(1)	(2)	(19)	(20)	(21)	(22)
Scheduled Caste and Scheduled Tribe(SC-ST)					
A	100	.08	.06	.14	21.00
B	101	.35	.20	.21	12.90
C	111	.23	.19	.19	9.00
D	102	.24	.16	.26	10.00
E	65	.45	.22	.30	10.80
Others(OTHER)					
A	230	.11	.13	.13	22.20
B	229	.08	.01	.05	12.20
C	316	.27	.10	.21	7.60
D	316	.03	.03	.04	10.10
E	181	.27	.16	.16	11.60

*NP: Non-parametric.

Table 4.3: Regression coefficient of $\ln y$ and $(\ln y)^2$ for a pooled regression of both WL and QL form of Engel equations.

Coefficients of	*Cereals*		Other food		*Adult good*		Clothing		Fuel and light	
	WL	QL	WL	QL	WL	QL	WL	QL	WL	QL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
$\ln y$	-.053 (13.835)	.255 (6.079)	.086 (24.263)	-.095 (2.450)	-.010 (4.215)	-.060 (2.313)	.004 (3.897)	-.011 (1.148)	-.026 (13.995)	-.088 (4.327)
$(\ln y)^2$		-.026 (7.382)		.015 (4.693)		.004 (1.935)		.001 (1.511)		.005 (3.059)
Chow test statistic* (F value)	54.449		22.034		3.785		2.469		9.367	
Likelihood-Ratio test statistic(χ^2 value)**	54.144		21.987		3.784		2.400		9.359	

Figures in parentheses indicate absolute t values.

*Chow test statistic $(F_{1,4639}) = \frac{RSS_{WL}-RSS_{QL}/no.of restriction}{RSS_{QL}/d.f}$.

Critical value at 5% level of significance = 3.84.

**Likelihood ratio test statistic $(\chi^2{}_1) = -2(\ln L_{WL} - \ln L_{QL})$.

Critical value at 5% level of significance = 3.84.

Nonparametric Curves (Cereals)

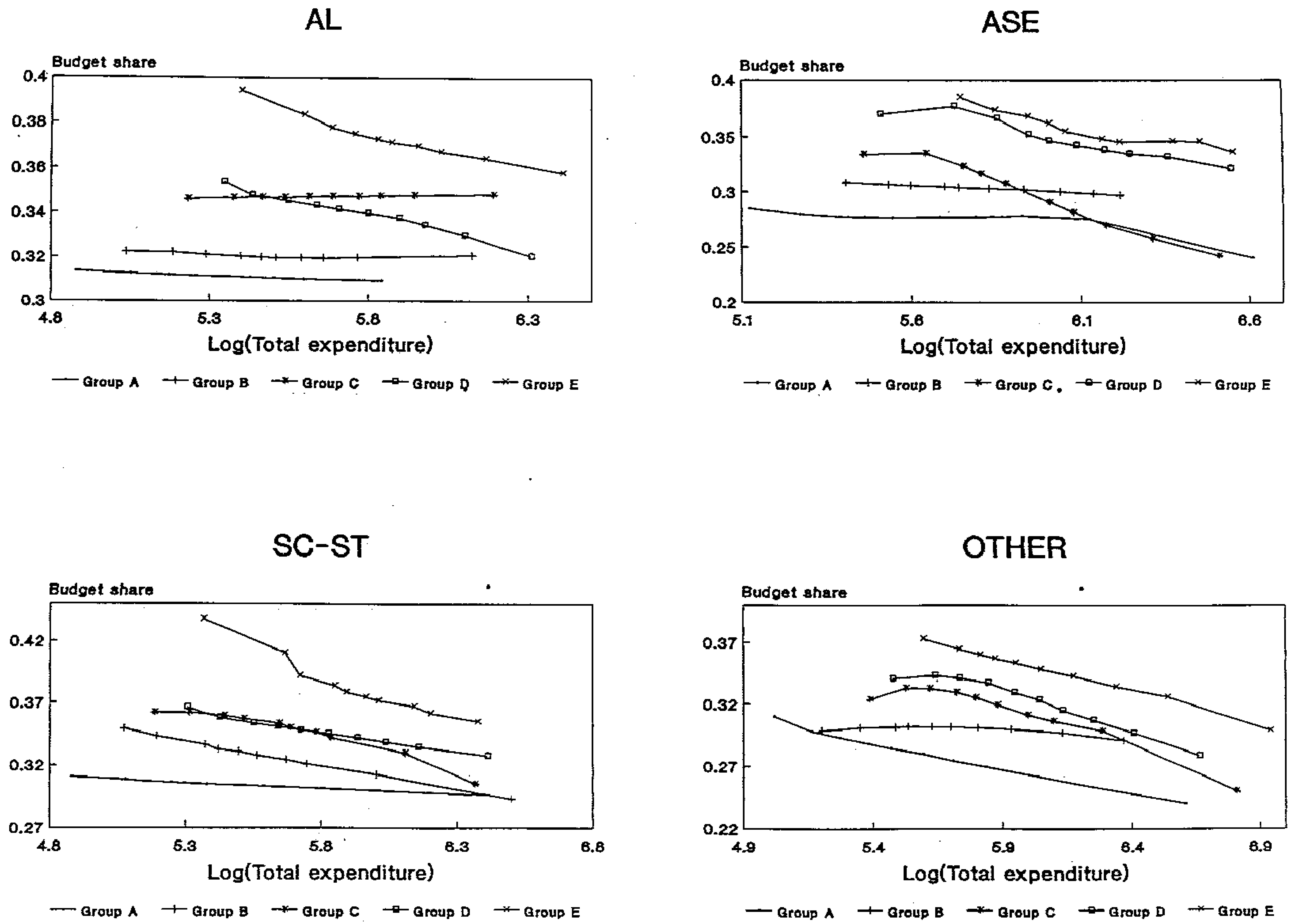


Figure 4.1

Nonparametric Curves (Other food)

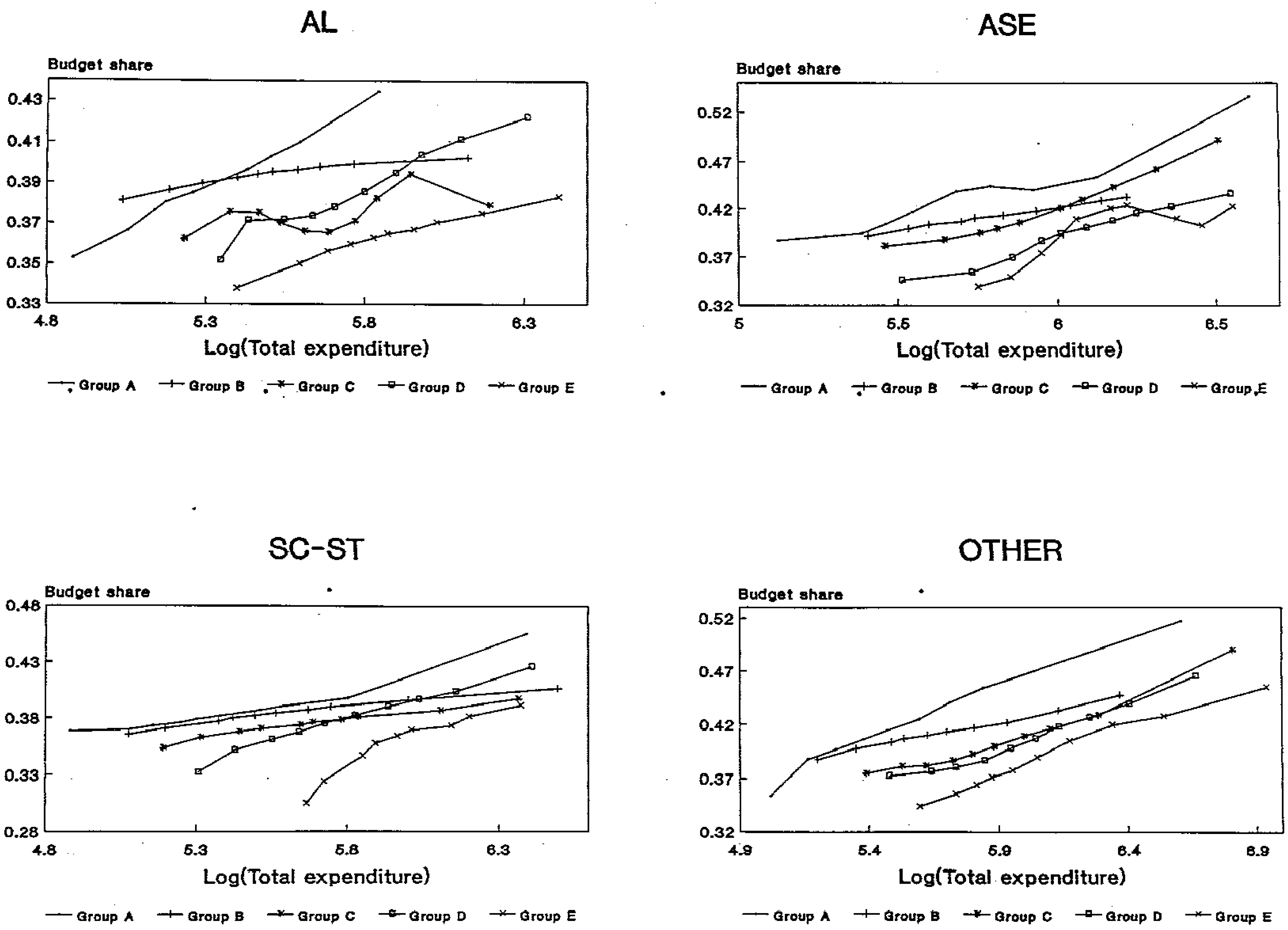


Figure 4.2

Nonparametric Curves (Adult good)

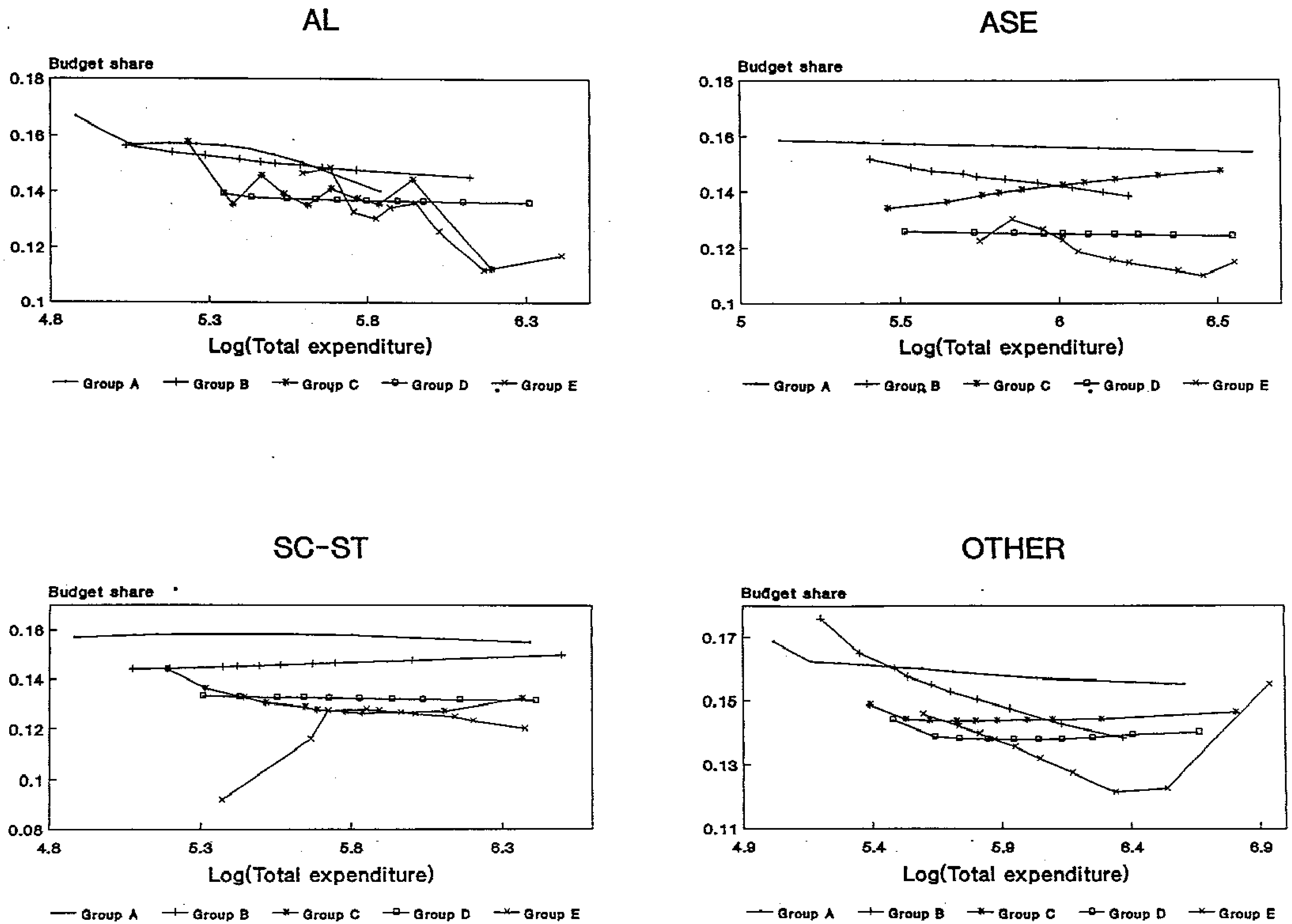


Figure 4.3

Nonparametric curves (Fuel and light)

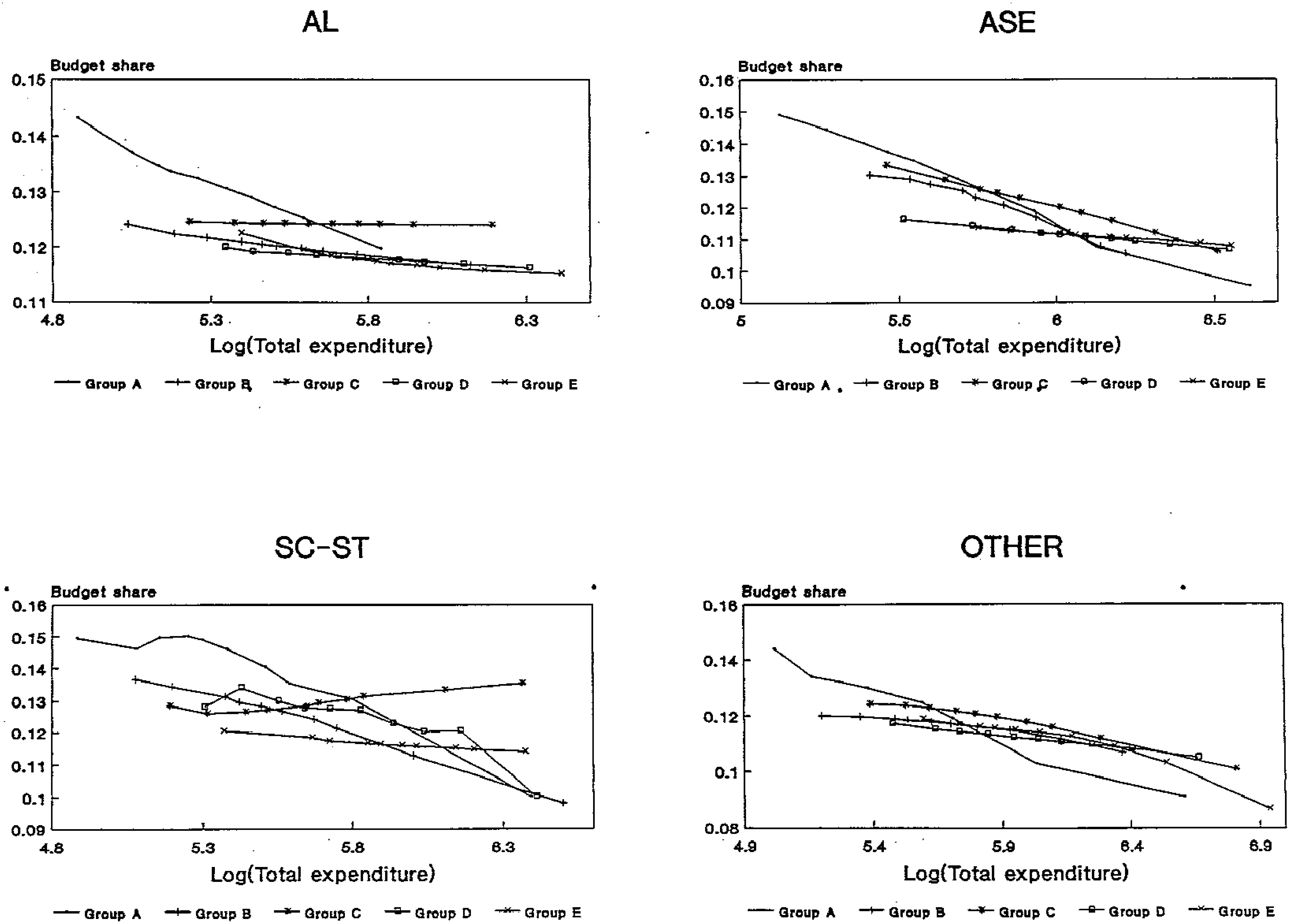


Figure 4.4

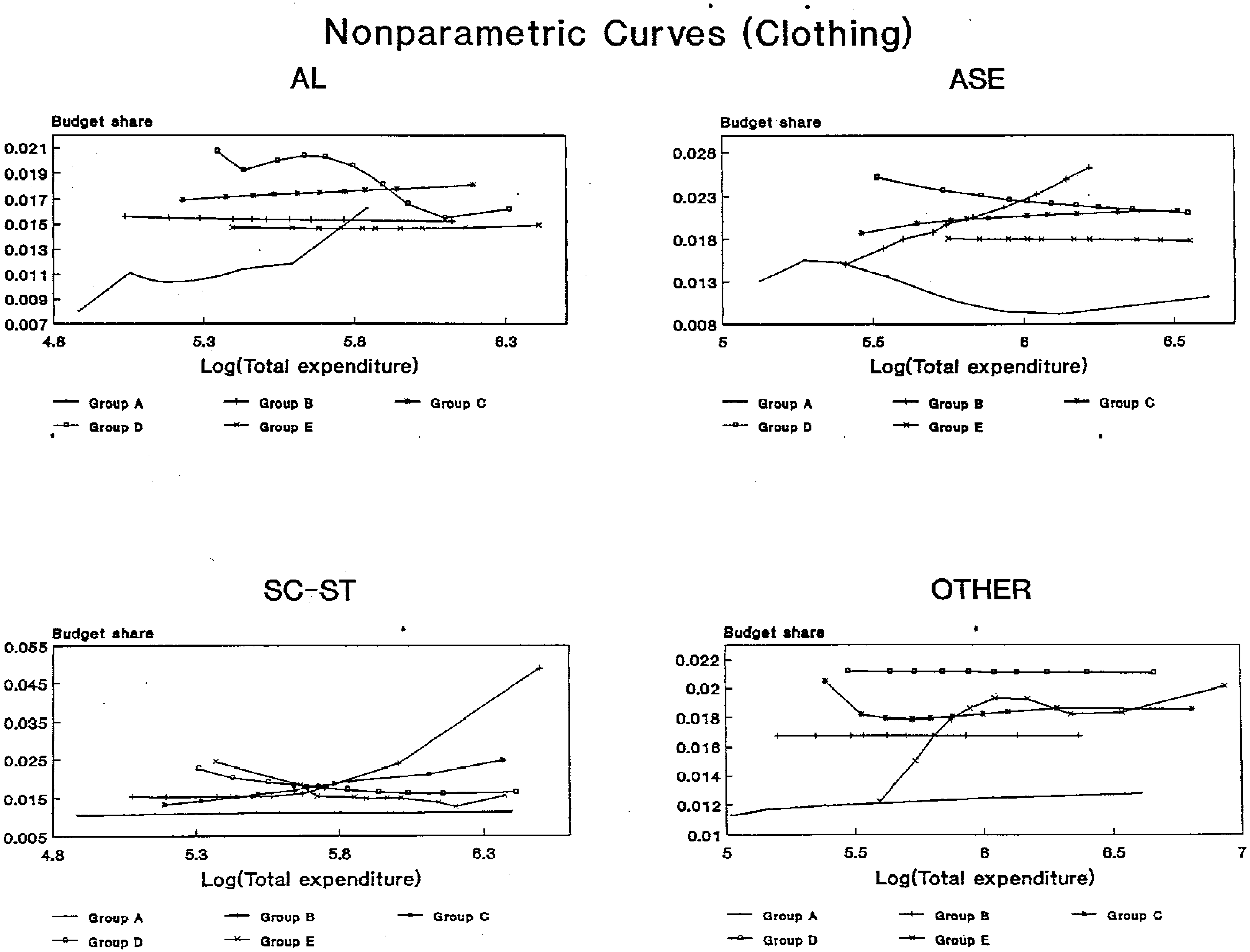

Nonparametric Curves (Clothing)
AL
Budget share
0.021
0.019
0.017
0.015
0.013
0.011
0.009
0.007
4.8
5.3
5.8
6.3
Log(Total expenditure)
Group A
Group B
Group C
Group D
Group E
ASE
Budget share
0.028
0.023
0.018
0.013
0.008
5
5.5
6
6.5
Log(Total expenditure)
Group A
Group B
Group C
Group D
Group E
SC-ST
Budget share
0.055
0.045
0.035
0.025
0.015
0.005
4.8
5.3
5.8
6.3
Log(Total expenditure)
Group A
Group B
Group C
Group D
Group E
OTHER
Budget share
0.022
0.02
0.018
0.016
0.014
0.012
0.01
5
5.5
6
6.5
7
Log(Total expenditure)
Group A
Group B
Group C
Group D
Group E

Figure 4.5

Chapter 5

Relative Cost of Children and Gender Bias: A Single Equation Approach

5.1 Introduction

We have mentioned earlier that there are two approaches to measuring *cost of children*, viz., the single equation approach and the systems approach. In this chapter we concentrate on the single equation approach. We may also recall that the two most widely used methods of measuring *cost of children* are Engel's (1895) method and Rothbarth's (1943) method. In Engel's method the proportion of income spent on *food*(i.e., *food share*) is taken to be the measure of a household's welfare, and the *cost of a child* is measured by calculating the compensation that would have to be paid to the parents to restore the household *food share* to its prenatal level. The Rothbarth method imputes the same welfare level to households that have the same level of consumption of *adult goods* and the *cost of a child* is measured by calculating the sum of money that would restore the level of expenditure on *adult goods* to its prenatal level[1]. Alternatively, the cost of a child can be expressed in

[1]For application of these methods see Deaton and Muellbauer(1986), Deaton, Castillo and Thomas(1989), Murthi(1994), Henderson(1949-50a)(1949-50b), Nicholson(1949). We may note that a problem with Engel's method is that as both adults and children consume *food* the effect of an additional child cannot be isolated. On the other hand, though Rothbarth's method is simple and intuitively appealing and considers *adult goods* that are exclusive to adults only, it is based on two simplifying assumptions that (a) birth of a child has no effect on parental preferences for *adult goods* and (b) the presence of children has only income effects on parental consumption.

the form of '*equivalence scale*' or '*relative cost index*', which is given by the ratio of the expenditures rather than the difference in expenditures. In this chapter we use both the Engel and the Rothbarth methods to estimate the *equivalence scale/relative cost* of children.

In recent times, the issue of gender bias in the intrahousehold allocation of consumption expenditure has received wide attention, especially in developing countries [Chen, Huq and D'Souza (1981), Dasgupta (1987), Sen (1988), Basu(1989, 1993) and Svedberg (1990)]. There is extensive evidence of a systematic bias towards men in some of these countries, including India [Bardhan (1988), Caldwell and Caldwell (1987) and Miller (1981)]. There is large empirical evidence of discrimination against female children in the provision of nutrition, health and education in India [Bardhan(1982), Sen and Sengupta(1983), Kynch and Sen(1983), Sen(1984), Harris(1990), Coale(1991), Harris (1990), Caldwell and Caldwell (1987), Miller (1981) and Dreze and Sen (1995)][2].

Recently Deaton (1989a) and Subramanian and Deaton (1991) have tried to study the issue of gender bias through what is called an *outlay equivalent ratio* (discussed in chapter 3). The *outlay equivalent ratio* of a child is the effect of an additional child on the demand for *adult good*, measured as the amount of additional outlay that would have been necessary to produce the same effect on demand, that additional outlay expressed as a fraction of total household expenditure per household member. If there is discrimination against a female child, then the reduction in expenditure on *adult goods* should be larger following the addition of a male child to the household than that following the addition of a female child, i.e., giving a larger negative value for a boy than for a girl. Based on a statistical test they found discrimination against female children in the age group 0-4 years for rural Maharashtra using the NSS 38th round (1983) consumption expenditure data[3]. Their results are, however, based on overall sample only.

To examine the issue of gender bias in terms of disparities in the intrafamily allocation of consumption goods, in this chapter we look at the *equivalence scales* separately for male and female children. A larger value of *equivalence scale*, i.e., compensation for the arrival of a child for a particular gender will indicate bias towards that gender. In this demand theoretic approach the underlying assumption

[2]See Quibria(1995) for a survey on gender bias in the context of Asian developing countries.

[3]Subramaniam(1996) examined this issue using the household level panel data on two states of India (Maharashtra and Andhra Pradesh) with respect to labour market returns. Though discrimination against female children was found from cross-sectional data, no gender discrimination in the allocation of resources was found after controlling for wealth effect.

is that parents allocate resources according to their own utility which depends on the well-being of their children measured in terms of consumption bundles only[4]. Strictly speaking, the different *equivalence scales* between boys and girls may simply reflect non-identical allocation between them as reflected in household spending decisions, which may be due to genuine differences in needs and/or deliberate discrimination. However, there are evidences in the literature that use these measures to determine sex-bias [Sen (1984), Bosch-Domenech (1991)].

This chapter is organised as follows: section 5.2 explains the methodology adopted in this paper, section 5.3 describes the data and results and, finally, section 5.4 draws the conclusions.

5.2 Methodology

The *equivalence scale* or *relative cost of a child* is given by the ratio

$$a(d^c, d^{aR}, u^R, p^R) = \frac{C(u^R, p^R, d^{aR}, d^c)}{C(u^R, p^R, d^{aR})}$$

where $C(u, p, d)$ gives the minimum total expenditure necessary to attain utility level u, given the price vector p and the demographic characteristics vector $d = (d^a, d^c)$ of the household. Here d^{aR} represents a reference family of two adults and (d^{aR}, d^c) a family with two adults and children.

The Engel scales have been worked out using the Working-Leser and the Quadratic Logarithmic(QL) forms of the budget share curves. To examine gender bias we use the following forms of engel curves for the Engel scale

$$w = \alpha + \beta_1 \ln y + \gamma_1({d^a}_{15+} - 2) + \gamma_2(m{d^c}_{0-14}) + \gamma_3(f{d^c}_{0-14}) + \epsilon \qquad (5.1)$$

and

$$w = \alpha + \beta_1 \ln y + \beta_2(\ln y)^2 + \gamma_1({d^a}_{15+} - 2) + \gamma_2(m{d^c}_{0-14}) + \gamma_3(f{d^c}_{0-14}) + \epsilon \quad (5.2)$$

where w is the budget share for *food*, y is the total expenditure, $({d^a}_{15+} - 2)$ denotes the number of adults (normalized)[5], $(m{d^c}_{0-14})$ denotes the number of male

[4]The other demand theoretic approach incorporating children endogeneously has been advocated by, Behrman(1988), Behrman, Pollak and Taubman (1982,1986). The other approaches are based on labour marker returns (Rosenzweig and Schultz (1982)), productivity of individual (Pitt, Rosenzweig and Hassan (1990)) and power of female members within the family (Haddad and Hoddinott (1991) and Thomas (1990)).

[5]A childless 2-adult household is considered as the reference household, for which the scale value is 1. The number of adult members in a household less two is used to measure the marginal effect of additional adults in that household.

children and $(fd^c{}_{0-14})$ denotes the number of female children in the age group 0-14 years. The Engel scales are obtained by equating the budget-shares on *food* of the comparison household and the reference household.

For the Rothbarth scale we use

$$pq = \delta + \eta_1 \ln y + \zeta_1(d^a{}_{15+} - 2) + \zeta_2(md^c{}_{0-14}) + \zeta_3(fd^c{}_{0-14}) + \epsilon \qquad (5.3)$$

and

$$pq = \delta + \eta_1 \ln y + \eta_2(\ln y)^2 + \zeta_1(d^a{}_{15+} - 2) + \zeta_2(md^c{}_{0-14}) + \zeta_3(fd^c{}_{0-14}) + \epsilon \quad (5.4)$$

where y is the same as above and pq is the expenditure on *adult good*[6]. Thus, for example, from equation (4.1), the Engel scale, for a male child, is given by

$$a_h^R = e^{\frac{-\gamma_2(md^c{}_{0-14})}{\beta_1}} \qquad (5.5)$$

when a 2 adult household is considered as reference. From equation (4.3), the Rothbarth scale obtained by equating expenditures on *adult good*, is given by

$$a_h^R = e^{\frac{-\zeta_2(md^c{}_{0-14})}{\eta_1}}. \qquad (5.6)$$

The *equivalence scale* by Engel's method from the QL form of engel equation is found as follows: equating the budget share of a comparison household (e.g., 2 adult households with male children and with income y^h) to that of a reference household (e.g., 2 adult household with income y^R), we have

$$\beta_1(\ln y^h - \ln y^R) + \beta_2\{(\ln y^h)^2 - (\ln y^R)^2\} = -\gamma_2(md^c{}_{0-14}) \qquad (5.7)$$

or

$$\beta_2(\ln y^h - \ln y^R)^2 + (\beta_1 + 2\beta_2 \ln y^R)(\ln y^h - \ln y^R) + \gamma_2(md^c{}_{0-14}) = 0. \qquad (5.8)$$

For $\ln y^R$ we take the average value of $\ln y$ of the households whose composition is identical to that of the reference household. Thus, given $\ln y^R$ equation (4.8) is a quadratic function of the unknown $\ln y^h$. Solving for $\ln y^h$ we obtain the *equivalence scale*(conditional on the value of $\ln y^R$). A similar procedure is used for the Rothbarth scale[7].

[6]Ideally, the Rothbarth scale should have been worked out using the forms for the *budget share curve* used to calculate Engel scale. But then solving for the Rothbarth scales become rather complicated. Therefore, for ease of computation, following Deaton and Muellbauer(1986) and Lancaster and Ray(1996), we have considered the *expenditure equations*.

[7]The estimated scales may be sensitive to the choice of the value of $\ln y^R$. We have, however, not examined the issue of robustness of these scales.

5.3 Data and Results

5.3.1 Data

The basic data set is the same as that used in previous chapters. The occupational, social and demographic classifications of households remain the same as before. Here the children group is further subdivided according to sex. We not only consider an age-group 0-14 years, but also consider three different age-groups (e.g., 0-5 years, 6-10 years and 11-14 years). Within the occupation groups, to separate out the caste habits effect, we further subdivide each occupation group into two social classes, viz., Scheduled Caste and Scheduled Tribe (SC-ST) and OTHERS. However, for the occupation classes NASE, OL and OH this subgrouping leads to very small sample sizes in each of these classes. We therefore confine our attention only to the two occupation groups AL and ASE and the two social classes within these two occupation groups and then estimate the *relative cost of a child* separately for each household composition. The final sample sizes become 620(SC-ST) and 1153(OTHERS) in the AL occupation group and 242(SC-ST) and 1564(OTHERS) in the ASE occupation group after excluding single-adult households from our sample as 2-adults households are considered to be the reference household.

The commodity groups we consider are (1) *cereals*[8] for estimating Engel's scale, and (2) *adult good* for estimating Rothbarth's relative cost.

5.3.2 Results

Equivalence scales

Table 5.1A presents the estimated Engel and Rothbarth scales for different occupation groups as well as for the two social groups within these occupational classes by different demographic compositions under the two engel curve specifications. Table 5.1B presents these scales for the overall sample[9]. Here we consider one children group with 0-14 years of age. The results can be summarised as follows:

1. The results substantiate the findings in Deaton and Muellbauer (1986), based on their analysis of the data on Sri Lanka and Indonesia, that the Engel model "will lead to estimate of child costs that are too large".

[8] Since we are dealing with *cost of children* here, it is desirable to choose commodities so that the effect of children can be isolated as far as possible. *Cereals*, in that sense, seems more appropriate than *food* which includes children food.

[9] The corresponding estimates of the parameters are presented in Tables C.1A and C.1B in Appendix B. Except in very few cases all the parameters turn out to be significant.

2. The *relative cost of a child* is sensitive to the estimation method and also to the occupational and social categories the household belongs to. For example, in the occupational category ASE (column 14 of table 5.1A) one child costs 81 percent of an adult (from both one child and two-children households) by Engel's method. The corresponding figure is 15 percent by Rothbarth's method. In the occupational category AL (column 8 in table 5.1A), on the other hand, by Engel's method one child costs 229 percent of an adult and for two children each costs 204 percent of an adult. By Rothbarth's method the corresponding figures are 8 percent for both[10]. We may put forward one reason why the Engel scale for occupation group AL is rather large compared to that for ASE. It could be that the AL group being comparatively poor, their children consume more *cereals* than those in the ASE group, who can possibly afford to substitute *cereals* by some children *food*. Such a possibility is also evident from our earlier findings from figure 4.1 in chapter 4 where the budget share of *cereals*, for a given household composition, can be seen to be higher of AL than for ASE.

3. For the overall sample the scales seem quite plausible and introduction of the quadratic logarithmic income term increases the scale values. This corroborates the findings in Lancaster and Ray (1996).

Table 5.2A and 5.2B present the scales for the 1 child households considering three children age-groups[11]. For the occupation group AL and social class OTHER within AL, Engel *equivalence scale* values are higher for the age-group 6-10 years compared to those in the other two groups. In other cases the scales increase with the age of children.

Gender Bias

To examine the issue of gender bias within the children group we first compute *outlay-equivalent ratios* corresponding to *cereals* and *adult good* following Subra-

[10]It may be noted that large discrepancies between the Engel and Rothbarth scales have also been found in Deaton and Muellbauer (1986), where for a household with two children, a child older than 5 years old costs 122 percent of an adult by Engel's method and costs 22 percent of an adult by Rothbarth's method.

[11]The corresponding parameter estimates are presented in tables C.2A and C.2B in Appendix C. It may be noted that some scale values are infeasible (having a value less than one). Such scale values are obtained due to infeasible estimates of the corresponding parameters (in the sense that they do not have the expected signs). This may have occurred due to some data problem. Such scale values have been excluded from our analysis. These parameters, however, are nonsignificant.

manian and Deaton (1991) (see equation (3.3) for male and female children separately). The values are presented in table 5.3. To test if the difference in the scales is statistically significant, we go back to the regression coefficients and compute the F-value for differences in the coefficients corresponding to the children characteristics. This is done in view of the fact that the *outlay-equivalent ratios* are nonlinear function of the underlying parameters and data. The parameters and the F-values are presented in table 5.4. None of the F-values turn out to be significant indicating that there is no gender bias in the overall sample with respect to *cereals* and *adult good*. It may, however, be mentioned here that Subramanian and Deaton(1991) found discrimination against female children in the age-group 0-4 years in terms of the commodity *tobacco and pan*.

Table 5.5A presents the Engel and Rothbarth *equivalence scales* for male and female children separately by occupational and social classes. Table 5.5B presents the corresponding scale for the overall sample[12]. Here we concentrate on households with 1 child only. When the combined age-group 0-14 years is considered, for the overall sample both the Engel and the Rothbarth scale values for female children are higher than those for male children. For the occupation group ASE and for AL (SC-ST) the Engel scales are higher for female children. For the occupational group AL and for ASE (SC-ST) the Rothbarth scales are higher for male children. However, when the social groups are combined in ASE, the Rothbarth scales are higher for female children.

Tables 5.6A and 5.6B based on three age-groups of children reveal the following[13]:

1. Engel scales are higher for female children in the age-group 0-5 years for both occupational and social groups, as well as for the overall sample. Such higher values are also observed in the age group 6-10 years for SC-ST (AL and ASE), and for OTHER in ASE.

2. The Rothbarth scales for male children in the age group 6-10 years are higher in the occupational category AL. This pattern is also observed for the two social classes within this category.

   In the occupational group ASE the female scales are observed to be higher

[12]The corresponding parameter estimates are presented in Tables C.3A and C.3B in Appendix C. Most of the parameters turn out to be significant. As mentioned earlier, the problem of infeasibility of the scale values arises here also in some cases due to some infeasible (non-significant) estimates of the parameters.

[13]The corresponding parameters estimates are presented in tables C.4A and C.4B. As discussed earlier, the problem of infeasible estimates exists.

for the age group 6-10 years for this group as a whole as well as for the social classes within the occupational category.

For the overall sample the Engel scale for male children is higher only for the age group 11-14 years.

To formally test the equality of the *equivalence scales* between male and female children we perform an F test of equality of coefficients of the demographic variables in the original regression. Table 5.7A presents the F-values for the occupational and social groups. Table 5.7B presents the F-values for the overall sample. In the case of one children group, none of the F values except for the Rothbarth scale in ASE turn out to be significant thus indicating that in this occupation group there is a bias towards female children. In the case of three children categories, for the Engel scale, only in the overall sample for the age-group 0-5 years the F value is significant. This indicates existence of bias towards female children in this age group. For the Rothbarth scale, the age-groups 0-5 years and 6-10 years show significant F-values for the occupation group ASE which again implies bias towards female children in these two age groups.

5.4 Conclusion

In this chapter we have tried to examine the treatment of children in relation to the household occupation group and social class for the rural sector of Maharashtra. It is observed that (1) the *relative cost of a child* is sensitive to the estimation method and also to the occupational category and social class the households belong to, (2) consistent with the earlier findings, here the Engel scale always gives higher values than the Rothbarth scale, (3)considering one children group, (i) the analysis based on *outlay equivalent ratios* shows no gender bias with respect to *cereals* and *adult good*, and (ii) in our case no bias against female children is observed with respect to *cereals* and *adult good* for ASE and (4) considering three children categories, in the age-group 0-5 years a bias towards female children is observed with respect to *cereals* for the overall sample, and in the age group 0-5 years and 6-10 years with respect to *adult good*, for the occupation group ASE.

Thus, what we seem to find in this chapter is that there is some evidence of gender bias in rural Maharashtra, but contrary to the common notion the bias is towards young and very young female children[14]. The results of this exercise

[14]Female children mortality and discrimination against girls in the intrahousehold allocation of food is more pronounced in the North Indian states than in the Southern states[Govt. of India (1988),

should, however, be treated carefully. It may be pointed out that *cereals* may not be a prime candidate for exhibiting gender bias, although the common notion is that difference in child mortality rate, which is prevalent in India [Bardhan(1988), Dyson (1987) and Dreze and Sen (1989)] is generally caused by disparities in the intrafamily allocation of food, nutrition and health care. Basu (1989), in fact, notes that in India at least, and perhaps in the rest of South Asia as well, sex differences in nutrition, where they exist, are not responsible for significant sex-differences in mortality. On the other hand, differential use of health care by the two sexes is a possible determinant of differences in child mortality[15]. The use of *adult good* can, however, be justified by the fact that it is consumed solely by adults and this cost serves as an indicator of the extent to which parents give up their own consumption. Thus, if parents treat female children less generously, the presence of female children should have less effect on adult consumption than the presence of their male siblings.

We conclude by noting that the study concentrates exclusively on commodities ignoring the effect of parental time and female labour supply. which are known to have considerable effect on *equivalence scale* values.

Miller (1981), Basu (1989)].

[15]The fact that for *education expenditure* and *health care* this bias may be more pronounced has also been noted by Dutta, panda and Wadhwa (1995), Dutta and Panda (1997).

Table 5.1A: Engel and Rothbarth *equivalence scales* for different household types by occupational groups and social categories within these occupational groups.

Household composition (d^a, d^c)*	Sample size	Occupational group AL						Occupational group ASE					
		WL form			QL form			WL form			QL form		
		SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
		Engel *equivalence scale*											
(2,0)	248	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
(2,1)	252	2.090	2.424	1.988	2.216	2.428	2.147	1.314	1.233	1.236	1.561	1.390	1.404
(2,2)	333	4.370	5.876	3.953	3.352	3.550	3.040	1.727	1.521	1.527	1.962	1.792	1.808
		Rothbarth *equivalence scale*											
		Linear			Quadratic			Linear			Quadratic		
(2,0)	248	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
(2,1)	252	1.030	1.024	1.026	1.039	1.043	1.043	1.041	1.022	1.024	1.041	1.082	1.079
(2,2)	333	1.060	1.049	1.052	1.077	1.085	1.085	1.089	1.045	1.048	1.085	1.155	1.150

Table 5.1B: Engel and Rothbarth *equivalence scale* for the overall sample

Household composition (d^a, d^c)*	Sample size	Engel *equivalence scale*		Rothbarth *equivalence scale*	
		WL	QL	Linear	Quadratic
(1)	(2)	(3)	(4)	(5)	(6)
(2,0)	335	1.000	1.000	1.000	1.000
(2,1)	333	1.336	1.624	1.023	1.059
(2,2)	430	1.786	2.153	1.047	1.114

*(d^a, d^c): d^a = Number of adults, d^c = number of children in the age-group(0-14 years)

Table 5.2A: Engel and Rothbarth *equivalence scales* for 1 child households by occupational groups and social categories for three children categories.

Household composition $(d^a, d_1^c, d_2^c, d_3^c)$*	Sample size	Occupational group AL						Occupational group ASE					
		WL form			QL form			WL form			QL form		
		SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Engel *equivalence scale*													
(2,0,0,0)	248	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
(2,1,0,0)	121	1.373	1.135	1.230	1.531	1.353	1.412	1.036	1.141	1.121	1.078	1.238	1.214
(2,0,1,0)	58	2.360	2.786	2.288	2.380	2.612	2.340	1.345	1.272	1.275	1.550	1.443	1.462
(2,0,0,1)	73	2.438	2.159	1.993	2.399	2.271	2.112	1.693	1.349	1.379	1.906	1.526	1.568
Rothbarth *equivalence scale*													
		Linear			Quadratic			Linear			Quadratic		
(2,0,0,0)	248	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
(2,1,0,0)	121	1.026	1.005	1.012	1.036	1.018	1.012	1.021	1.010	1.011	1.041	1.046	1.046
(2,0,1,0)	58	1.050	1.053	1.054	1.080	1.086	1.054	1.032	1.025	1.026	1.036	1.108	1.100
(2,0,0,1)	73	.983**	1.003	.996**	.955**	1.002	.996**	1.098	1.045	1.051	1.160	1.099	1.103

** Infeasible estimates

Table 5.2B: Engel and Rothbarth *equivalence scale* for the overall sample for three children categories

Household composition $(d^a, d_1^c, d_2^c, d_3^c)$*	Sample size	Engel *equivalence scale*		Rothbarth *equivalence scale*	
		WL	QL	Linear	Quadratic
(1)	(2)	(3)	(4)	(5)	(6)
(2,0,0,0)	335	1.000	1.000	1.000	1.000
(2,1,0,0)	171	1.095	1.181	1.001	1.025
(2,0,1,0)	70	1.382	1.581	1.045	1.097
(2,0,0,1)	92	1.414	1.604	1.034	1.049

*$(d^a, d_1^c, d_2^c, d_3^c)$: d^a = Number of adults, d_1^c = number of children in the age-group(0-5 years), d_2^c = number of children in the age-group (6-10 years) and d_3^c = number of children in the age-group (11-14 years).

Table 5.3: Outlay-Equivalent Ratios for WL and QL forms of engel curves by age and gender

Commodity	Male age-group(years)				Female age-groups(years)			
	0-5	6-10	11-14	15 and above	0-5	6-10	11-14	15 and above
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
WL form								
Cereals	-.061	.434	.515	.372	.162	.494	.426	.459
	(1.356)	(9.644)	(11.444)	(6.764)	(2.946)	(7.541)	(13.813)	(10.089)
Adult good	-.037	-.291	-.102	.260	-.073	-.269	-.076	.092
	(.440)	(3.464)	(1.146)	(2.731)	(.695)	(2.360)	(1.206)	(1.180)
QL form								
Cereals	.055	.417	.495	.356	.156	.480	.411	.438
	(.618)	(7.316)	(7.071)	(4.811)	(2.000)	(6.076)	(6.738)	(6.537)
Adult good	-.031	-.281	-.086	.277	-.069	-.261	-.065	.106
	(.492)	(4.460)	(1.564)	(4.397)	(.972)	(3.346)	(.916)	(1.683)

Figures in parentheses are the asymptotic absolute t-values.

Table 5.4: Regression coefficients of children variables by age and gender groups for equations of outlay equivalent-ratios and F - values for equality of demographic coefficients

	male age-groups (years)			female age-groups (years)		
Commodity	0-5	6-10	11-14	0-5	6-10	11-14
(1)	(2)	(3)	(4)	(5)	(6)	(7)
			WL form			
Cereals	-.104	-.006	.016	-.078	.011	-.008
	(7.039)	(.371)	(.971)	(5.256)	(.682)	(.423)
Adult good	-.019	-.056	-.028	-.024	-.052	-.024
	(1.999)	(5.978)	(2.657)	(2.575)	(5.384)	(2.179)
F-value	0-5 years	6-10 years	11-14 years	all three groups		
(d.f)	(1,4808)	(1,4808)	(1,4808)	(3,4808)		
Cereals	2.806	.871	1.431	1.708		
Adult good	.275	.090	.090	.152		
			QL form			
Cereals	-.103	-.006	.015	-.076	.011	-.008
	(6.933)	(.374)	(.916)	(5.126)	(.730)	(.411)
Adult good	-.097	-.055	-.028	-.025	-.053	-.025
	(2.104)	(5.982)	(2.607)	(2.699)	(5.433)	(2.897)
F-value	0-5 years	6-10 years	11-14 years	all children groups		
(d.f)	(1,4807)	(1,4807)	(1,4807)	(3,4807)		
Cereals	2.876	.957	1.297	1.715		
Adult good	.294	.068	.060	.141		

Figures in parentheses are absolute t-values.

$F_{1,4807}$ with 95% confidence interval = 3.84.

$F_{3,4807}$ with 95% confidence interval = 2.60.

Table 5.5A: Engel and Rothbarth *equivalence scale* for 1 child household by occupational groups and social classes within these occupational groups.

Household composition	Sample size	Occupational group AL						Occupational group ASE					
		WL			QL			WL			QL		
(d^a, md^c, fd^c)*		SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Engel equivalence scale													
(2,0,0)	248	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
(2,1,0)	139	1.990	2.610	1.990	2.110	2.500	2.150	1.230	1.200	1.190	1.420	1.350	1.340
(2,0,1)	113	2.270	2.200	1.980	2.320	2.340	2.150	1.390	1.270	1.280	1.700	1.430	1.460
Rothbarth equivalence scale													
		Linear			Quadratic			Linear			Quadratic		
(2,0,0)	248	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
(2,1,0)	139	1.040	1.030	1.040	1.050	1.050	1.050	1.060	.999**	1.010	1.070	1.040	1.050
(2,0,1)	113	1.020	1.020	1.020	1.020	1.030	.950**	1.030	1.040	1.040	1.060	1.120	1.110

**Infeasible estimates.

Table 5.5B: Engel and Rothbarth *equivalence scale* for 1 child household for the overall sample

Household composition	Sample size	Engel *equivalence scale*		Rothbarth *equivalence scale*	
(d^a, md^c, fd^c)*		WL	QL	Linear	Quadratic
(1)	(2)	(3)	(4)	(5)	(6)
(2,0,0)	335	1.000	1.000	1.000	1.000
(2,1,0)	182	1.317	1.502	1.018	1.047
(2,0,1)	151	1.356	1.569	1.029	1.069

*(d^a, md^c, fd^c): d^a = number of adults, md^c = number of male children in the age group (0-14 years), fd^c = number of female children in the age group (0-14 years).

Table 5.6A: **Engel and Rothbarth *equivalence scale* for 1 child households by occupational and social groups for three children categories.**

Household composition $(d^a, md_1^c, fd_1^c, md_2^c, fd_2^c, md_3^c, fd_3^c)$*	Sample size	Occupation Group-AL						Occupation Group-ASE					
		WL			QL			WL			QL		
		SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Engel *equivalence scale*													
(2,0,0,0,0,0,0)	248	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
(2,1,0,0,0,0,0)	61	1.170	1.100	1.140	1.270	1.280	1.270	1.010	1.100	1.070	.940**	1.170	1.140
(2,0,1,0,0,0,0)	60	1.590	1.170	1.330	1.760	1.420	1.540	1.070	1.180	1.170	1.190	1.290	1.280
(2,0,0,1,0,0,0)	28	2.330	3.010	2.370	2.350	2.720	2.380	1.390	1.240	1.250	1.590	1.400	1.430
(2,0,0,0,1,0,0)	30	2.260	2.530	2.200	2.320	2.480	2.270	1.280	1.320	1.320	.990**	1.490	1.500
(2,0,0,0,0,1,0)	50	2.190	2.180	1.960	2.240	2.270	2.080	1.480	1.320	1.330	1.660	1.490	1.490
(2,0,0,0,0,0,1)	23	2.800	2.090	2.020	2.610	2.240	2.140	1.950	1.380	1.430	2.170	1.560	1.640
Rothbarth *equivalence scale*													
		Linear			Quadratic			Linear			Quadratic		
(2,0,0,0,0,0,0)	248	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
(2,1,0,0,0,0,0)	61	1.020	1.010	1.020	1.030	1.030	1.020	1.001	1.001	1.002	.930**	1.030	1.030
(2,0,1,0,0,0,0)	60	1.030	.980**	1.010	1.050	1.010	1.030	1.040	1.010	1.010	1.130	1.050	1.050
(2,0,0,1,0,0,0)	28	1.070	1.080	1.080	1.110	1.120	1.120	1.030	1.001	.990**	.999**	1.070	1.060
(2,0,0,0,1,0,0)	30	1.030	1.030	1.030	1.060	1.040	1.050	1.050	1.050	1.050	1.110	1.470	1.140
(2,0,0,0,0,1,0)	50	1.020	1.001	.990**	1.010	.970**	.980**	1.230	1.010	1.030	2.340	1.002	1.040
(2,0,0,0,0,0,1)	23	.940**	1.020	.990**	.880**	1.040	.990**	.980**	1.080	1.070	.880**	1.180	1.160

*$(d^a, md_1^c, fd_1^c, md_2^c, fd_2^c, md_3^c, fd_3^c)$: md_1^c = number of male children in the age group (0-5 years), fd_1^c = number of female children in the age group (0-5 years), md_2^c = number of male children in the age group (6-10 years), fd_2^c = number of female children in the age group (6-10 years), md_3^c = number of male children in the age group (11-14 years), fd_3^c = number of female children in the age group (11-14 years).

** Infeasible estimates.

Table 5.6B: Engel and Rothbarth *equivalence scale* for 1 child households for the overall sample for three children categories

Household composition $(d^a, md_1^c, fd_1^c, md_2^c, fd_2^c, md_3^c, fd_3^c)$*	Sample size	Engel *equivalence scale*		Rothbarth *equivalence scale*	
		WL	QL	Linear	Quadratic
(1)	(2)	(3)	(4)	(5)	(6)
(2,0,0,0,0,0,0)	335	1.000	1.000	1.000	1.000
(2,1,0,0,0,0,0)	86	1.042	1.120	.997**	1.023
(2,0,1,0,0,0,0)	85	1.167	1.335	1.004	1.027
(2,0,0,1,0,0,0)	34	1.446	1.732	1.030	1.078
(2,0,0,0,1,0,0)	36	1.472	1.732	1.030	1.078
(2,0,0,0,0,1,0)	62	1.539	1.798	1.030	1.026
(2,0,0,0,0,0,1)	30	1.524	1.798	1.039	1.075

*$(d^a, md_1^c, fd_1^c, md_2^c, fd_2^c, md_3^c, fd_3^c)$: md_1^c = number of male children in the age group (0-5 years), fd_1^c = number of female children in the age group (0-5 years), md_2^c = number of male children in the age group (6-10 years), fd_2^c = number of female children in the age group (6-10 years), md_3^c = number of male children in the age group (11-14 years), fd_3^c = number of female children in the age group (11-14 years).

** Infeasible estimates.

Table 5.7A: **F value for equality of children coefficients for 1 child households by occupational groups and social classes within these groups**

F-value for age-groups	Occupational group AL						Occupational group ASE					
	WL			QL			WL			QL		
	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(d.f)	(1,611)	(1,1144)	(1,1764)	(1,610)	(1,1143)	(1,1763)	(1,233)	(1,1555)	(1,1797)	(1,232)	(1,1554)	(1,1796)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Engel *equivalence scale*												
0-5 years	1.369	.048	.797	1.441	.072	.945	.073	.972	1.645	.200*	.826	1.570
6-10 years	.436	.011	.023	.005	.346	.162	1.104	.173	.779	.076*	.381	.360
11-14 years	.012	.344	.176	.430	.004	.034	.178	.621	.635	1.482	.193	.873
age-group(combined)	.493	.422	.006	.569	.347	.0007	.820	1.181	2.503	1.452	.887	2.144
Rothbarth *equivalence scale*												
	Linear			Quadratic			Linear			Quadratic		
0-5 years	.025	.261*	.048	.080	.094	.014	.301	.355	.234	1.324*	.048	.120
6-10 years	.679	2.295	3.116	.453	2.534	3.086	.076	4.210	4.345*	.594*	1.683	1.777
11-14 years	1.555*	.578*	.018*	1.662*	.991*	.077*	5.904*	4.712	1.863	5.284*	6.172	3.002
age-group(combined)	.807	.674	1.146	.502	.336	.535	.720	6.177	4.611	.017	3.741	3.174

The critical value of $F_{(1,>120)}$ at 5 percent level of significance is 3.84

* We ignore these F-values as these correspond to the infeasible values in table 5.6A.

Table 5.7B: F value for equality of children coefficients for 1 child households for the overall sample

Equivalence scales	F value for age groups			
	0-5 years	6-10 years	11-14 years	all three groups
(1)	(2)	(3)	(4)	(5)
WL form				
Engel	4.524	.021	.101	.590
(d.f)	(1,4647)	(1,4647)	(1,4647)	(1,4651)
Rothbarth	.209	1.800	.176	1.013
(d.f)	(1,4647)	(1,4647)	(1,4647)	(1,4651)
QL form				
	F value for age groups			
Engel	4.149	.037	.003	.583
(d.f)	(1,4646)	(1,4646)	(1,4646)	(1,4650)
Rothbarth	.015	.999	1.365	1.117
(d.f)	(1,4646)	(1,4646)	(1,4646)	(1,4650)

The critical value of $F_{(1,>120)}$ at 5 percent level of significance is 3.84.

Chapter 6

Rank Test of the Demand System

6.1 Introduction

The single equation models discussed so far lack a utility theoretic background. The direct and indirect effect of prices (through the change in the demographic composition of a household) are also overlooked in this framework. The systems approach, which we turn to in the following two chapters, overcomes these shortcomings and enables one to model the effect of prices as well as the interaction between prices and household composition.

In the chapter 4 we have examined the possible forms of the engel curves for some selected items for rural households of Maharashtra. To formulate a demand system using this information we first need to estimate the rank of the demand system that is coherent with the data. Rank of any demand system is the maximum dimension of the function space spanned by the engel curves of the demand system. The rank test is a prespecification test, providing information about the degree of separability, aggregate structure and cost function structure. This chapter is devoted to the rank test.

Very little empirical work on rank test exists. Hausman, Newey and Powell (1988) estimated rank within the context of polynomial engel curves. Härdle and Jerison (1986) obtained Kernel estimate of engel curves and derived rank implication of their results. We, in this chapter, apply a nonparametric procedure proposed and used in Lewbel (1991) and Gill and Lewbel (1992) for estimating the rank of a demand system .

As demographic and socioeconomic factors are important determinants of the household demand pattern, we first apply rank test to a cross-sectional data (i.e., without considering price variation) separately for households of different demographic compositions within individual occupational and social groups. However, as rank of the demand system is defined to be equal to the supremum of the set consisting of the spaces spanned by the engel curves for given prices [Lewbel(1991)], we bring in price variation as well and estimate the rank for different price situations.

The layout of this chapter is as follows; section 6.2 describes the test procedure, section 6.3 presents the data (specific to this chapter) and results, and finally, section 6.4 draws the conclusions.

6.2 The Rank test

We briefly describe below the rank test of Gill and Lewbel (1992)[1] applied here. Let the budget share equations be

$$w_h = Z.Q(X_h) + \epsilon_h, \; h = 1, 2, ..., H \tag{6.1}$$

where $X_h = \ln y_h$, ϵ_h is a n-vector of mean zero errors that are assumed to be independent of X_h and $\epsilon' l = 0$ where l is the n-vector of ones (in view of $w' l = 1$).

To determine r, the rank of the demand system (i.e, rank of Z), the equation is postmultiplied by $\Lambda(X_h)'$, where $\Lambda(X)$ is the vector of n functions having finite mean. Taking expectation across households yields

$$\mathrm{E}\ (w_h \Lambda(X_h)') = Z.\mathrm{E}\ (Q(X_h)\Lambda(X_h)') + \mathrm{E}\ (\epsilon_h \Lambda(X_h)') \tag{6.2}$$

Since ϵ is independent of X,

$$\Theta = \mathrm{E}\ (w_h \Lambda(X_h)') = Z\mathrm{E}\ (Q(X_h).\Lambda(X_h)')$$

so $rank(\Theta) = r$, *unless some component of* Q *is orthogonal to all elements of* Λ *or* the price regime has locally rank less than r.

Letting $\hat{\Theta} = \sum_h [w_h \Lambda(X_h)']/H$, the rank is estimated using the Lower-Diagonal-Upper-Triangular (LDU) decomposition of $\hat{\Theta}$, given by

$$\hat{P}\hat{\Theta}\hat{M} = \hat{L}\hat{D}\hat{U}$$

where $\hat{P}$ and $\hat{M}$ are permutation matrices, $\hat{L}$ and $\hat{U}'$ are lower triangular matrices and $\hat{D}$ is diagonal matrix.

[1]In a recent paper Cragg and Donald (1995) have modified the test. However, due to non-availability of this paper we have not been able to incorporate the modification.

$$\hat{L} = \begin{bmatrix} \hat{L}_{11(r\times r)} & 0_{(r\times(n-r))} \\ \hat{L}_{21((n-r)\times r)} & \hat{L}_{22((n-r)\times(n-r))} \end{bmatrix}$$

$$\hat{U} = \begin{bmatrix} \hat{U}_{11(r\times r)} & \hat{U}_{12(r\times(n-r))} \\ 0_{((n-r)\times r)} & \hat{U}_{22((n-r)\times(n-r))} \end{bmatrix}$$

and

$$\hat{D} = \begin{bmatrix} \hat{D}_{1(r\times r)} & 0_{(r\times(n-r))} \\ 0_{((n-r)\times r)} & \hat{D}_{2((n-r)\times(n-r))} \end{bmatrix}$$

with elements of $\hat{D}$ decreasing in magnitude along the diagonal. Let $\hat{d}_2 = Diag(\hat{D}_2)$ and $\Gamma_{((n-r)^2\times(n-r))}$ be such that $vec(\hat{D}_2) = \Gamma\hat{d}_2$.

Define

$$\hat{O} = \begin{bmatrix} -\hat{L_{22}}^{-1}\hat{L_{21}}\hat{L_{11}}^{-1} & : & \hat{L_{22}} \end{bmatrix}$$

$$\hat{K} = \begin{bmatrix} -\hat{U_{11}}^{-1}\hat{U_{12}}\hat{U_{22}}^{-1} \\ \hat{U_{22}}^{-1} \end{bmatrix}$$

and

$$\hat{W} = \Gamma'(\hat{K}' \otimes \hat{O})(\hat{M}' \otimes \hat{P})\hat{V}(\hat{M} \otimes \hat{P}')(\hat{K} \otimes \hat{O}')\Gamma$$

where $\hat{V}$ is the variance-covariance matrix of $\hat{\Theta}$.

Under the null hypothesis $H_0 : rank(\Theta) = r$, so $d_2 = 0$

$$H\hat{d_2}'\hat{W}^{-1}\hat{d}_2 \sim \chi^2_{n-r}.$$

Since $d_2 = 0$ is equivalent to $rank(\Theta) \leq r$, the test is consistent against the alternative that $rank(\Theta) > r$.

6.3 Data and results

6.3.1 Data

The basic data remain the same as described before. The occupational and social classification and demographic groupings within these classes have also been discussed earlier. Demographic groupings within these classes are not considered in case of varying price situations due to insufficient sample sizes.

We introduce price variability into the system by considering *unit values* over the regions. In other words, spatial variations of *unit values* are considered. The *unit value* or *nominal price* for each individual commodity is derived by dividing the expenditure by the quantity. The practice of taking *unit value* as an indicator of market price in a cross-section study started with the classic study by Prais and Houthakker (1955) where they thoroughly analysed the behaviour of the *unit values*. There have been a series of papers by Timmer and Alderman (1979), Pitt (1983), all of which have regressed quantities on *unit values*. Deaton (1987,1988,1989c,1990) estimated price elasticities of demand from spatial price variation as recorded through *unit values* in household survey data. Crawford, Laisney and Preston (1996) used *unit values* in demand system estimation by specifying engel curve forms with a model of quality choice which is consistent with the demand theory and the quantity-quality relationship. Case(1991) chose to treat *unit values* as error-ridden measurement of prices rather than to model them as the outcome of quality choice.

It may, however,be mentioned that there are a number of complicating factors when *unit values* are used as indicators of the market prices. First, consumers choose the quality of their purchase and *unit values* reflect this choice. Moreover, quality choice may itself be affected by *unit values*. Thus, *unit values* reflect quality as well as genuine price variation. Therefore the regression of quantity on *unit values* is a regression of one choice variable on another and so the problem of identification, simultaneity bias will arise. Besides this change in price will change the composition of household's purchase. So the substitution between individual commodities within the group will generate a less than proportionate increase in *unit values*. Second, measured *unit values* are also contaminated by errors of measurement in expenditures and in quantities and are likely to be spuriously negatively correlated with measured quantities [Deaton (1988)].

In this chapter we adopt the procedure described in Yen and Roe (1989) for computing the price indices for the commodity groups from the *unit values*. The procedure is described briefly below. All individual *unit values* are deflated by their corresponding sample means to account for different measuring units. Then the price index for each commodity group is taken to be the weighted sum of all deflated component *unit values* in the group, weights being the expenditure shares. The assumption we make are (1) the intra-regional price variation is negligible compared to the interregional price variation for the six NSS regions[2] and (2) the regional average of these indices represent the price for the commodity group in that region. We may note here that these price indices serve only as a proxy as the procedure of computation is rather crude.

[2]The regions have been described in chapter 2.

6.3.2 Results

The rank test was applied to all demographic groups within the occupational as well as social classes. The underlying assumption here is that the distribution of preferences is independent of the distribution of income, which may be considered to be valid for homogeneous demographic groups [Lewbel (1991)]. The "instrument" list Λ, in our case, consists of 1, $y, \ln y, (\ln y)^2, \frac{1}{y}$. Following Lewbel (1991), each element of Λ was divided by its mean in each sample, to ensure that Θ is not ill-conditioned as a result of the enormous range of magnitudes in the functions comprising Λ. Table 6.1 summarises the results of the rank test without price variation for three possible ranks, viz., 1, 2 and 3. In all cases the magnitudes of the χ^2-statistics drops dramatically from $r = 1$ to $r = 2$ indicating that the rank is 2.

The implication of the above result is that given a price regime for each demographic group within the occupational and social classes, the budget share curve can be specified by an extended Working Leser form in view of a better performance of the QL model compared to the WL model as described in Chapter 4. In particular, if the above result holds for multiple price regimes, one could specify a quadratic, yet rank 2 integrable demand system with the budget share curves of the form

$$w_{ih} = \alpha_i + \beta_i(\ln y_h + \rho(\ln y_h)^2) \tag{6.3}$$

where i stands for commodity, h for observation, and ρ is a constant. This formulation basically assumes that one column (that corresponds to $(\ln y)^2$ of the coefficient matrix, denoted as Z in section (6.2)) is a constant multiple of another column, corresponding to $\ln y$.

Table 6.2A summarises the results of the rank test for different price situations under different occupational and social classifications and table 6.2B gives the results for the overall sample. In few cases, e.g., in regions 1,3 and 4 for AL, in region 1 for ASE and in regions 1,4 and 6 for SC-ST the magnitudes of the χ^2-statistic are non significant for r=1. In all other cases the rank test indicates a rank of 2.

It may be mentioned here that the results obtained are in sharp contrast with those for developed countries like the U.S., U.K. and Australia, which are found to have rank three demands [Banks, Blundell and Lewbel (1997), Lewbel(1991), Ray (1996), Lancaster and Ray(1996)]. The nonlinearity, in these cases are observed for non-basic goods in the higher income range. Our results corroborate the findings of Ray (1996) on Indian data and of Burgess and Ping Ping (1995) on Chinese rural data[3]. In our case, the possible explanations for the rank two results could be that (i)

[3]There is less curvature in the Chinese budget share-expenditure relationship because living stan-

the budget shares on non basic goods are rather low and their variation is small, (ii) the range of income (total expenditure) is too small to capture the nonlinearity and (iii) household composition, a major determinant of household behaviour, omission of which may cause nonlinearity, is taken into account by running nonparametric regression and *rank* test separately for different demographic groups.

6.4 Conclusion

In this chapter we have applied the LDU rank test of Gill and Lewbel(1992) to estimate the rank of the demand system admissible by our data. Application of the test to homogeneous demographic and occupational groups indicate a rank of 2 for the demand system consisting of the commodities under consideration at a given price regime. Introduction of price variation through regionwise decomposition of the occupation/social groups yields the same results for the rank test except in few cases. For the overall sample the 'rank two demands' result is retained in all price situations.

It may be mentioned here that a stronger rank test can be constructed by estimating systems of demand equations of the forms we have explored and then perform likelihood-ratio tests. We leave this exercise to be included as a part of chapter 7.

dards in China are relatively evenly distributed on a narrow support.

Table 6.1: LDU rank test chi-squared statistics by demographic groups.

Demographic group	Rank= r					
	1(4)*	2(3)	3(2)	1(4)	2(3)	3(2)
	Agriculture Labourer(AL)			Agricultural Self Employed(ASE)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
A	18.370	0.020	0.001	10.666	0.734	0.032
B	0.506	0.096	0.002	42.540	2.340	0.001
C	4.257	0.071	0.011	35.960	0.050	0.001
D	19.092	0.233	0.022	23.480	0.010	0.001
E	10.140	0.101	0.001	11.890	0.100	0.001
	Scheduled Caste and Scheduled Tribe(SC-ST)			Others(OTHER)		
A	11.428	0.144	0.017	100.210	0.530	0.010
B	20.010	2.170	0.001	43.960	4.430	0.010
C	5.030	0.050	0.001	50.820	0.340	0.001
D	24.490	0.010	0.001	70.040	0.280	0.001
E	19.970	0.030	0.010	29.400	0.740	0.001

*Figures in parentheses denote the respective degrees of freedom(d.f).

The critical values at 5 percent level of significance are as follows:

χ^2 with 4 d.f: 9.488.

χ^2 with 3 d.f: 7.815.

χ^2 with 2 d.f: 5.991.

Table 6.2A: LDU rank test chi-squared statistics by regions.

Different regions	Rank= r					
	1(4)*	2(3)	3(2)	1(4)	2(3)	3(2)
	Agricultural Labourer(AL)			Agricultural Self Employed(ASE)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Region 1	6.28	0.20	0.02	4.30	0.62	0.01
Region 2	42.14	0.03	0.00	18.49	0.06	0.00
Region 3	8.69	0.47	0.01	13.87	0.02	0.00
Region 4	6.08	1.01	0.00	15.02	0.40	0.01
Region 5	10.18	0.06	0.01	27.30	0.57	0.01
Region 6	11.54	0.03	0.01	15.97	0.01	0.00
	Schedule Caste and Schedule Tribe(SC-ST)			Others(OTHER)		
Region 1	2.49	0.57	0.05	22.21	0.06	0.01
Region 2	32.86	0.22	0.01	35.95	2.17	0.00
Region 3	15.16	0.52	0.01	19.22	0.14	0.00
Region 4	7.11	0.33	0.10	68.72	2.98	0.01
Region 5	15.12	0.38	0.01	48.94	1.31	0.01
Region 6	8.22	0.74	0.02	20.04	0.04	0.03

Table 6.2B: LDU rank test chi-squared statistics for overall sample

Different regions	rank=r		
	1(4)*	2(3)	3(2)
(1)	(2)	(3)	(4)
Region 1	17766920.80	0.01	0.00
Region 2	2995280.06	0.11	0.00
Region 3	653503.51	0.81	0.00
Region 4	51719713.30	1.03	0.00
Region 5	290106741.00	0.11	0.00
Region 6	567285477.00	0.29	0.00

*Figures in parentheses denote the respective degrees of freedom(d.f).

The critical values at 5 percent level of significance are as follows:

χ^2 with 4 d.f : 9.488.

χ^2 with 3 d.f : 7.815.

χ^2 with 2 d.f : 5.991.

Chapter 7

Relative Cost of Children: The Systems Approach

7.1 Introduction

This chapter is concerned with measurement of *cost of a child* using demand systems proposed herein. The analysis in chapter 4 reveals that in almost all cases a quadratic relation between the budget share and the logarithm of total expenditure ($\ln y$) explains the true relationship better than the linear one. This indicates that in specifying a demand system the WL type engel equations need to be supplemented by a quadratic term in $\ln y$, giving rise to a quadratic PIGLOG type system. On the other hand, results of the rank test described in chapter 6 points to a rank-two demand system. In view of this, in this chapter we propose and estimate a rank-two Quadratic Logarithmic (QL) demand model. We also propose and estimate a PIGLOG (rank two) system and a rank three QL system and compare the log-likelihood values for a stronger rank test. Household demographic characteristics are incorporated into these systems and the *relative cost of children* is measured using the iso-prop method (which applies Engel's method to any subset of necessary commodities) taking the share of *adult good* (found to be a necessary item in chapter 4) as an indicator of welfare[1]. These costs are compared with those found from the single equation approach.

The plan of this chapter is as follows: section 7.2 describes the theoretical background of the proposed models, section 7.3 specifies the models, section 7.4 presents the results, and finally, section 7.5 draws the conclusions.

[1]See Blackorby and Donaldson (1994).

7.2 Theoretical Background of the Model

Banks, Blundell and Lewbel (1997) considered engel curves of the form

$$w_i = A_i(p) + B_i(p)\ln\frac{y}{a(p)} + E_i(p)(\ln(\frac{y}{a(p)}))^2 \qquad (7.1)$$

where $a(p)$ is a price deflator and $A_i(p), B_i(p), E_i(p)$ are any differentiable functions. They showed that *all integrable demand systems of the form (7.1) either have*

$$E_i(p) = \rho(p)B_i(p) \qquad (7.2)$$

for some function $\rho(p)$ (so the rank is less than three), or they are rank three quadratic logarithmic budget share systems having indirect utility functions of the form

$$\ln u = [\{\frac{(\ln y - \ln a(p))}{b(p)}\}^{-1} - \lambda(p)]^{-1} \qquad (7.3)$$

where the term $(\frac{(\ln y - \ln a(p))}{b(p)})$ is the indirect utility function of a PIGLOG demand system, and the extra term λ is a differentiable, homogeneous of degree zero function of prices.

The general form of the budget share equations consistent with our empirical findings can be represented by

$$w_i = A_i(p) + B_i(p)\ln y : \quad WL \qquad (7.4)$$

$$w_i = A_i(p) + B_i(p)\ln y + E_i(p)(\ln y)^2 : \quad QL - rank\ two. \qquad (7.5)$$

When $E_i(p)$ is of the form (7.2), with ρ independent of prices. For comparison we also look at the budget share equation of the form

$$w_i = A_i(p) + B_i(p)\ln y + E_i(p)(\ln y)^2 : \quad QL - rank\ three. \qquad (7.6)$$

Note that these forms are variants of (7.1) and thus can be derived from the general form (7.3).

We now turn to the issue of measurement of *child cost*. Blackorby and Donaldson (1994) provided closed form characterization of the utility function in terms of the expenditure/cost function for both the iso-prop and the Rothbarth method. They introduced the following two general classes of *cost of children* indices. The first class, - *relative cost of children* index, regards the cost as equal in percentage terms for all households, while the second class, *absolute cost of children* index, regards the cost as equal in absolute terms. They also showed that although the iso-prop method is related to the relative index and the Rothbarth method to the absolute index, neither method corresponds exactly to its counterpart. In what follows, we briefly discuss their characterization.

Suppose the preference of a household is represented by a utility function $u = u(q_g, q_{g^*}, d)$ where q_g is a vector of *adult goods* (or alternatively, necessities), q_{g^*} is a vector of all other goods, $d = (d^a, d^c)$ is the vector of demographic characteristics with d^c: vector describing the characteristics of children and d^a: vector of all other types of household characteristics.

Let $C(u, p_g, p_{g^*}, d)$ be the expenditure function that gives the minimum expenditure necessary to attain utility level u at prices $p = (p_g, p_{g^*})$ for a household with demographic characteristics d. Let d^{aR} be the demographic characteristic vector for the reference household which has no children. The *relative cost of children* index is given by the ratio

$$\frac{C(u^R, p_g^R, p_{g^*}^R, d^{aR}, d^c)}{C(u^R, p_g^R, p_{g^*}^R, d^{aR})} \tag{7.7}$$

for a children composition vector d^c, holding the reference utility level and price level constant. Similarly, the *absolute cost of children* index is given by

$$C(u^R, p_g^R, p_{g^*}^R, d^{aR}, d^c) - C(u^R, p_g^R, p_{g^*}^R, d^{aR}). \tag{7.8}$$

However, these measures are dependent on the utility level, which is unobservable. In order that these measures be *exact* (that is, independent of the utility level), the expenditure functions corresponding to these two indices must be of the form

$$C(u, p_g, p_{g^*}, d) = C(u, p_g, p_{g^*}, d^{aR}) Re(p_g, p_{g^*}, d^{aR}, d^c) \tag{7.9}$$

for the *relative cost*, $C(u, p_g, p_{g^*}, d^{aR})$ being the expenditure function for the childless reference household, by construction, $Re(.)$ is homogeneous of degree zero in all prices (p_g, p_{g^*})) and,

$$C(u, p_g, p_{g^*}, d) = C(u, p_g, p_{g^*}, d^{aR}) + Ab(p_g, p_{g^*}, d^{aR}, d^c) \tag{7.10}$$

for the *absolute cost*, where $Ab(.)$ is homogeneous of degree 1 in p_g and p_{g^*}[2]. The *relative cost* of children is given by $Re(p_g, p_{g^*}, d^{aR}, d^c)$ and the *absolute cost* by $Ab(p_g, p_{g^*}, d^{aR}, d^c)$.

The iso-prop method of measuring *child cost* is related to the relative index. It looks at the expenditure share on some subset of commodities (often chosen to be necessities such as *food*) and regards different types of households to be at the same utility level whenever the shares are equal. The Rothbarth measure, on the other

[2] The *exactness* discussed above is termed *Independence of Base*(IB) by Lewbel (1989c).

hand, is in levels rather than in shares and it is related to the absolute measure. Here households with the same outlay on some subset of commodities (*adult goods*) are considered to have the same welfare level. Thus the iso-prop method requires that

$$\frac{\sum_{i\in q_g} p_i q_i(u, p_g, p_{g^*}, d^a, d^c)}{C(u, p_g, p_{g^*}, d^a, d^c)} = \frac{\sum_{i\in q_g} p_i q_i(u, p_g, p_{g^*}, d^{aR})}{C(u, p_g, p_{g^*}, d^{aR})} \tag{7.11}$$

where g represents a group of necessary items, and the Rothbarth method requires that

$$\sum_{i\in q_g} p_i q_i(u, p_g, p_{g^*}, d^a, d^c) = \sum_{i\in q_g} p_i q_i(u, p_g, p_{g^*}, d^{aR}) \tag{7.12}$$

where g represents a group of *adult good* items. Blackorby and Donaldson (1994a) showed that for (7.11) to hold the expenditure function must be of the form

$$C(u, p_g, p_{g^*}, d) = D(u, p_g, p_{g^*}, d^a)F(u, p_g, p_{g^*}, d^a, d^c) \tag{7.13}$$

where F is homogeneous of degree of zero in p_g, and for (7.12) to hold the expenditure function must be of the form

$$C(u, p_g, p_{g^*}, d) = D(u, p_g, p_{g^*}, d^a) + F(u, p_g, p_{g^*}, d^a, d^c). \tag{7.14}$$

In this chapter we concentrate on the *relative cost of children* index. It may be mentioned that, when there is only one item in group g (one *adult good* in our case), the form corresponding to (7.13) will be [Browning(1988,1992)]

$$C(u, p_g, p_{g^*}, d) = D(u, p_g, p_{g^*}, d^a)F(u, p_{g^*}, d^a, d^c). \tag{7.15}$$

Thus if $F()$ in (7.13) is independent of u and $Re()$ in (7.9) is homogeneous of degree zero in p_g, then the *relative cost of children* index can be estimated using iso-prop method. However, as $Re()$ is homogeneous of degree zero in (p_g, p_{g^*}), this implies that $Re()$ is homogeneous of degree zero in p_{g^*} also. Therefore, the final form of the expenditure function is given by

$$C(u, p_g, p_{g^*}, d) = C(u, p_g, p_{g^*}, d^{aR})Re(p_g, p_{g^*}, d^{aR}, d^c) \tag{7.16}$$

where $Re()$ is homogeneous of degree zero in p_{g^*} and p_g. For the one *adult good* case the final form will be

$$C(u, p_g, p_{g^*}, d) = C(u, p_g, p_{g^*}, d^{aR})Re(p_{g^*}, d^{aR}, d^c) \tag{7.17}$$

where $Re()$ must be homogeneous of degree zero in p_{g^*}.

From the above discussion it is now evident that one can combine (7.3) and (7.17) to formulate demand systems incorporating demographic variables whereby the *relative cost of children* will be independent of the utility level and the cost may be estimated using iso-prop method. The next section is devoted to formulation of such systems. At this point, we must also recognize that the PIGLOG functional form cannot be used to calculate the *relative cost of children* from the system. This is because given exactness of the *relative cost of children* index, the index is not recoverable from data under PIGLOG preferences [Blackorby and Donaldson (1994)][3]. It may be noted that even though the *exactness* or IB assumption is a strong restriction, one requires such an assumption for complete identification of the scales. In the framework, we are considering here, the restriction of *exactness* is imposed rather than being testable. However, as pointed out in Blundell and Lewbel (1991) and Blackorby and Donaldson (1993,1994), the test is conclusive only in the case of rejection[4].

7.3 Proposed Models

Keeping in mind the engel curve forms (7.4)-(7.6) and equation (7.17), we propose the following forms for $a(p), b(p)$ *and* $\lambda(p)$ in (7.3)

$$a(p) = a_1(p)a_2(p) \tag{7.18}$$

with

$$a_1(p) = e^{\frac{\alpha_0}{2}} \prod_{i \in g^*} (p_i)^{\delta_i}, \quad \sum_{i \in g^*} \delta_i = 0,$$

and

$$a_2(p) = e^{\frac{\alpha_a}{2}} \prod_{i \in g \cup g^*} (p_i)^{\xi_i}, \quad \sum_{i \in g \cup g^*} \xi_i = 1, \; 0 < \xi_i < 1,$$

$$\alpha_a = 1 + \sum_{oc=1}^{7} \nu_{0oc}(d^a{}_{15+} - 2)Du_{oc},$$

[3]The corresponding condition relating to the *absolute cost of children* index is that preferences cannot be quasi-homothetic.

[4]Murthi(1994) tested the restriction implied by exactness in the context of different parametric forms of engel curves on Sri Lankan data and in most of the cases exactness was not rejected. Pashardes (1995), on the other hand, found rejection of the hypothesis on U.K data for the models he proposed. Gozalo (1997) and Pendakur (1994) propose different nonparametric tests of the IB restriction on engel curves. Gozalo statistically rejects IB while Pendakur does not reject. Blundell and Lewbel (1991) statistically reject IB, but also find that imposing the restriction has almost no effect on the estimated scales.

and

$$\frac{\alpha_0}{2} = \frac{\alpha_a}{2} + \sum_{oc=1}^{7} \nu_{1oc}(d^c_{0-5})Du_{oc} + \sum_{oc=1}^{7} \nu_{2oc}(d^c_{6-10})Du_{oc} + \sum_{oc=1}^{7} \nu_{3oc}(d^c_{11-14})Du_{oc},$$

$$b(p) \;=\; \prod_{i \in g \cup g^*} (p_i)^{\beta_i}, \quad \sum_{i \in g \cup g^*} \beta_i = 0, \tag{7.19}$$

and

$$\lambda(p) = \begin{cases} 0 & \text{for PIGLOG} \\ \rho b(p) & \text{for QL(rank two)} \\ \rho b(p) + \sum \lambda_i \ln p_i, \ \ with \sum \lambda_i = 0 & \text{for QL(rank three)}^4. \end{cases} \tag{7.20}$$

It may be noted that QL(rank three) nests both QL(rank two) and PIGLOG. QL(rank two) is obtained when $\lambda_i = 0$ for all i, and PIGLOG is obtained when $\rho = 0$ and $\lambda_i = 0$ for all i. Here $({d^a}_{15+} - 2)$ denotes the number of adults (normalized), as a childless 2-adults household is considered as reference[6]. There are three different children age groups and d^c's denotes the number of members in different children age groups. Du_{oc} denotes a dummy variable which equals one when a household belongs to the particular occupation/ social group (oc). The parameter α_a relates to adult characteristics and takes the value 1 for the reference household, ν's relate to children characteristics that give the marginal effect of children on the consumption pattern and α_0 is a linear function of adult and children characteristics. It may be observed that the formulation does not allow interaction between children characteristics and item specific effects.

The corresponding budget share equations are given by

$$w_i = \begin{cases} \Lambda_i + \beta_i \ln(\frac{y}{a(p)}) & \text{for PIGLOG} \\ \Lambda_i + \beta_i \ln \frac{y}{a(p)} + \rho\beta_i(\ln(\frac{y}{a(p)}))^2 & \text{for QL(rank two)} \\ \Lambda_i + \beta_i \ln \frac{y}{a(p)} + (\rho\beta_i + \frac{\lambda_i}{b(p)})(\ln(\frac{y}{a(p)}))^2 & \text{for QL(rank three),} \end{cases} \tag{7.21}$$

where

$$\Lambda_i = \begin{cases} \xi_i & \text{for } \textit{adult good} \\ \delta_i + \xi_i & \text{for other commodities.} \end{cases}$$

[5]Similar formulations of $\lambda(p)$ has been proposed by Pashardes(1995) in the Almost Ideal Demand System framework.

[6]This has been explained in chapter 5.

We have seen earlier that the *relative cost of children* can be measured using the iso-prop method and is independent of the utility level if and only if the expenditure function is of the form (7.17). Comparing the above system with (7.17) one can establish that

$$C(u, p_g, p_{g^*}, d^{aR}) = a_2(p) \times (e^{\frac{b(p)}{\lambda(p)+\frac{1}{\ln u}}}) \tag{7.22}$$

and

$$Re(p_{g^*}, d^{aR}, d^c) = a_1^*(p), \tag{7.23}$$

with α_a equal to 1 (as d^{aR} denotes reference household). Therefore, the *exact relative cost of children* is given by

$$a_1(p) = e^{\frac{\alpha_0}{2}} \prod_{i \in g^*} (p_i)^{\delta_i}.$$ [6]

Note that

$$\ln a(p) = \frac{\alpha_0}{2} + \sum_{i \in g^*} \delta_i \ln p_i + \frac{\alpha_a}{2} + \sum_{i \in g \cup g^*} \xi_i \ln p_i. \tag{7.24}$$

In the absence of price variations the R.H.S. of (7.24) equals

$$1 + \sum_{oc=1}^{7} \nu_{0oc}(d^a{}_{15+} - 2) Du_{oc} + \sum_{oc=1}^{7} \nu_{1oc}(d^c_{0-5}) Du_{oc} + \sum_{oc=1}^{7} \nu_{2oc}(d^c_{6-10}) Du_{oc} + \sum_{oc=1}^{7} \nu_{3oc}(d^c_{11-14}) Du_{oc}$$

which can be interpreted as the logarithm of household general equivalence scale.

7.4 Results

The basic data have already been described in the earlier chapters. All three demand systems are estimated by nonlinear maximum likelihood method. We may recall that the five commodities considered here are *cereals, other food, adult good, clothing* and *fuel and light.* Note that as pointed out by Muellbauer(1974) *equivalence scales* cannot be identified when demand systems are estimated on cross-section data assuming prices to be constant. As is often done, price variation is introduced as identifying information. Here price variation is brought in by considering regional variation in *unit values*[8],[9]. However, it may be pointed out that

[7] It may be noted from forms (7.17) and (7.3) that the children effect has to be formulated through $a(p)$ only.

[8] A detailed description of the price data has been given in chapter 6.

[9] It may, however, be noted that even this may not yield well-determined scales if a rank two demand system is used [Ray(1983b), Muellbauer and Pashardes(1982), Pashardes(1995)]. This could be due to the limited covariance between price and demographic characteristics in survey data [Dickens, Fry and Pashardes (1993)].

this is not the only identifying information on cross-section data. First, we can use nutritionist's information on food requirements to fix the food scales and estimate the system conditional upon this identifying restriction. Another procedure is to use Henderson (1949, 1950) and Nicholsons' (1949) technique of using Rothbarth (1943) scale where child scales are zero for some goods that can be attributed to adults only (such as *tobacco, drink* and *adult cloth*). The third alternative as suggested by Kakwani (1977) is to consider income of the households together with the expenditure. In fact, in order to identify the expenditure on children Kakwani introduced *savings* together with the assumption that demographic effects on this item are absent. An alternative possibility of identification of scales has been suggested by Muellbauer (1980) where he assumed that if demand for a good first increases with total expenditure and then reaches a saturation level at a level of total expenditure covered by the sample without becoming inferior thereafter, then the scale for that good is identified at the saturation level and can be used as identifying information for calculating the scale at a lower level of expenditure.

Table 7.1 presents the log-likelihood values for the three models with the budget share forms described in equation (7.21). The log-likelihood values suggest that QL(rank two) is significantly better than the PIGLOG model. However, a comparison between the log-likelihood values of QL(rank two) and QL(rank three) shows that QL(rank three) model fails to be a significant improvement over the QL(rank two) model. In view of this, we present here our results relating to the QL(rank two) model only.

Table 7.2 presents the parameter estimates of the QL(rank two) model. The parameters δ_i's, ξ_i's, β_i's and ρ turn out to be significant and the β_i's have the expected signs. However, not all coefficients of the dummy variables are significant. It may be observed that the coefficients increase with the increase in the age of children for all occupation and social classes, a pattern that seems quite plausible. In the single equation approach the effect of children on individual items could be examined separately. Here, as a consequence of the formulation, when children characteristics are independent of the item subscript, the dummies fail to capture the effect of children on the consumption pattern of individual items.

Table 7.3 presents the estimates of expenditure elasticities (calculated at sample averages) for the two social classes SC-ST and OTHER within the two major occupation classes, viz., AL and ASE. The commodity type (i.e., whether it is a necessary/luxury item) is consistent with our earlier findings. The occupational and social classes do not seem to have too much of an effect on the value of expenditure elasticity.

Table 7.4 presents the estimates of the *cost of a child* for the above occupational/ social classes. The cost is sensitive to the occupational and social classes the households belong to as observed earlier in case of the single equation approach. For comparison the corresponding Engel scale values (obtained from table 5.2A in chapter 5) are also presented in the same table. The costs estimated from the system are much larger in magnitude compared to the Engel scales except for the occupation group AL in the age group 6-10 years. Given the fact that Engel scales are overestimates of the true cost (Deaton and Muellbauer (1986), Lancaster and Ray(1996)), our estimates seem too large. In view of our earlier findings in chapter 4 the reason for such results could be given as follows : an additional child acts like a decrease in the budget. Now, for the necessary commodity in question (*adult good* in our case) the reduction in expenditure on the commodity due to the addition of a child to the household offsets the reduction in the budget in such a manner that the net effect comes to a decrease in the *budget share*. In such a case the system will produce large estimates of the cost because the household is being compensated while it does not need to be. Thus it seems that while measuring the *cost of children* using the iso-prop method rather than considering just the fact that item is a *necessary* item, the overall effect of an additional child on the *budget share* of the item should be examined carefully.

7.5 Conclusion

This chapter measures the *cost of a child* through the systems approach and compares the results with those obtained from the single equation approach. Taking the share of *adult good* as an indicator of welfare, the *cost of a child* is obtained using a Quadratic Logarithmic (rank two) system, proposed herein. The estimated costs are much higher than the Engel scales obtained using a single equation framework.

Some limitations of this study may be pointed out here. First, the models, by construction, are rather restrictive, as the *exactness* property, which could be a testable one, is built into the model. Second, due to limitation of our price data the models have been proposed so as to have limited interaction between prices and demographic characteristics. Finally, the issue of gender bias has been omitted in view of an already large number of parameters in the system proposed.

Table 7.1: Log-likelihood values for PIGLOG, QL(rank two) and QL(rank three) demand systems

Serial number	System	Number of parameters	Log-lihood values (L_i)
(1)	(2)	(3)	(4)
1	PIGLOG	39	30064.74
2	QL(rank two)	40	30076.40
3	QL(rank three)	44	30079.92

$-2(L_1 - L_2) = 23.32$ (Critical value of $\chi^2_{(1)}$ at 5% level of significance is 3.84).
$-2(L_2 - L_3) = 7.04$ (Critical value of $\chi^2_{(4)}$ at 5% level of significance is 9.49).

Table 7.2: Estimates of Parameters of QL(rank two) demand system

Parameter	value	Parameter	value	parameter	value
δ_{cereal}	.254 (28.40)	$\delta_{clothing}$	-.293 (279.71)	$\beta_{otherfood}$	.075 (174.68)
ξ_{cereal}	.255 (28.50)	$\xi_{clothing}$	.314 (150.85)	$\beta_{adultgood}$	-.003 (14.71)
$\delta_{otherfood}$	.003 (10.05)	$\delta_{fuelandlight}$	.036 (4.73)	$\beta_{clothing}$	-.012 (11.02)
$\xi_{otherfood}$	.116 (23.60)	$\xi_{fuelandlight}$	.146 (26.44)	$\beta_{fuelandlight}$	-.012 (7.03)
$\xi_{adultgood}$	.169 (23.84)	β_{cereal}	-.048 (121.92)	ρ	-.010 (2.44)

Household characteristics parameters

Occupational/ social categories	Age group (years)							
	15+*		0-5		6-10		11-14	
	parameter	value	parameter	value	parameter	value	parameter	value
NASE	ν_{01}	.040 (.44)	ν_{11}	.045 (1.60)	ν_{21}	.132 (.60)	ν_{31}	.110 (.85)
AL	ν_{02}	.119 (.40)	ν_{12}	.117 (1.20)	ν_{22}	.137 (1.20)	ν_{32}	.151 (1.00)
OL .	ν_{03}	.151 (.95)	ν_{13}	.116 (1.60)	ν_{23}	.171 (1.05)	ν_{33}	.162 (1.50)
ASE	ν_{04}	.038 (1.75)	ν_{14}	.058 (1.20)	ν_{24}	.056 (.95)	ν_{34}	.144 (1.00)
OH	ν_{05}	.102 (1.00)	ν_{15}	.041 (2.25)	ν_{25}	.051 (1.00)	ν_{35}	.119 (1.25)
SC-ST	ν_{06}	.209 (1.30)	ν_{16}	.137 (.13)	ν_{26}	.257 (.95)	ν_{36}	.351 (1.00)
OTHER	ν_{07}	.149 (1.20)	ν_{17}	.128 (.85)	ν_{27}	.195 (1.02)	ν_{37}	.249 (.90)

*Noramlised adults (described in chapter 5)

Figures in parentheses are the absolute t-values.

Table 7.3: Expenditure elasticity for the QL(rank two) demand system by occupational groups and social classes within these occupational groups

Commodity	Expenditure elasticity*			
	Occupation group AL		Occupation group ASE	
	SC-ST	OTHER	SC-ST	OTHER
(1)	(2)	(3)	(4)	(5)
Cereals	.861	.850	.853	.839
Other food	1.232	1.211	1.211	1.173
Adult good	.979	.979	.978	.978
Clothing	.203	.150	.287	.282
Fuel and light	.896	.885	.879	.873

* Expenditure elasticity for QL(rank two) demand system $= 1 + \frac{\beta_i}{w_i}(1 + 2\rho \ln(\frac{y}{a(p)}))$.

Table 7.4: *Relative cost of children* of the 1 child household for three children categories by occupational groups and social classes within these occupational groups

Household composition	Occupation group AL		Occupation group ASE	
$(d^a, d^c{}_{0-5}, d^c{}_{6-10}, d^c{}_{11-14})$*	SC-ST	OTHER	SC-ST	OTHER
(1)	(2)	(3)	(4)	(5)
(2,0,0,0)	1.000	1.000	1.000	1.000
(2,1,0,0)	2.236	2.216	2.108	2.089
	(1.531)	(1.353)	(1.078)	(1.238)
(2,0,1,0)	2.572	2.417	2.372	2.229
	(2.380)	(2.612)	(1.550)	(1.443)
(2,0,0,1)	2.865	2.589	2.817	2.570
	(2.399)	(2.271)	(1.906)	(1.526)

Figures in parentheses are the corresponding Engel scales from the QL model in single equation approach.

$^*(d^a, d^c{}_{0-5}, d^c{}_{6-10}, d^c{}_{11-14})$: d^a = Number of adults, $d^c{}_{0-5}$ = number of children in the age-group(0-5 years), $d^c{}_{6-10}$ = number of children in the age-group (6-10 years) and $d^c{}_{11-14}$ = number of children in the age-group (11-14 years).

Chapter 8

Summary and Conclusion

In this dissertation we have attempted to measure the *cost of children*, which plays a crucial role in matters relating to welfare and public policy like child benefits and compensation policies of the government. The cost is measured based on the single equation as well as the systems approach using the 38th round National Sample Survey (NSS) data on household consumer expenditure for rural Maharashtra (relating to the period of January to December, 1983).

The first chapter provides a brief account of the basic literature on empirical demand analysis which is relevant for welfare comparison between households. To be specific in this chapter we discuss parametric and nonparametric engel curves, the systems approach to Demand Analysis, incorporation of demographic variables into demand systems and finally different approaches to measurement of *cost of children*.

Chapter 2 describes the sample design and survey coverage of the NSS data and presents the definitions and concepts adopted in the 38th NSS enquiry. Regional information on the state of Maharashtra is also provided in this chapter.

Chapter 3 attempts to identify *adult goods* for the given consumer expenditure data using the concept of *outlay equivalent ratio* of Deaton, Castillo and Thomas (1989). Here we suggest a modification of their procedure. Based on the commonly used Working-Leser form of engel curves and using the modified procedure, we identify six items, viz., *tea-coffee, pan, tobacco, intoxicants, adult cloth* and *adult personal care* as *adult goods.* It is also found that a combination of all these goods as well as the one excluding *adult personal care* can be treated as a composite *adult good.* In the subsequent chapters we treat the latter combination as a single commodity and call it *adult good.*

To determine the shapes of the engel curves for some selected items, viz., *cere-*

als, other food, clothing, fuel and light and *adult good* in chapter 4 we use the nonparametric Kernel regression method which allows consistent estimation of a regression model without specifying its functional form in advance. To place emphasis on the sensitivity of the shape of the engel curves to household characteristics, we divide the overall sample into homogeneous subsamples in terms of demographic compositions, occupational groups and social classes. We compare the empirical performance of the nonparametric curve with those of the Working-Leser(WL) and the Quadratic Logarithmic(QL) forms. The performances of the QL and WL forms turn out to be very close to the nonparametric one. However, a closer look suggests that the QL form gives a statistically better fit than the WL form. From this analysis it turns out that *cereals, fuel and light* and *adult good* are necessary items. It is also observed that given total consumer expenditure, as the number of children increases, the budget share for *cereals* increases and that for *adult good* decreases.

Chapter 5 measures the *relative cost of children* using the single-equation approach by applying Engel and Rothbarth methods. For the Engel measure the WL and QL forms of budget share curves and for the Rothbarth measure log linear and log quadratic forms of expenditure curves are used. The alternative children categories considered here are (i)a single children category of the age group of 0-14 years and (ii) three separate children categories of the age groups 0-5 years, 6-10 years and 11-14 years, respectively. *Cost of children* are estimated separately for households classified by occupation and social categories in order to eliminate the effects of factors such as source of income, tradition or class habits in determining these costs. It is observed that the *relative cost of a child* is sensitive to the estimation method and also to the occupational categories and social classes of the households considered. Consistent with earlier findings, the Engel scales turn out to be much larger in magnitude than the Rothbarth scales. The issue of gender-bias is also addressed through introduction of male-female distinction among children. No bias against female children is observed. In fact, for some age groups bias towards female children is observed.

Chapter 6 estimates the rank of the demand system that is coherent with our data, the commodities being the ones mentioned in chapter 5. The rank of a demand system is the maximum dimension of the function space spanned by the engel curves of the demand system. To determine the rank, we use a nonparametric procedure proposed and used in Lewbel (1991) and Gill and Lewbel (1992). Application of the test to data relating to homogeneous demographic and occupational groups indicate a rank of two for the demand system at a given price regime. Introduction of price variation through regionwise decomposition of the data yields the same result for all price situations except in few cases.

Chapter 7 is concerned with measurement of *relative cost of children* using the systems approach. Blackorby and Donaldson (1994a) provided a closed form characterization of the cost function for (i) the *relative cost of children* index to be *exact*, i.e., independent of the utility level, and (ii) the iso-prop method, which applies Engel's method to any subset of commodities (often chosen to be necessities), to be *exact* (this *exactness* means equality of the budget share on these commodities for the comparison and reference household). In this chapter we propose and estimate (using the price data constructed in chapter 6) a rank-two Quadratic Logarithmic (QL) demand system (based on the results obtained in chapters 4 and 6) incorporating household demographic compositions and occupational and social characteristics. The underlying cost function of this demand system satisfies both types of *exactness*. In a similar manner, we also propose and estimate a PIGLOG (rank two) and a QL(rank three) demand system, which nests the PIGLOG and QL (rank two) models. However, in view of the superiority of the performance of the QL (rank two) system in terms of likelihood ratio test, we consider only the QL (rank two) system for the subsequent analysis.

We estimate the *relative cost of a child* taking the budget share of *adult good* (which has been found to be a necessary item in chapter 4) as an indicator of household welfare. As found earlier, the cost is sensitive to the household characteristics like its occupation, cast and religion. A comparison with the single equation approach shows that the estimates from the system are larger than the Engel scales obtained in chapter 4. We have mentioned earlier that these scales are *conditional* scales, the underlying assumptions being that there is no utility derived from children and the number of children is predetermined. Given the fact that welfare comparison requires *unconditional* scales and that there exist models and empirical studies in the literature, where the number of children is treated as endogeneous and it is recognised that children also yield a stream of utilities, we need to put our results in proper perspective. To do this, we first look at the relevant literature.

There are two basic approaches to modeling the fertility behaviour of a household. One is in the framework of household demand model which originated with the work of Becker (1960), Willis (1973) and the other is the synthesis model developed by Easterline (1978), Easterline, Pollak and Watcher (1980) [Birdsall (1988)]. In the household demand model parents are assumed to maximize the utility function, which includes not only consumption bundles but also the number of children and the quality (i.e., educational and health status of children) as arguments. Utility is maximized subject to a production function for children, a function of money income and parental time allocated between market and nonmarket production and also a couple-specific trait, called 'fecundity' [Rosenzweig and Schultz(1983, 1985, 1987)]. The full-income budget constraint is defined in terms of non-labour income and total value of parents' time. In the full-income budget constraint shadow prices are used which reflect the opportunity cost of the market goods and household members' time, used as inputs to produce a unit of household commodity. In this demand theoretic model of fertility behaviour cost of children has two parts - one is the direct cost of bringing up the children(as they need to be fed, clothed, kept in good health, looked after and schooled) and the other part is the opportunity cost of children which is measured by the amount of income foregone in the process of bringing up of a child [Ray (1998)]. Here children are assumed to be a source of satisfaction for parents and they also consume resources which have alternative uses. In addition, parents control the number of children they should have [Schultz, T.P (1997)]. The synthesis model combines the economists' demand-oriented analysis with demographers' modeling of the supply of children, thus synthesizing economic and demographic approaches. It also incorporates some aspects of sociologists' emphasis on the endogeneity of tastes, that is incorporating the fact that one family's fertility behaviour is influenced by the fertility behaviour and average consumption of other families [Birdsall (1988)]. Empirical application of these two types of fertility choice models include the works of Rosenzweig and Evension (1977), Rosenzweig and Schultz (1982), Schultz (1976, 1985, 1993), Mincer (1974), Behrman, Pollak and Taubman (1982), Behrman (1988), Behrman and Wolfe (1984), Wolfe and Behrman (1986) etc.

The above approach to explaining household fertility behaviour through utility maximization is, however, more appropriate for developed countries. In advanced countries a family's decision to have children is more likely to be a rational one in the sense that there will be no more children in a family than the parents can economically care for on standards which the family views as appropriate. So the birth-control techniques have been developed very rapidly in such efficiency that in the great majority of families, the number of children does not exceed the number desired. But in developing and underdeveloped countries deliberate control of birth of a child is not as evident [Barnett (1998)]. Some reasons, especially in the context of India, can be put forward: First, the lack of literacy, education, economic development and ready availability of safe and efficient contraceptive devices pose problems. Second, due to agrarian structure of the economy, extended or joint-family is more prevalent in rural India. Here family structure is very important in creating externalities that lead to high fertility. Thus, parents' decision is not the sole determinant of the number of children in a household[see Ray (1998)]. Third, in a low income country it is not possible to have a planned family size due to uncertainty and lack of information with regard to the chance of survival of a new born baby. It may also be mentioned at this point that family size intentions are likely to have a bearing on the level of consumption of highly durable goods like housing [McClements (1977)] rather than on the types of commodities we have considerd here.

One could, in principle, estimate the *unconditional* model and test the validity of the assumption of exogeneity of children. For this, ideally one would require panel data [Birdsall (1988)]. This is because fertility decisions are not made all at once but are sequential (thus, number of children is much less endogeneous in the short-run than are the purchases of goods). Moreover, the variables of interest include shadow prices of time of household members who are not employed in the market, child quality and fecundity, price of child quality (i.e., price of schooling, health care etc.), price of child quantity (i.e., access to and cost of contraceptives methods), price of parental time (i.e., expected wage rate for men and women) and data on fertility or biological status of women. Such detailed information is not, however, available from the NSS consumption and demographic data we have.

Given that we have to satisfy ourselves with the *Conditional* scales, we try to see virtue in conventional calculation of the *conditional equivalence scale* estimated on the assumption of exogeneity of household composition. Deaton and Muellbauer (1980), Binh and Whiteford (1990) and Pashardes (1991), among others, argue that the cost function *conditional* upon household composition has the clear interpretation of being the cost of reaching a given level of utility associated with the consumption of marketed goods, given household composition. As the number of dependents increases, given the prevailing household ethics and household technology for their maintenance, the cost of reaching a given utility level must increase. As a measure of the cost of children, the *conditional* cost function is a particularly attractive tool for analyzing the full decision problem of adults in deciding on the number of children. Deaton and Muellbauer (1980) illustrate this in a simple planning model. What emerges from their analysis is that lower the level of *conditional* utility, which measures the real value of consumption for a given household composition, smaller should be the gain in welfare from an increase in the number of children, and below some critical level of *conditional* utility, it is optimal not to have children. So the poorest adults would plan to have no children unless children actually contributed to market income. However, given the irreversibility of children, adults may have children as a result of mishaps in contraception or overoptimistic forecasts of income potentials. Their argument suggests that the conventional *equivalence scale* underestimates the compensation required to make a poor couple with children to be as well off as one without children. Above the critical level, the conventional cost measure overestimates the cost and around the critical level there will be little or no bias. So, as long as the increase in welfare from having a child does not offset the increase in cost, our estimates will go through, though it might overestimate the true cost. Given the estimated *conditional* cost function, we could, in principle, estimate the indifference curves from planned fertility behavior and combine the two to give full cost comparisons. However, apart from various other problems, there are likely to be substantial variations in the preferences of adult couples that makes welfare comparisons difficult. If we argue that the object of the exercise is to find a summary statistic of the relative budget constraints faced by different households rather than 'welfare comparison' as such, then we can overcome the difficulty by choosing some set of references at which to make the comparison. The estimated *conditional* cost function is a vital information for such an exercise.

The *conditional equivalence scale* measures can be used in income maintenance policies. If the minimum standard of living of the adults, which it is the purpose of the policy to support, is in the region of critical level of *conditional* utility, then there will be little bias even if the relevant welfare function is the *unconditional* one, i.e., the one which includes children as endogeneous argument. Also, as children do not participate in the family planning decision, what is relevant for them is the *conditional* concept of welfare function since that effectively determines how much consumption of goods they can engage in. If, therefore, the only way of distributing income to children is through the adults and the aim of the income maintenance policy is to ensure that no child falls below a certain minimum, the relative benefits paid to couples with various number of children is given by the *equivalence scales* defined by the *conditional* cost function. The *conditional* cost function can also be useful in intertemporal planning problem. For the one-period notion of the *conditional* cost function to be applicable in an intertemporal framework, we have to assume weak intertemporal separability of the welfare planning function in market goods, given household composition [Deaton and Muellbauer (1980)].

The other contexts where these *equivalence scale* measures can be used are: evaluating welfare policies such as compensation and allowance policies regarding the change in income tax structure and interpersonal comparison of welfare needed to measure poverty and inequality. Given that there is a system of allowance for children in the income tax law or a family allowance provision in assessing taxable income of family, our cost measures serve as a guideline for fixing up the amount of allowances. Consideration of differences in needs due to varying family sizes, which has been taken into account through these measures of *scales*, is an important factor to affect relative tax liabilities in order to maintain horizontal equity. One of the very few studies that have used these *scale* measures for the assessment of income tax exemption is by Senecca and Taussing (1971) where they attempt to investigate the query of horizontal equity in personal income taxation taking into consideration the size of tax-paying units, i.e., number of individuals sharing a given total money income. Similarly, in deciding social security payments to poorer households, our cost measures, which reflect the differential requirement of households categorized by occupational and social status, will serve as a basis for fixing up the amount of security payment. Our estimates of *food* Engel *equivalence scales* (derived in chapter 5) are also useful in deciding household quota for goods distributed under the scheme of rationing through public distribution. Also, while measuring inequality of income distribution in a society if we take the distribution of nominal income only, this will serve as a proxy for the distribution of welfare across household. Unless household composition is taken into account, it makes little sense to compare the money incomes of different households. The distribution of scaled income can actually be appropriately used to measure inequality in the distribution of welfare itself [Lewbel(1989c)]. So, in this social objective of measuring normative inequality based on welfare comparison our estimates will be useful in calculating an appropriate index.

We have pointed out several shortcomings of the present exercise in the respective chapters. We conclude by making some general comments and mentioning some issues that we have not been able to incorporate in this study. First, chapter 1 touches upon only the portions relevant for this study of the vast literature on Applied Demand Analysis. Second, the empirical analysis does not take into account the fact that the data used here are survey data. In other words, the issues relating to the survey design, sampling scheme and measurement error have not been incorporated in the estimation procedure. Third, data limitation forced us to confine our attention to the state of Maharashtra for a single survey period.

The present study may be extended in various directions. Some of these include the following :-

i. estimation of the system using repeated cross-section data which is a more appropriate one than what we have done here,

ii. introduction of male-female distinction among children to examine the issue of gender bias in the context of a complete system,

iii. allowing more interaction between price and demographic characteristics,

iv. choosing an alternative appropriate *necessary* item for the iso-prop method to measure *child cost* , and,

v. using the estimates of *equivalence scale* or *cost of children* in the context of policy formulation.

We leave these extensions of this study as a future research agenda.

References

1. Allen, R.G.D. and Bowley, A.:"Family Expenditure"; London: P.S. King and Son, 1935.

2. Banks, J., Blundell, R. and Lewbel, A.: Tax Reform and Welfare Measurement: Do We Need Demand System Estimation"; The Economic Journal, 1996, Vol-106, 1227-1241.

3. Banks, J., Blundell, R. and Lewbel, A.: "Quadratic Engel Curves, Indirect Tax Reform And Welfare Measurement"; Review of Economics and Statistics, 1997, Vol-XXIX, No.4, 527-539.

4. Bardhan, P. : "Little Girls and Death in India"; Economic and Political Weekly, 1982, Vol-17, 1448-50.

5. Bardhan, P. : " Sex-Disparity in Child Survival in Rural India", in P.Bardhan and T.N.Srinivasan (eds.) 'Rural Poverty in South Asia', New york, Columbia University Press, 1988.

6. Barnett, H.J. : "Population Problems: Myths and Realities"; in Demeny, P. and McNicall, G. (eds.) 'The Earthscan Reader in Population and Development', 1998, Earthscan Publication Ltd., 244-256.

7. Barten, A.P. : "Family Composition, Prices and Expenditure Patterns"; In P.E.Hart, G.Mills and J.K.Whitaker eds 'Econometric Analysis for National Economic Planning', Butterworths, London, 1964.

8. Barten, A.P. : "Evidence on the Slutsky Conditions for Demand Equations"; Review of Economics and Statistics, 1967, Vol-49, 77-84.

9. Barten, A.P. : "The Systems of Consumer Demand Function Approach : A Review"; Econometrica, 1979, Vol-45, 23-51.

10. Basu, A.M. : "Is Discrimination in Food Really Necessary for Explaining Sex Differentials in Childhood Mortality?"; Population Studies, 1989, Vol-43, 193-210.

11. Basu, A.M. : "How Pervasive are Sex-Differentials in Childhood Nutritional Levels in South Asia?"; Social Biology, 1993, Vol-4, 25-39.

12. Becker, G.S.: "An Economic Analysis of Fertility"; in Universities- National Bureau Committee for Economic Research ed. 'Demographic and Economic Change in Developed countries', Princeton University Press, Princeton, 1960.

13. Behrman, Jere R. : "Intrahousehold Allocation of Nutrient in Rural India: Are Boys Favored? Do Parents Exhibit Inequality Aversion?"; Oxford Economic Papers, 1988, Vol-40, 32-54.

14. Behrman, Jere R., Pollak, R. and Taubman, Paul. : "Parental Preferences and Provision for Progeny"; Journal of Political Economy, 1982, Vol-84, S143-S162.

15. Behrman, Jere R., Pollak, R. and Taubman, Paul. : "Do Parents Favor Boys?"; International Economic Review, 1986, Vol-27, 31-52.

16. Behrmen, Jere R. and Wolfe, B.L.: " A More General Approach to Fertility Determination in a Developing Country: The Importance of Biological Supply Considerations, Endogeneous Tastes and Unperceived Jointness"; Economica, 1984, Vol-51, 319-339.

17. Bhattacharya, K.: "Employment Fluctuation in Rural India : A Statistical Analysis with Special Reference to Maharashtra"; Ph.D. Dissertation, Indian Statistical Institute, Calcutta, 1995.

18. Bierens, H.: "Uniform Consistency of Kernel Estimates of a Regression Function Under Generalised Conditions"; Journal of the American Statistical Association, 1983, Vol-77, 699-707.

19. Bierens, H.: "Kernel Estimators of Regression Function"; in Truman F. Bewley (eds.) Advances in Econometrics, New York, Cambridge University Press, 1987.

20. Bierens, H., Pott-Buter, H.: "Specification Of Household Engel Function by Non-Parametric Regression" ; Econometric Reviews, 1990, vol-9, 123-210.

21. Binh, T.N. and Whiteford, P. : "Household Equivalence Scales : New Australian Estimates from the 1984 Household Expenditure Survey"; The Economic Record, 1990, September, 221-234.

22. Birdsall, N. : "Economic Approaches to Population Growth"; in Hollis Chenery and Srinivasan, T.N. (eds.) 'Handbook of Development Economics', Amsterdam: North Holland, 1988, 477-542.

23. Blackorby, C. and Donaldson, D.: "Adult Equivalence Scales and The Economic implementation of Interpersonal Comparison of Well-Being"; Social Choice and Welfare, 1993, Vol-10, No-4, 335-361.

24. Blackorby, C. and Donaldson, D.:"Measuring The Cost of Children: A Theoretical Framework"; In Blundell.R, Preston.I and Walker.I eds 'The Measurement of Household Welfare', CUP, Cambridge, 1994.

25. Blackorby, C., Primont, D. and Russel, R.R.: "Duality, Separability and Functional Structure : Theory and Economic Applications"; Amsterdam, North-Holland, 1978.

26. Blundell, R.W.: "Consumer Behaviour : Theory and Empirical Evidence"; Economic Journal, 1988, Vol-98, 16-65.

27. Blundell, R. W. and Lewbel, A.: "The Information Content of Equivalence Scales"; Journal of Econometrics, 1991, Vol-50, 49-68.

28. Blundell, R. W., Pashardes, P. and Weber, G.: "What Do We Learn About Consumer Demand Patterns from Micro Data?"; American Economic Review, 1993, Vol-83, 570-597.

29. Bosch-Domenech, A. : "Economies of Scale, Location, Age and Sex-Discrimination in Household Demand"; European Economic Review, 1991, Vol-35, 1589-1595.

30. Bourguignon, F. and Pierre-Andre Chiappori. : "Collective Models of Household Behavior : An Introduction"; European Economic Review, 1992, Vol-36, 355-64.

31. Brown, J.A.C. and Deaton, A.S. : "Models of Consumer Behaviour : A Survey"; Economic Journal, 1972, Vol-82, 1145-1236.

32. Browning, M. : "The Exact Preference Associated with the Engel and Rothbarth Methods"; Dept. of Economics, McMaster University. 1988.

33. Browning, M. : "Children and Household Economic Bahaviour"; Journal of Economic Literature, 1992, Vol-30, 1434-1475.

34. Buhmann, B., Rainwater L., Schmaus, G. and Smeeding, T.M. : "Equivalence Scale, Well-Being, Inequality and Poverty : Sensitivity Estimate Across Ten Countries Using the Luxembourg Income Study Database", Review of Income and Wealth, 1988, Vol-3, 115-42.

35. Burgess, R. and Ping Ping, W. : "Chinese Rural Household Expenditure Analysis"; L.S.E-STICERD Discussion Paper, 1995, No-EF. 13.

36. Byron, R.P. : "Methods for Estimating Demand Equation Using Prior Information : A Series of Experiments with Australian Data"; Australian Economic Papers, 1968, Vol-7, 227-48.

37. Byron, R.P. : A Simple Method for Estimating Demand System Under Separable Utility Assumption"; Review of Economic Studies, 1970a, Vol-37, 261-74.

38. Byron, R.P. : "The Restricted Aitken Estimation of Sets of Demand Relations"; Econometrica, 1970b, Vol-38, 816-30.

39. Caldwell, P. and Caldwell, J.C. : "Where There is a Narrower Gap Between Female and Male Situations"; mimeo, 1987, Australian National University.

40. Case, A. : "Spatial Patterns in Household Demands"; Econometrica, 1991, Vol-59, 953-65.

41. Chakrabarty, M.: "Adult Good Identification and Demographic Separability-The Case of Rural Maharashtra"; Sarvekshana, 1995, Vol-XIX, No-2, October-December.

42. Chen, L.C., Huq, E. and D'Souza, S. : " Sex Bias in the Family Allocation of Food and Health Care in Bangladesh"; Population and Development Review, 1981, Vol-7, 55-70.

43. Christensen, L.R., Jorgenson, D.W. and Lau, L.J. : "Transcendental Logarithmic Utility Functions"; American Economic Review, 1975, Vol-65, 267-83.

44. Coale, A. : "Excess Female Mortality and The Balance of The Sexes: An Estimate of The Number of Missing Female"; Population and Development Review, 1991, Vol-17, 517-23.

45. Coondoo, D. and Majumder, A.: "A System of Demand Equations Based on Price Independent Generalised Linearity"; International Economic Review, 1987, Vol-28, 213-28.

46. Cragg, J.G. and Donald, S.G. : "Inferring the Rank of a Matrix", mimeo, University of British Columbia, 1995.

47. Cramer, J.S.: "Empirical Econometrics"; Amsterdam, North-Holland, 1969.

48. Crawford, I., Laisney, F. and Preston, I.: "Estimation of Household Demand Systems Using Unit Value Data"; Working Paper Series, No. W96/16, The Institute for Fiscal Studies, London, 1996.

49. Dasgupta, M.: "Selective Discrimination Against Female Children in Rural Punjub, India"; Population and Development Review, 1987, Vol-13, 77-100.

50. Deaton, A.S.: "Optimal Taxes and the Structure of Preferences"; Econometrica, 1981, Vol-49, 1245-60.

51. Deaton. A.S.: "Demand Analysis"; Handbook of Econometrics, 1986 Vol-111, Edited by Z. Griliches and Intrilligator, M.D.

52. Deaton, A.S.: "Estimation of Own and Cross Price Elasticities from Household Survey Data"; Journal of Econometrics, 1987, Vol-36, 7-30.

53. Deaton, A.S.: "Quality, Quantity, and Spatial Variation of Price"; American Economic Review, 1988, Vol-78, 418-430.

54. Deaton, A.S. : "Looking For Boy-Girl Discrimination in Household Expenditure Data"; The World Bank Economic Review, 1989a, Vol-3, 1-15.

55. Deaton, A.S.: "Rice Prices And Income Distribution In Thailand: A Non-Parametric Analysis" ; Economic Journal, 1989b, vol-99, 1-37.

56. Deaton, A.,S.: "Household Survey Data and Pricing Policy in Developing Countries"; The World Bank Economic Review, 1989c, Vol-3, 183-210.

57. Deaton, A.S.: "Price Elasticities from Survey Data- Extensions and Indonesian Results"; Journal of Econometrics, 1990, Vol-44, 281-309.

58. Deaton.A.S.: "Data and Econometric Tools for Development Analysis"; in Jere Behrman and T.N.Srinivasan (eds) Handbook of Development Economics, Amsterdam, Elsevier, 1995, Vol-3a, 1785-882.

59. Deaton, A.S.: "The Analysis of Household Surveys: A Microeconometric Approach to Development Policy"; John Hopkins University Press, Baltimore and London, 1997.

60. Deaton, A.S., Castillo, J.R. and Thomas, D.:"The Influence of Household Consumption On Household Expenditure Patterns: Theory and Spanish Evidence"; Journal of political Economy, 1989, Vol-97, 179-200.

61. Deaton, A.S. and Muellbauer, J.:"Economics and Consumer Behaviour"; New York, Cambridge University Press, 1980a.

62. Deaton, A.S. and Muellbauer, J. : "An Almost Ideal Demand System"; American Economic Review, 1980b, Vol-70, 312-326.

63. Deaton, A.S. and Muellbauer, J.: "On Measuring Child Cost: With Application To Poor Countries"; Journal of Political Economy, 1986, Vol-94, 720-44.

64. Dev, S.M.: "Poverty Alleviation Programs : A Case Study of Maharashtra with Emphasis on Employment Guarantee Scheme"; Discussion Paper 77, Indira Gandhi Institute of Development Research, 1992.

65. Dickens, R., Fry, V. and Pashardes, P.: "Non-Linearities and Equivalence Scales", Economic Journal, 1993, Vol-103, 359-68.

66. Diewert, W.E. : "An Application of the Shephard Duality Theorem : A Generalized Leontief Production Function"; Journal of Political Economy, 1971, Vol-79, 481-507.

67. Diewert, W.E. and Parkar, C. : " Tests for Consistency of Consumer Data and Nonparametric Index Numbers"; UBC : Working Papers 78- 27, mimeo, 1978.

68. Dreze, J. and Sen, A.K. : " Indian Economic Development and Social Opportunity"; 1995, Clarendon Press, Oxford.

69. Dutta, B., Panda, M. and Wadhwa, W. : "Human Development in India"; mimeo, Indian Statistical Institute, Delhi, 1995.

70. Dutta, B. and Panda, M.: "Gender Bias in India"; mimeo, Indian Statistical Institute, Delhi, 1997.

71. Easterline, R.A. : "The economics and Sociology of Fertility: A Synthesis"; in Tilley, C. ed. 'Historical Studies of Changing Fertility', Princeton University Press, Princeton, 1978.

72. Easterline, R.A., Pollak, R.A. and Watcher, M.C. : "Toward a More General Economic Model of Fertility Determination: Endogeneous Preferences and Natural Fertility"; in Easterline, R.A. ed 'Population and Economic Change in Developing Countries', University of Chicago Press, Chicago, 1980.

73. Engel, E.: "Die Produktion und Konsumptionsverhaltnisse des Konigreichs Sachsen"; International Statistical Institute Bulletin, 1857, Vol-9, 1-125.

74. Engel, E: "Die Lebenskosten Belgischer Arbeiter-Familien Fruher and Jetzt"; International Statistical Institute Bulletin, 1895, Vol-9, 1-74.

75. Fisher, F.M.: "Household Equivalence Scales and Interpersonal Comparisons", Review of Economic Studies, 1987, Vol-54, 519-24.

76. Forsyth, F.G.: "The Relationship Between Family Size and Family Expenditure"; Journal of Royal Statistical The Royal Statistical Society, 1960, Series A, Vol-123, 367-97.

77. Friend, I. and Jones, R. (eds.):"Proceedings of the Conference on Income, Consumption and Savings", Vol-I, University of pennsylvania Press, 1960.

78. Fry, V. and Pashardes, P.: "An Almost Ideal Quadratic Logarithmic Demand System for the Analysis of Micro Data, City University Discussion Paper, No 25, 1992.

79. Gill, L. and Lewbel, A.: "Testing the Rank and Definiteness of Estimated Matrices With Applications to Factor, State-Space and ARMA Models"; Journal of the American Statistical Association, 1992, Vol-87, 766-776.

80. Gorman, W.M. : "Community Preference Fields", Econometrica, 1953, Vol-21, 63-80.

81. Gorman, W.M. : "Separable Utility and Aggregation", Econometrica, 1959, Vol-27, 469-81.

82. Gorman, W.M. : "On a Class of Preference Fields", Metroeconomica, 1961, Vol-13, 53-56.

83. Gorman, W.M. : "The Structure of Utility Functions", Review of Economic Studies, 1968, Vol-5, 369-90.

84. Gorman, W.M. : "Tricks With Utility Functions"; In Artis, M.J. and Nobay, A.R. eds 'Essays in Economic Analysis', CUP, Cambridge, 1976.

85. Gorman, W.M.: "Some Engel Curves" ; in Essays in the Theory and Measurement of Consumer Behaviour in Honour of Sir Richard Stone, Ed. by Angus Deaton, Cambridge University Press, Cambridge, 1981.

86. Government of India. : "Child Mortality Estimates in India"; Census of India 1981, Occasional Paper, 1988, No-5, Demography Division, Office of Registrar General, New Delhi.

87. Gozalo, P.L. : "Nonparametric Bootstrap Analysis with Application to Demographic Effects in Demand Functions"; Brown University Working paper, 1997, Journal of Econometrics, forthcoming.

88. Haddad, L. and Hoddinott, J.: "Gender Aspects of Household Expenditures and Resource Allocation in the Cote D'Ivoire"; Applied Economic Discussion Paper, 1991, Series-112, University of Oxford.

89. Härdle, W.: "Applied Nonparametric Regression" ; Cambridge University Press, Cambridge, England, 1990.

90. Härdle, W. and Jerison, M.: "The Evolution of Engel Curves Over Time"; Discussion Paper, No.A-178, SFB 303, University of Bonn, 1988.

91. Harris, B.: "The Intrahousehold Distribution of Hunger" In J. Dreze and A.K. Sen eds. 'The Political Economy of Hunger', Oxford, Clarendon Press, 1990.

92. Hausman, J.A., Newey, W.K. and Powell, J.L : "Nonlinear Errors in Variables: Estimation of Some Engel Curves"; Jacob Marschak Lecture of the Econometric Society, Australian Economics Congress, 1988.

93. Henderson, A.M.:"The Cost of Children"; Population Studies, Parts I-III, 1949-50a, vol-3, 130-50, vol-4, 267-98.

94. Henderson, A.M.: "The Cost Of A Family" Review of Economic Studies, 1949-50b, vol-17, 127-48.

95. Houthakker, H.S. : "Additive Preferences"; Econometrica, 1960, Vol-28, 224-56.

96. Howe, H., Pollak, R.A. and Wales, T.J. : "Theory and Time Series Estimation of the QE System", Econometrica, 1979, Vol-47, 1231-47.

97. Jorgenson, D.W. , Lau. L.J. and T. Stoker. : "The Transcendental Logarithmic Model of Aggregate Consumer Behaviour"; in R. Basmann and G. Rhodes (eds.) Advances in Econometrics, 1982, Vol-1.

98. Jorgenson, D.W., and Slesnick, D.T. : "Aggregate Consumer Behaviour and Household Equivalence Scales"; Journal of Business and Economic Statistics, 1987, Vol-5, 219-32.

99. kakwani, N. : " On the Estimation of Consumer Unit Scales"; Review of Economics and Statistics, 1977, Vol-59, 507-510.

100. Kynch, J. and Sen, A.K.: "Indian Women: Well-being and Survival"; Cambridge Journal of Economics, 1983, Vol-7, 363-80.

101. Lancaster, G. and Ray, R.: "Comparison Of Alternative Methods Of Estimating Household Equivalence Scales: The Australian Evidence On Pooled Time Series Of Unit Record Data"; forthcoming in The Economic Record, 1996.

102. Lau, L.J. : "Budgeting and Decentralization of Allocation Divisions"; Memorandum No. 89, Center for Research in Economic Growth, Stanford University, 1969.

103. Lau, L.J. : "Existence Conditions for Aggregate Demand Functions"; Technical Report 248, Institute for Mathematical Studies in Social Sciences, Stanford University, 1977.

104. Leontief, W.: "Introduction to a Theory of the Internal Structure of Functional Relationships"; Econometrica, 1947, Vol-15, 361-73.

105. Leser, C.E.V.: "Forms of Engel Functions"; Econometrica, 1963, Vol-31, 694-703.

106. Lewbel, A.: "A Unified Approach to Incorporating Demographic or Other Effects into Demand Systems"; Review of Economic Studies, 1985, Vol-52, 1-18.

107. Lewbel, A.: "A Nonlinear Representative Consumer"; Brandeis University, Working Paper, No 131, 1986.

108. Lewbel, A.: "Fractional Demand Systems"; Journal of Econometrics, 1987a, Vol-36, 311-337.

109. Lewbel, A.: "Characterizing Some Gorman Engel Curves"; Econometrica, 1987b, Vol-55, 1451-1459.

110. Lewbel, A.: "A Demand System Rank Theorem" ; Econometrica, 1989a, Vol-57, 701-705.

111. Lewbel, A.: "Exact Aggregation and a Representative Consumer"; Quarterly Journal of Economics, 1989b, Vol-104, 622-633.

112. Lewbel, A.: "Household Equivalence Scales and Welfare Comparisons"; Journal of Public Economics, 1989c, Vol-39, 377-391.

113. Lewbel, A.: "Full Rank Demand Systems"; International Economic Review, 1990, Vol-31, 289-300.

114. Lewbel, A.: "The Rank of Demand Systems: Theory And Nonparametric Estimation" ; Econometrica, 1991, Vol-59, 711-730.

115. Loftsgaader, D.Q. and Quesenberry, G.P. : "A Nonparametric Estimate of a Multivariate Density Function"; Annals of Mathematical Statistics, 1965, Vol-36, 1049-51.

116. Majumder, A.: "Measuring Income Responses : A Log-Quadratic Demand Model For Consumers in India"; Empirical Economics, 1992, Vol-17, 315-21.

117. Majumder, A. and Chakrabarty, M.: "A Nonparametric Exploratory Analysis of the Form of Engel Curves And Rank of Demand System -The Case of Rural Maharashtra"; forthcoming, 1998, Sankhyā, Series B.

118. McClements, L. : "Equivalence Scales For Children"; Journal of Public Economic Economies, 1977, Vol-8, 191-210.

119. McMillan, J., Ullah, A. and Vinod, HD.: "Estimation of the Shape of the Demand Curve by Nonparametric Kernel Method"; In Raj, B.(ed.) 'Advances in Econometrics and Modelling, Kluwer Academic Publishers, Dordrecht, Netherlands, 1989, 85-92.

120. Miller, B.D. : "The Endangered Sex : neglect of Female Children in Rural North India"; Ithaca, NY, Cornell University Press, 1981.

121. Mincer, J. : "Schooling, Experience and Earnings"; Columbia University Press, 1974.

122. Muellbauer, J.: "Household Composition, Engel Curves and Welfare Comparisons Between Households: A Duality Approach"; European Economic Review, 1974, Vol-5, 103-22.

123. Muellbauer, J. : "Aggregation, Income Distribution and Consumes Demand"; Review of Economic Studies, 1975, Vol-62, 525-43.

124. Muellbauer, J. : "Community Preference and the Representative Consumer", Econometrica, 1976, Vol-44, 979-99.

125. Muellbauer, J. : "Testing the Barten Model of Household Consumption Effects and the Cost of Children"; Economic Journal, 1977, Vol-87, 460-87.

126. Muellbauer, J.: "The Estimation of the Prais-Houthakker Model of Equivalence Scales"; Econometrica, 1980, Vol-48, 153-76.

127. Muellbauer, J. and Pashardes, P.: "Testing the Barten Equivalence Scale Hypothesis in a Flexible Functional Form Context"; Birkbeck College Discussion Paper 112, London, 1982.

128. Murthi, M.: "Engel Equivalence Scales in Sri Lanka: Exactness, Specification, Measurement Error"; In Blundell.R, Preston.I and Walker.I eds.'The Measurement of Household Welfare', CUP, Cambridge, 1994.

129. Murthy, M.N. and Ray, A.S.: "Development of the Sample Design of the Indian National Sample Survey Design During Its First Twentyfive Rounds"; Sankhya, The Indian Journal of Statistics, 1975, Vol-37, Series C, 1-42.

130. Murty, KN.: "Consumer Behaviour in India"; European Economic Review, 1980, Vol-14, 221-35.

131. Nadaraya, E. A.: "On Estimating Regression" ; Theory Prob Appl 10, 186-90, 1964.

132. Nelson, J.A. : "Household Economies of Scale in Consumption : Theory and Evidence", Econometrica, 1988, Vol-56, 1301-14.

133. Nelson, J.A. : "Methods of Estimating Household Equivalence Scales : An Empirical Investigation"; Review of Income and Wealth, 1992, Vol-38, 295-310.

134. Nelson, J.A.: "Household Equivalence Scales : Theory Versus Policy?"; Journal of Labour Economics, 1993, Vol-11, 471-93.

135. Nicholson, J.L.:"Variations in Working Class Family Expenditure"; Journal of The Royal Statistical Society, 1949, Series-A, 112, 359-411.

136. Nicholson, J.L.: "Appraisal of Different Methods of Estimating Equivalence Scales and Their Results"; The Review of Income and Wealth, 1976, Vol-22, 1-11.

137. Nicol, C.J.: "An Empirical Comparison of Nonparametric and Parametric Engel Functions" ; Empirical Economics, 1993, vol-18, 233-249.

138. Nicol, C. J. : "Identifiability of Household Equivalence Scales Through Exact Aggregation : Some Empirical Results"; Canadian Journal of Economics, 1994, Vol-XXVII, No.2, 307-28.

139. Pashardes, P.: "Contemporaneous and Intertemporal Child Costs: Equivalent Expenditure vs. Equivalent Income Scales"; Journal of Public Economics, 1991, Vol-45, 191-213.

140. Pashardes, P.: "Equivalence Scales in a Rank-3 Demand System"; Journal of Public Economics, 1995, Vol-58, 143-158.

141. Pendaker, K. : "Semiparametric Estimates and Tests of Base-Independent Equivalence Scales"; mimeo, Simon Fraser University.

142. Pitt, M.M.: "Food Preferences and Nutrition in Rural Bangladesh"; Review of Economics and Statistics, 1983, Vol-65, 105-14.

143. Pitt, M., Rosenzweig, M.R. and Hassan, N.: "Productivity, health and Inequality in the Intrahousehold Distribution of Food in Low-Income Countries"; American Economic Review, 1990, Vol-80, 1139-56.

144. Pollak, R.A.: "Conditional Demand Functions and Consumption Theory"; Quarterly Journal of Economics, 1969, Vol-83, 70-78.

145. Pollak, R.A. and Wales, T.J. : "Estimation of Complete Demand Systems from Household Budget Data"; American Economic Review, 1978, Vol-68, 348-59.

146. Pollak, R.A. and Wales, T.J. : "Welfare Comparisons and Equivalence Scales"; American Economic Review, 1979, Vol-69, 216-21.

147. Pollak, R.A. and Wales, T.J.: "Comparison of the Quadratic Expenditure System and Translog Demand Systems with Alternative Specifications of Demographic Effects"; Econometrica, 1980, Vol-48, 595-612.

148. Pollak, R.A. and Wales, T.J. : "Demographic Variables in Demand Analysis"; Econometrica, 1981, Vol-49, No-6, 1533-51.

149. Prais, S.J. and Houthakker, H.S. : "The Analysis of Family Budgets"; Cambridge, Cambridge University Press, 1955.

150. Quibria, M.G.: "Gender and Poverty: Issues and Policies with Special Reference to Asian Developing Countries"; Journal of Economic Surveys, 1995, Vol-9, No.4, 373-411.

151. Radhakrishna, R. and Murthy, K.N. : "Models of Complete Expenditure System for India", Working Paper 80-98, International Institute for Applied Systems Analysis, 1980.

152. Ray, D. : "Development Economics"; Princeton University Press, Princeton, 1998.

153. Ray, R. : "Analysis of Time-Series of Household Expenditure Survey for India"; Review of Economics and Statistics, 1980, Vol-62, 595-602.

154. Ray, R. : "The Testing and Estimation of Complete Demand Systems on Household Budget Surveys : An Application of AIDS"; European Economic Review, 1982, Vol-17, 349-69.

155. Ray, R. : "Measuring The Costs Of Children : An Alternative Approach"; Journal of Public Economics, 1983b, Vol-22, 89-102.

156. Ray, R. : "A Dynamic Analysis of Expenditure Patterns in Rural India. U.K"; Journal of Development Economics, 1989, Vol-19, 283-297.

157. Ray, R.: "Complete Demand Systems and Recent Welfare Application in India: A Review"; Journal of Quantative Economics, 1991, Vol-7, 1-22.

158. Ray, R. : "Modelling the Impact of Children On Household Expenditure Behaviour and Welfare"; Discussion Paper(93-11), Dept. of Economics, University of British Columbia, 1993.

159. Ray, R. : "Demographic Variables in Demand System: The Case for Generality"; Empirical Economics, 1996, Vol-21, 307-15.

160. Ray, R. : "Nesting Flexible Demand Functional Form : Econometric Evidence for India and U.K."; Sankhyā, Series B, 1996, 254-273.

161. Rosenzweig, Mark R. and Evenson, R.E.: " Fertility, Schooling and the Economic Contribution of Children in Rural India"; Econometrica, 1977, Vol-45, 1065-1079.

162. Rosenzweig, Mark R. and Schultz, T. Paul.: "Market Opportunities, Genetic Endowments and Intrafamily Resource Distribution: Child Survival in Rural India"; American Economic review, 1982, Vol-72, 803-15.

163. Rosenzweig, Mark R. and Schultz, T. Paul.: "Consumer Demand and Household Production: The Relationship Between Fertility and Child Mortality"; American Economic review, 1983, Vol-73, 38-42.

164. Rosenzweig, Mark R. and Schultz, T. Paul.: " The Demand and Supply of Births: Fertility and its Life-Cycle Consequences"; American Economic Review, 1985, Vol-75, 992-1015.

165. Rosenzweig, Mark R. and Schultz, T. Paul.: "Fertility and Investments in Human Capital"; Journal of Econometrics, 1987, Vol-36, 163-184.

166. Rothbarth, E.:"Note on a Method of Determining equivalent Income for Families of Different Compositions"; Appendix 4 in War-Time Pattern of Saving and Spending, By Charles Madge, Occasional Paper no 4, Cambridge University Press, 1943.

167. Russel, T. : "On a Theorem of Gorman"; Economic Letters, 1983, Vol-11, 223-24.

168. Samuelson, P.A. : "A Note on the Pure Theory of Consumer Behaviour"; Economica, 1938, Vol-5, 61-71.

169. Schultz, H. : "The Theory and Measurement of Demand"; Chicago University Press, Chicago, 1938.

170. Schultz, T. P. : "Determinants of Fertility"; in Coale, A.J. ed 'Economic Factors in Population Growth', Macmillan, 1976.

171. Schultz, T. P. : " Changing World Prices, Women's wages and the Fertility Transition"; Journal of Political Economy, 1985, Vol-93, 1126-1154.

172. Schultz, T. P. : " Investments in Women's Human Capital and Development"; Journal of human Resources, 1993, Vol-28, 690-974.

173. Schultz, T. P. : "The Demand for Children in Low Income Countries"; in Rosenzweig, M. and Stark, O. (eds.) 'Handbook of Population and Family Economics', Amsterdam, North-Holland, 1997, 349-430.

174. Sen, A.K. : "Family and Food: Sex-Bias in Poverty"; In A.K. Sen ed. 'Resources, Values and Development', Cambridge, Harvard University Press, 1984.

175. Sen, A.K. : "Family and Food: Sex -Bias in Poverty"; in Bardhan.P and Srinivasan, T.N. (eds.) 'Rural Poverty in South Asia', New York, Columbia University, 1988.

176. Sen, A.K. and Sengupta, Sunil.: "Malnutrition of Rural Children and The Sex Bias"; Economic and Political Weekly, 1983, Vol-8, 855-64.

177. Seneca,J. J. and Taussing, M.K.: "Family Equivalence Scales and Personal Income Tax Exemption for Children"; Review of Economics and Statistics, 1971, Vol-53, 253-262.

178. Silverman, BW.: " Density Estimation for Statistics and Data Analysis"; Chapman and Hall, London, 1986.

179. Sono, M.: "The Effect of Price Changes on the Demand and Supply of Separable Goods"; International Economic Review, 1960, Vol-2, 239-71.

180. Stone, J.R.N. : "The Measurement of Consumers' Expenditure and Behaviour in the United Kingdom, 1920-1938"; Cambridge, Cambridge University Press, 1954a, Vol-I.

181. Stone, J.R.N. : "Linear Expenditure Systems and Demand Analysis : An Application to the Pattern of British Demand"; Economic Journal, 1954b, Vol-64, 511-27.

182. Strotz, R.H.: " The Empirical Implication of a Utility Tree"; Econometrica, 1957, Vol-25, 269-80.

183. Strotz, R.H.: "The Utility Tree - A Correction and Further Apprisal"; Econometrica, 1959, Vol-27, 482-88.

184. Subramaniam, R.: "Gender-Bias in India: The Importance of Household Fixed-Effects"; Oxford Economic Papers, 1996, Vol-48, 280-299.

185. Subramanian, S. and Deaton, A.S. : "Gender effects in Indian consumption Patterns"; Sarvekshana, 1991, Vol-14, 1-7.

186. Subramanian, S., and Deaton, A.S.: "The Demand For Food and Calories Further Evidence from India"; Sarvekshana, 1994, Vol-60, 1-17.

187. Svedberg, P. : "Undernutrition in Sub-Saharan Africa: Is there a Gender Bias?"; Journal of Development Studies, 1990, Vol-26, No-3, 469-486.

188. Sydenstricker, E. and King, W.I. : "The Measurement of the Relative Economic Status of Families", Quarterly Publication of the American Statistical Association, 1921, Vol-17, 842-57.

189. Theil, H. : "The Information Approach to Demand Analysis"; Econometrica, 1965, Vol-33, 67-87.

190. Thomas, D.: "Intra-Household Resource Allocation: An Inferential Approach"; Journal of Human Resources, 1990, Vol-25, 635-63.

191. Timmer, C.P. and Alderman, H.: "Estimating Consumption Parameters for Food Policy Analysis"; American Journal of Agricultural Economics, 1979, Vol-61, 982-87.

192. Tobin, J:"Estimation of Relationship for limited Dependent Variable"; Econometrica, Vol-26, 24-36, 1958.

193. Watson, G. S.: "Smooth Regression Analysis" ; Sankhya, Series A, 26, 359-72, 1964.

194. Willis, R. : "A New Approach to the Economic Theory of Fertility"; Journal of Political Economy, 1973, March/April (Supplement), S14-S64.

195. Wold, H. and Jureen, L.: "Demand Analysis"; Upasala:Almqvist and Wikesells, 1953.

196. Wolfe, B.L. and Behrman, J.R. : "Child Quantity and Quality in a Developing Country: Family Background, Endogeneous Tastes and Biological Supply Factors"; Economic Development and Cultural Change, 1986, Vol-34, 703-730.

197. Working, H. : "Statistical Laws of Family Expenditure"; Journal of the American Statistical Association, 1943, Vol-38, 43-56.

198. Yen, T.S. and Roe, L.T.:"Estimation of a Two-Level Demand System With Limited Dependent Variables"; American Journal of Agricultural Economics, February, 1989, 85-98.

Appendix A

List of Items

1. ADULT CLOTH: This group includes dhoti, saree, cloth for shirt, pajama, salwar, coat, trousers etc.
2. ADULT GOOD: This group in chapters 4, 5, 6 and 7 includes tea-coffee, pan, intoxicants and adult cloth.
3. ADULT PERSONAL CARE: This group includes shaving blades, other non-electrical shaving requisites, torch light, fountain pen, lock, walking stick, lighter, sunglass, other goods for personal care.
4. CEREALS: This group includes cereal, gram and cereal substitute.
5. CLOTHING: This group includes chaddar, dopatta, wraper, lungi, gamcha, bed-cover, mats, knitting wool etc.
6. DURABLE GOOD: This group includes purchase and repair of durable goods.
7. FOOD: This group in chapter 3 includes cereals and pulse and pulse products, milk, edible oil, meat, egg,fish, vegetables, fruits, salt, sugar, spices.
8. FUEL AND LIGHT: This group includes coke, firewoods, electricity, dung-cake, kerosine, matches, coal, coalgas, gas, other oil used for lighting, candles, gobar gas etc.
9. INTOXICANTS: This group includes ganja, bhang, charas, foreign liquor, opium, beer, other drugs and intoxicants and also biri, cigarettes, tobacco, zarda etc.

10. MEDICAL: This group includes expenditure on medicine of different types and medical services, payments to doctor, nurse, etc. on account of professional fees and expenditure incurred for clinical tests, etc.

11. MISCELLANEOUS: This group includes amusement, toilet articles, sundry articles, consumer services and conveyance.

12. OTHER FOOD: This group includes food excluding cereals and beverages such as cold beverages, fruit juice, chocolate, biscuit, prepared sweets and other processed food.

13. PAN: This group includes pan leaf, pan finished, supari, katha, lime, other ingredients for pan.

14. TEA-COFFEE: This group includes tea(number of cups and leaf) and coffee(number Of cups and powder).

15. UNCLASSIFIED: This group includes club fee, rent and taxes.

Appendix B

Figures

Parametric and Nonparametric Curves with Confidence Bands

Cereals (Group-A)

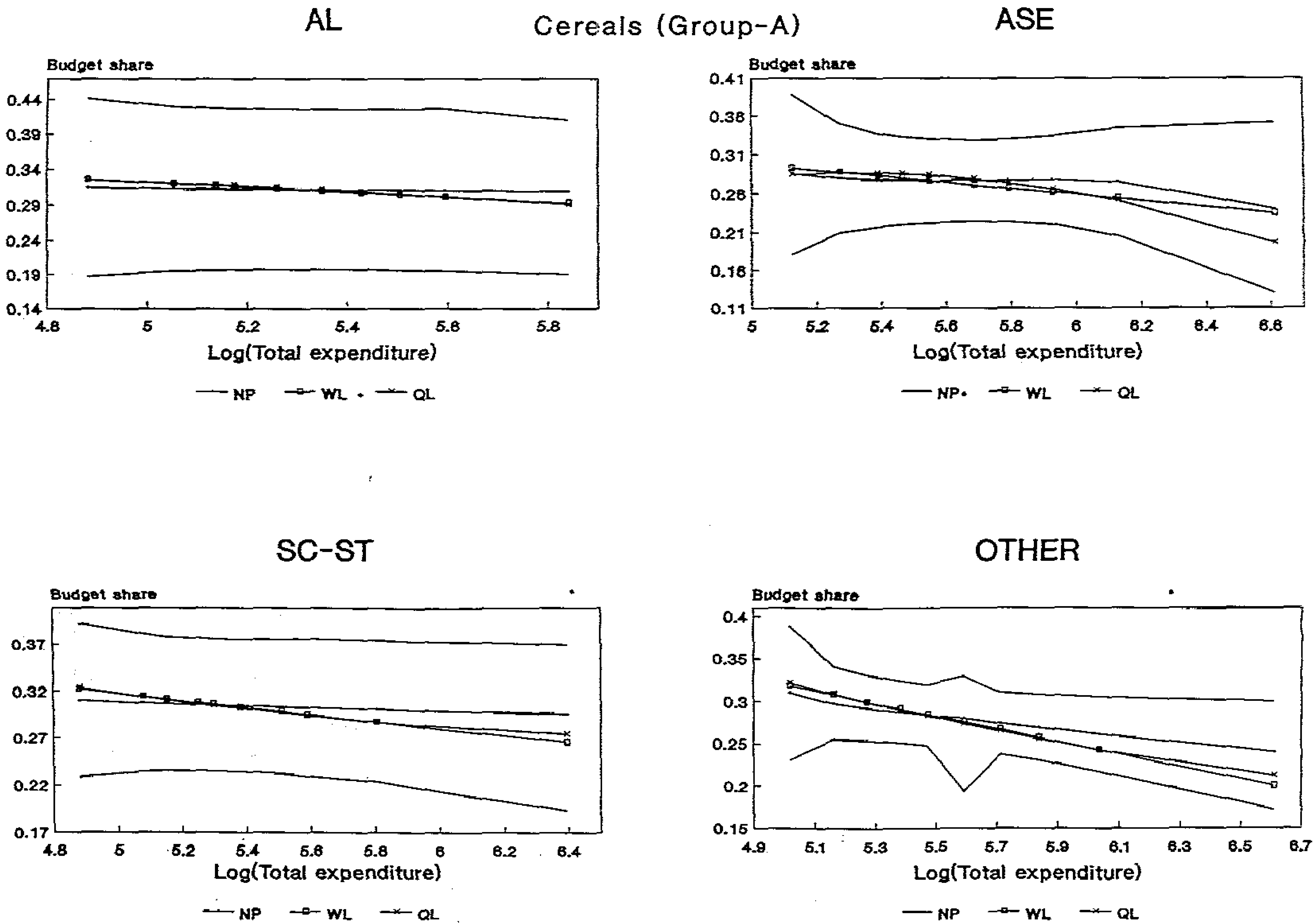


Figure B.1

Parametric and Nonparametric Curves with Confidence Bands

Cereals (Group-B)

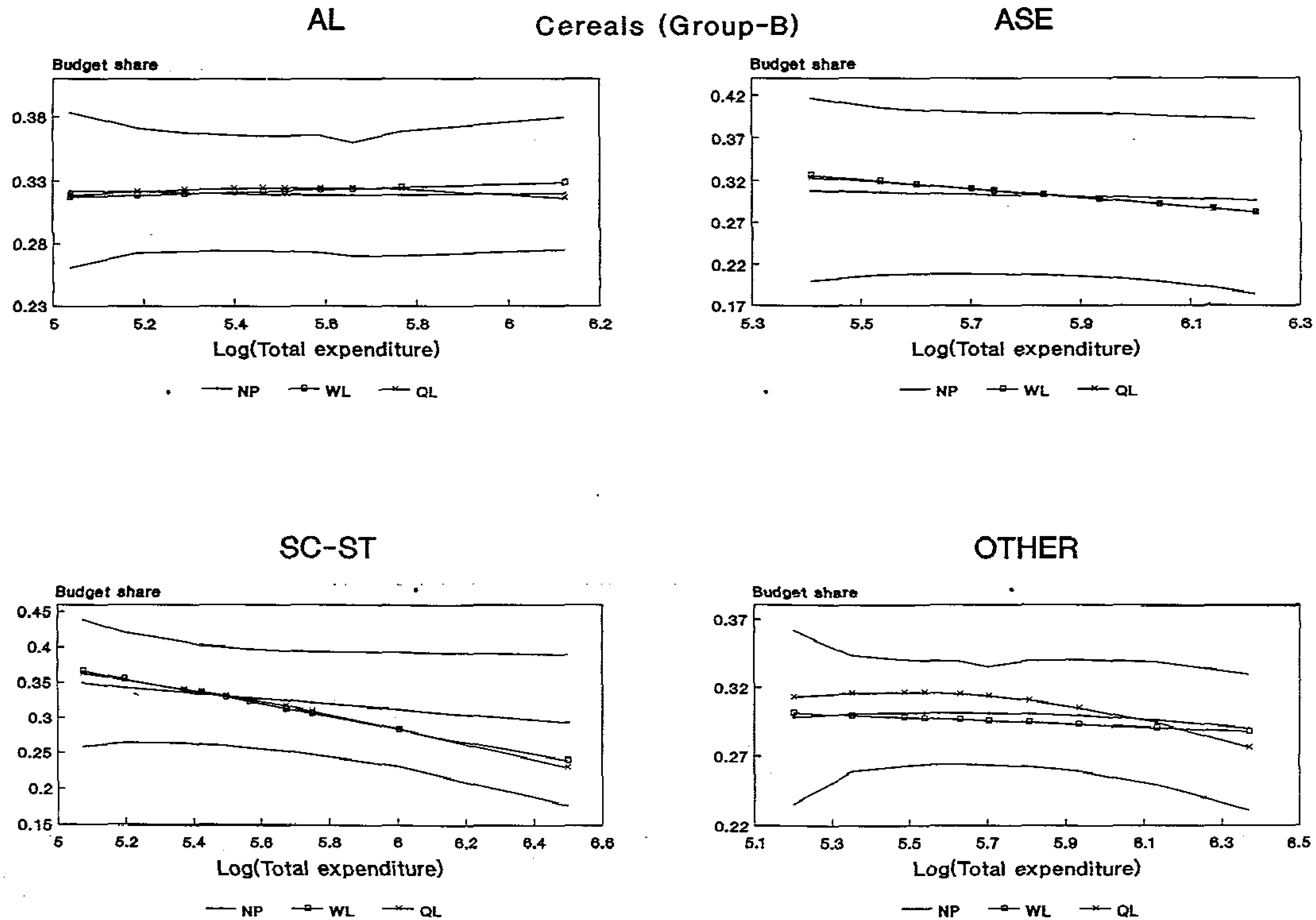


Figure B.2

Parametric and Nonparametric Curves with Confidence Bands

Cereals (Group-C)

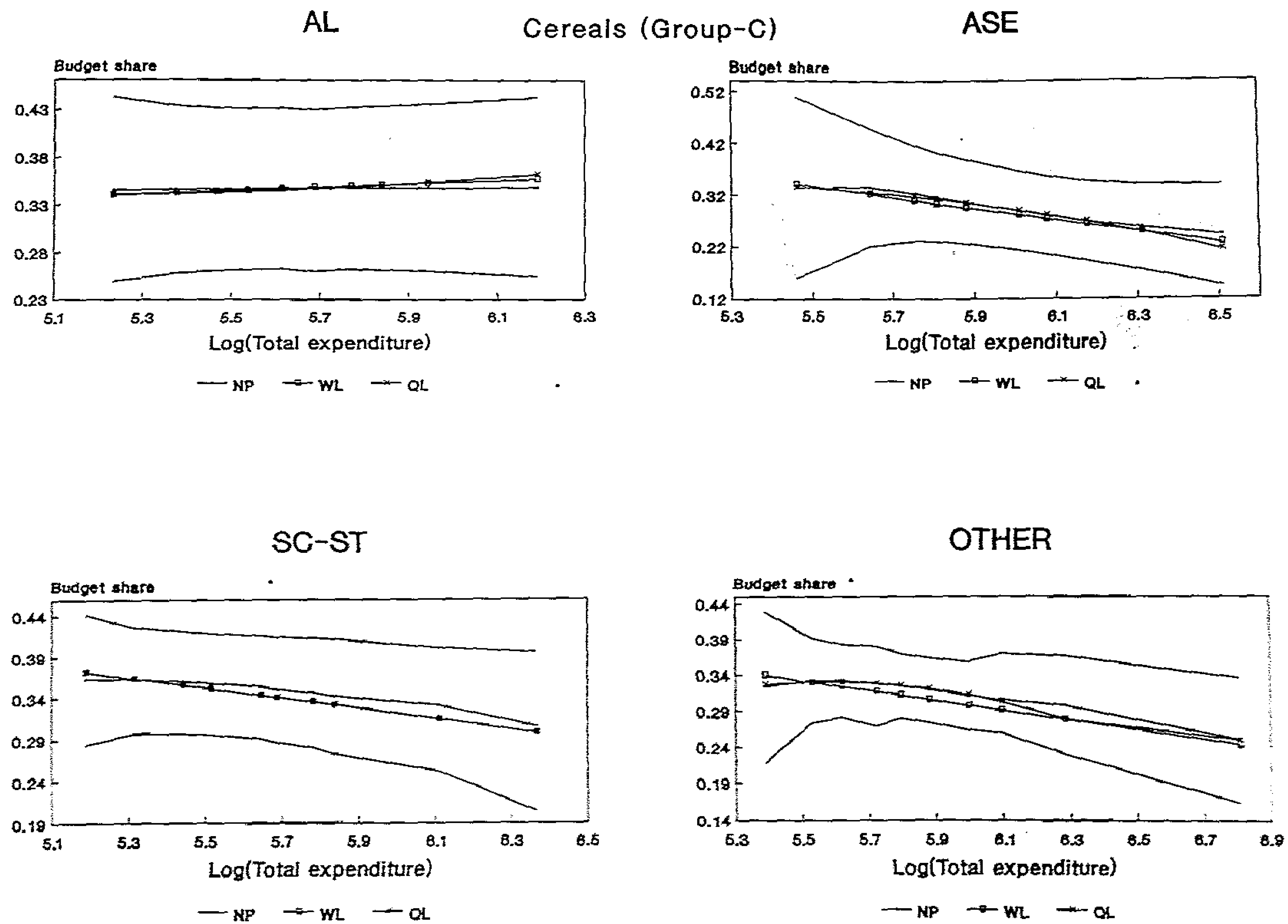


Figure B.3

Parametric and Nonparametric Curves with Confidence Bands

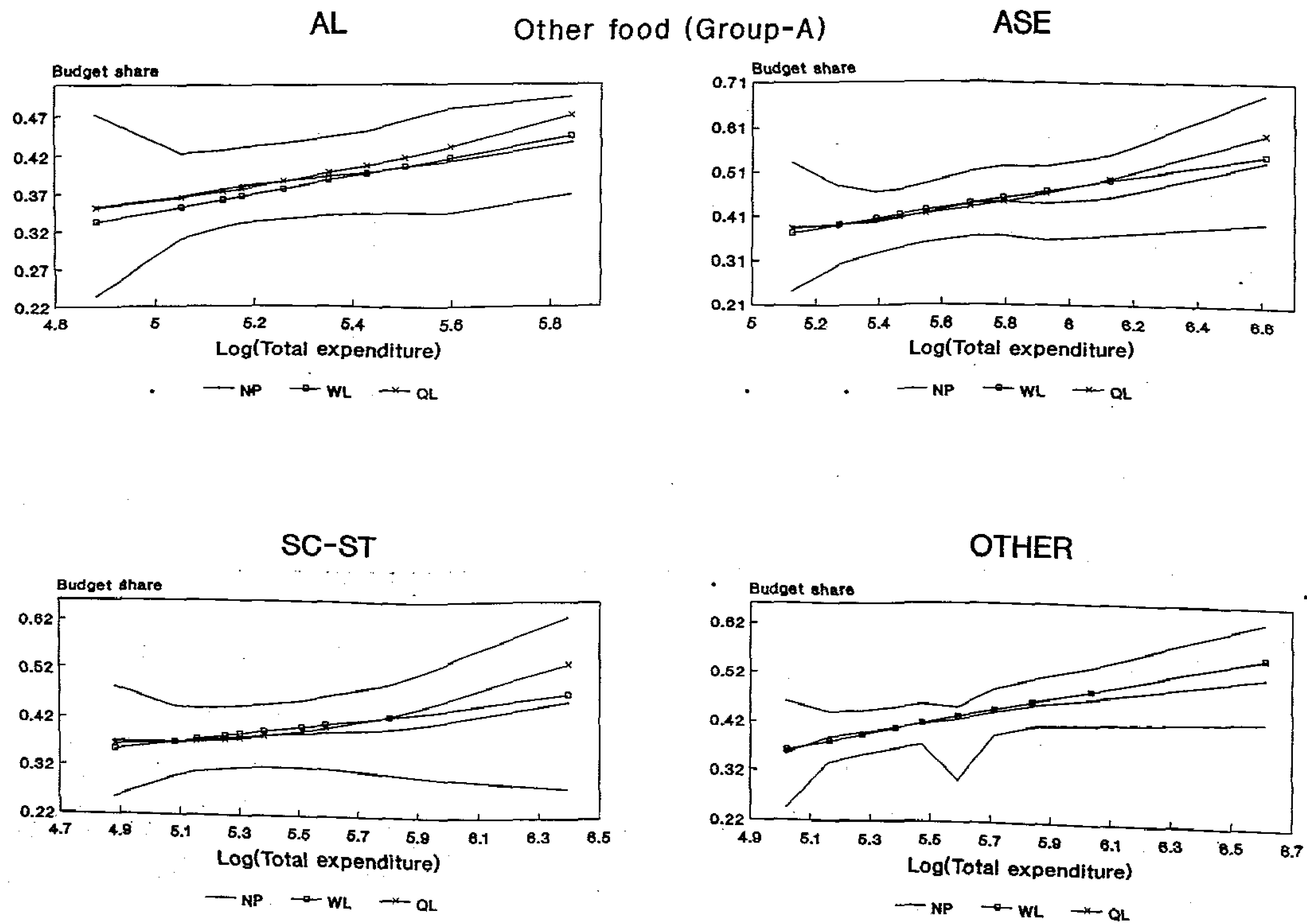


Figure B.4

Parametric and Nonparametric Curves with Confidence Bands

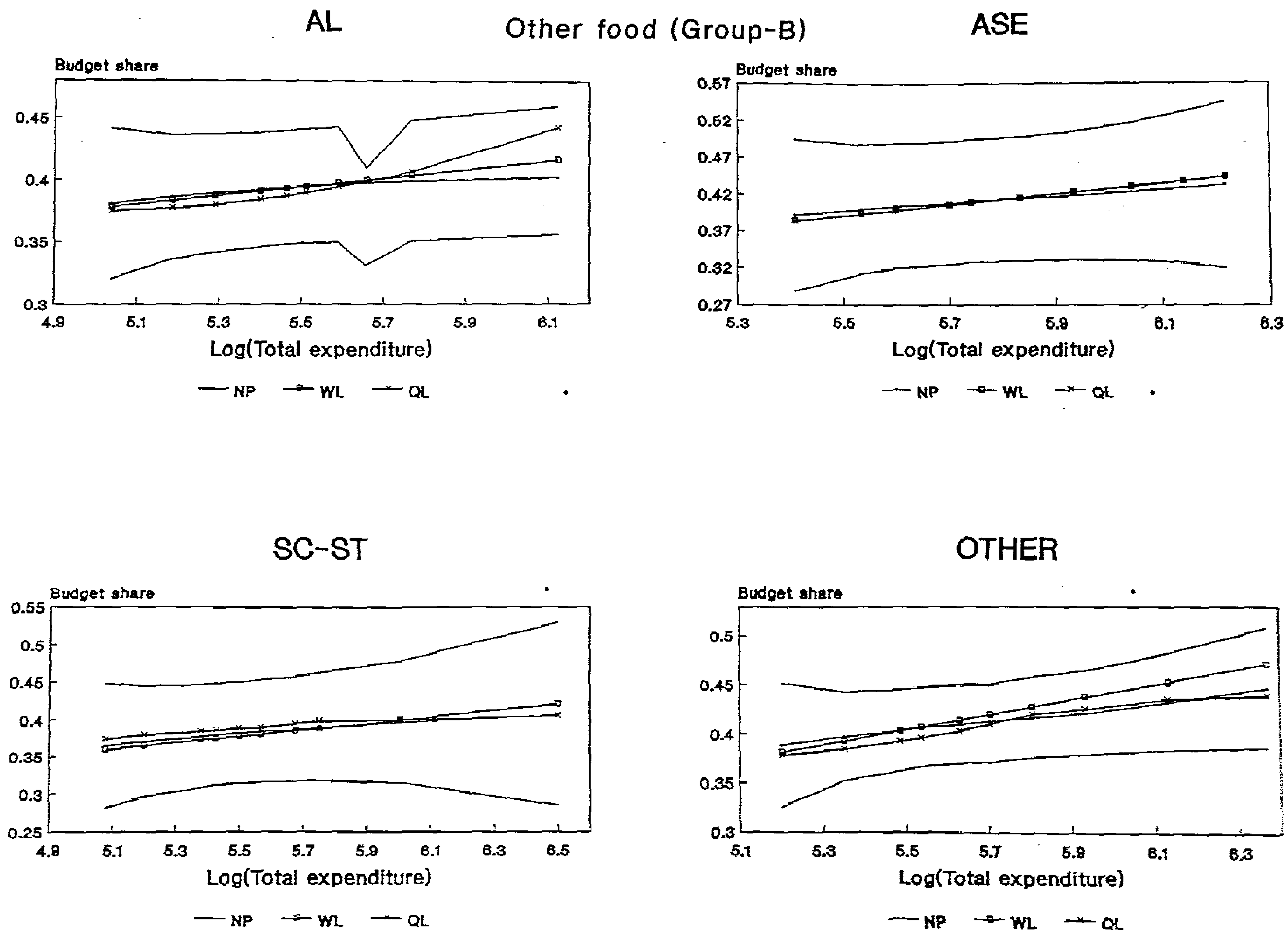


Figure B.5

Parametric and Nonparametric Curves with Confidence Bands

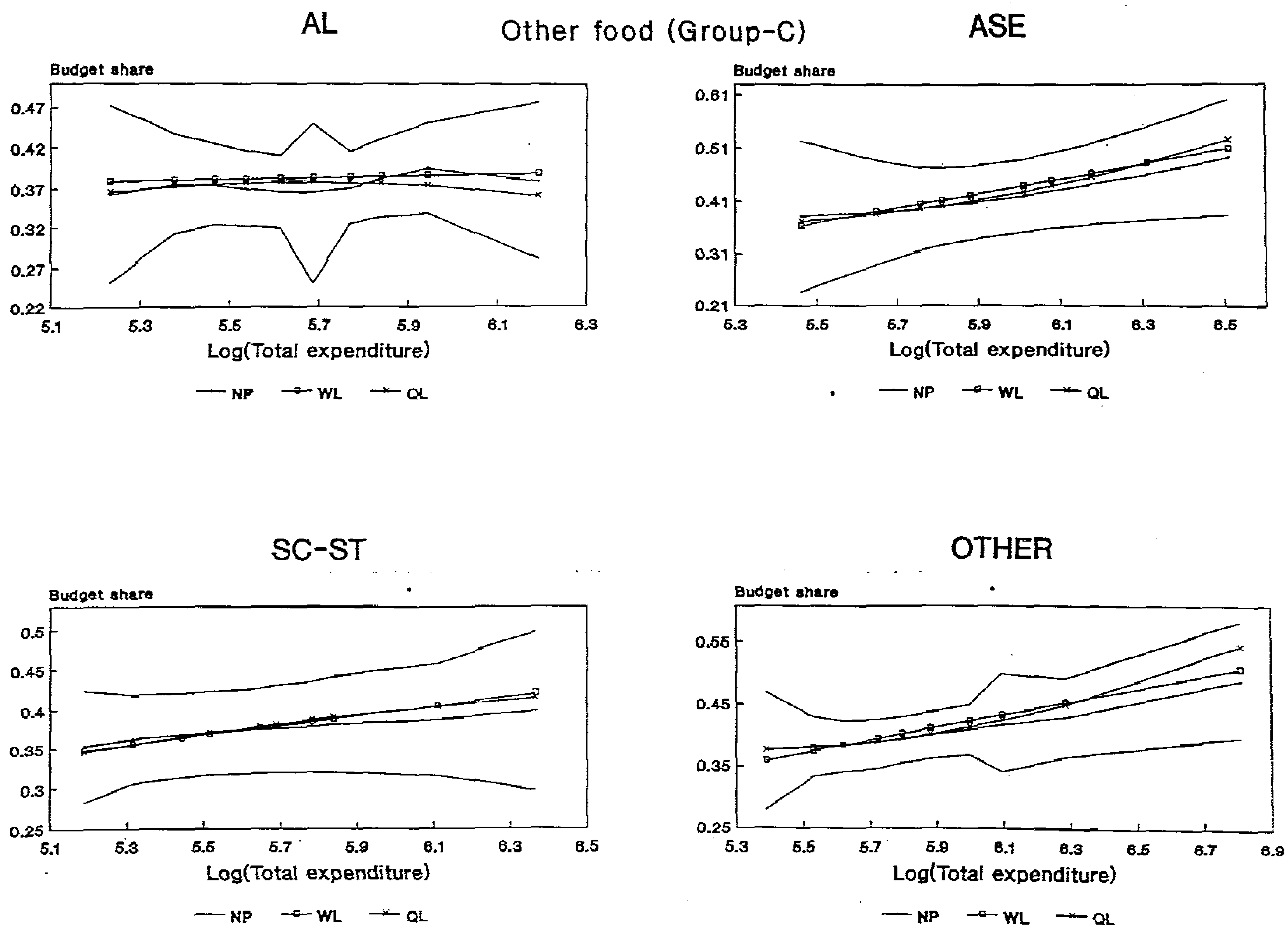


Figure B.6

Parametric and Nonparametric Curves with Confidence Bands

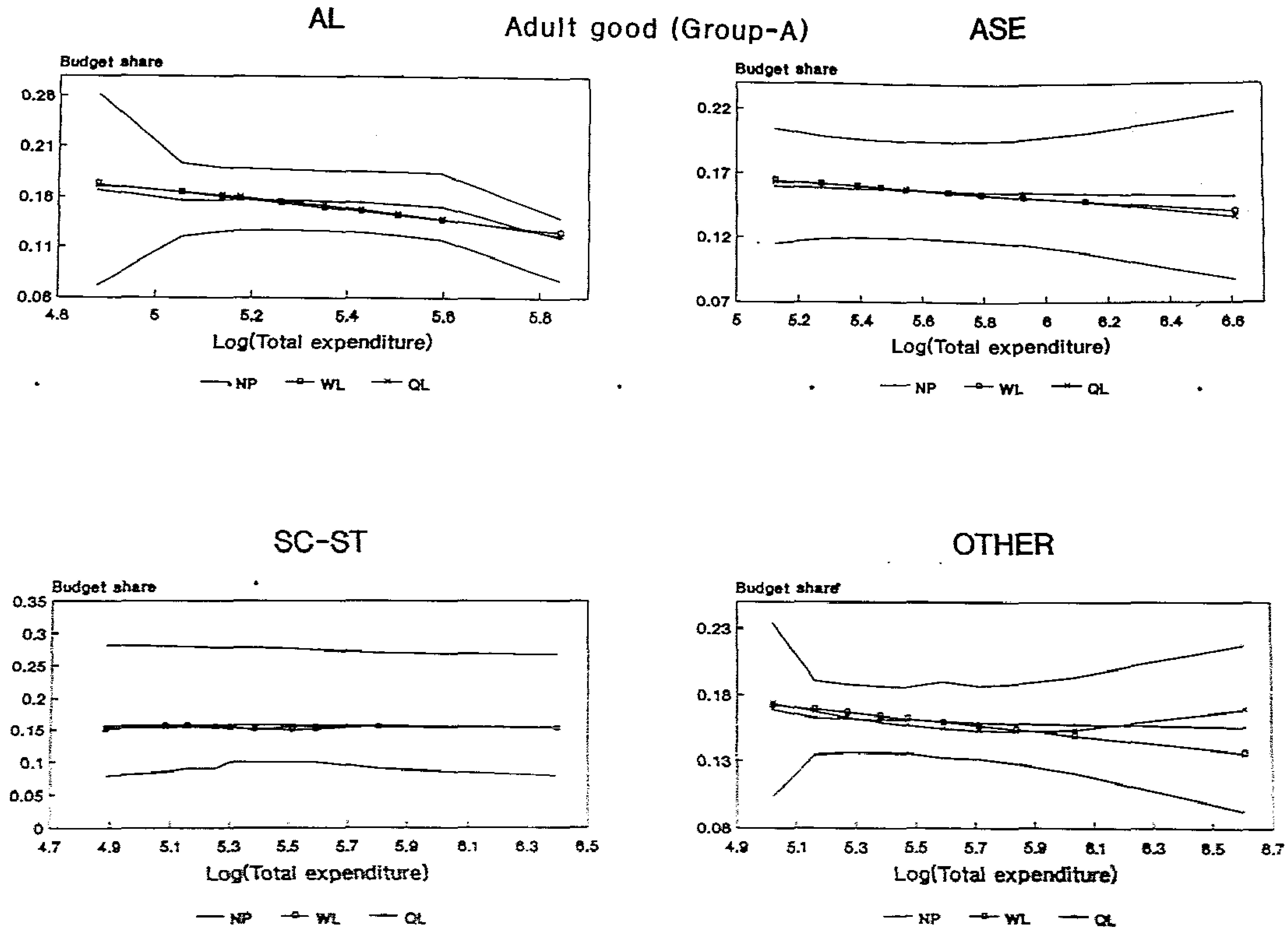


Figure B.7

Parametric and Nonparametric Curves with Confidence Bands

Adult good (Group-B)

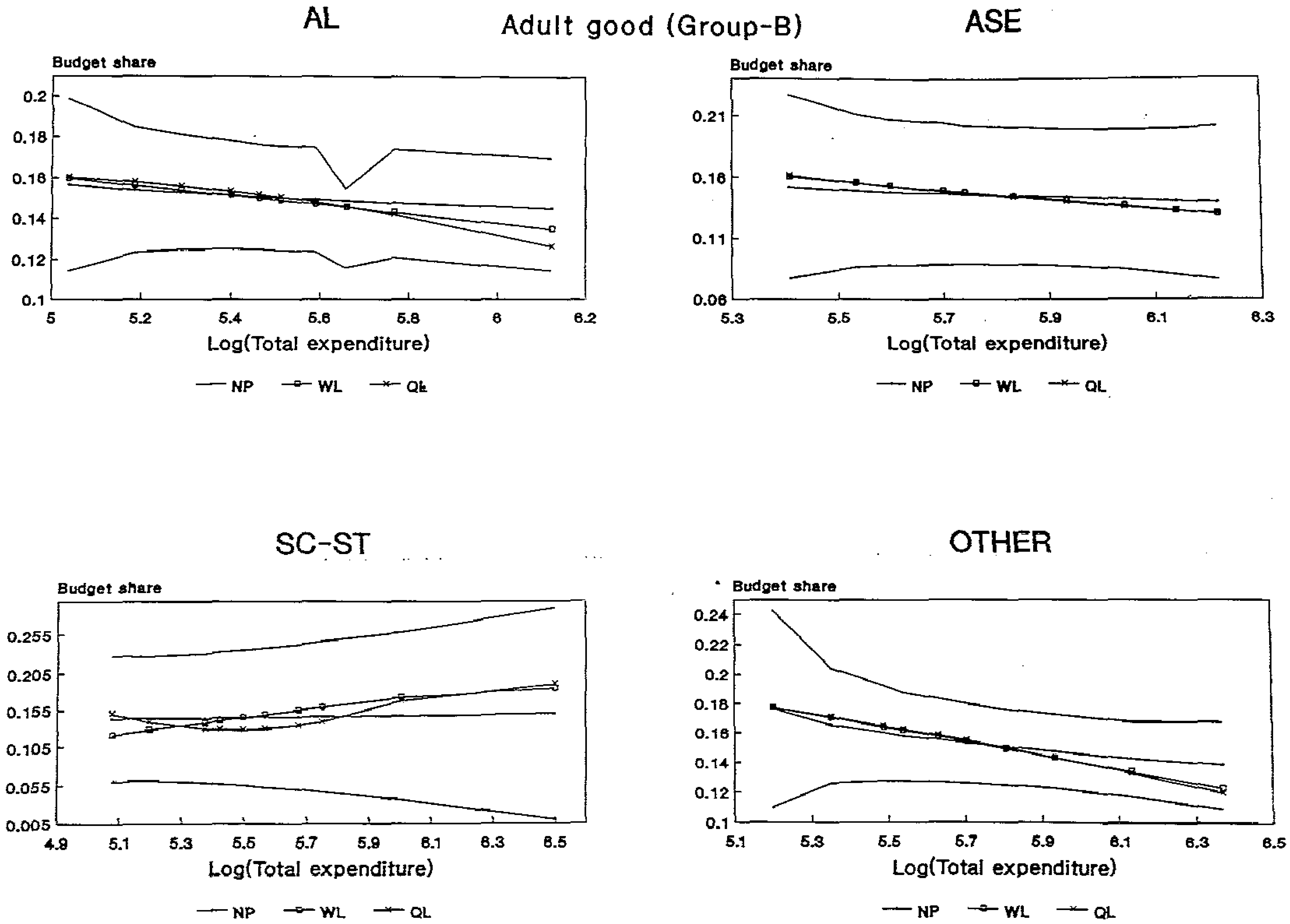


Figure B.8

Parametric and Nonparametric Curves with Confidence Bands

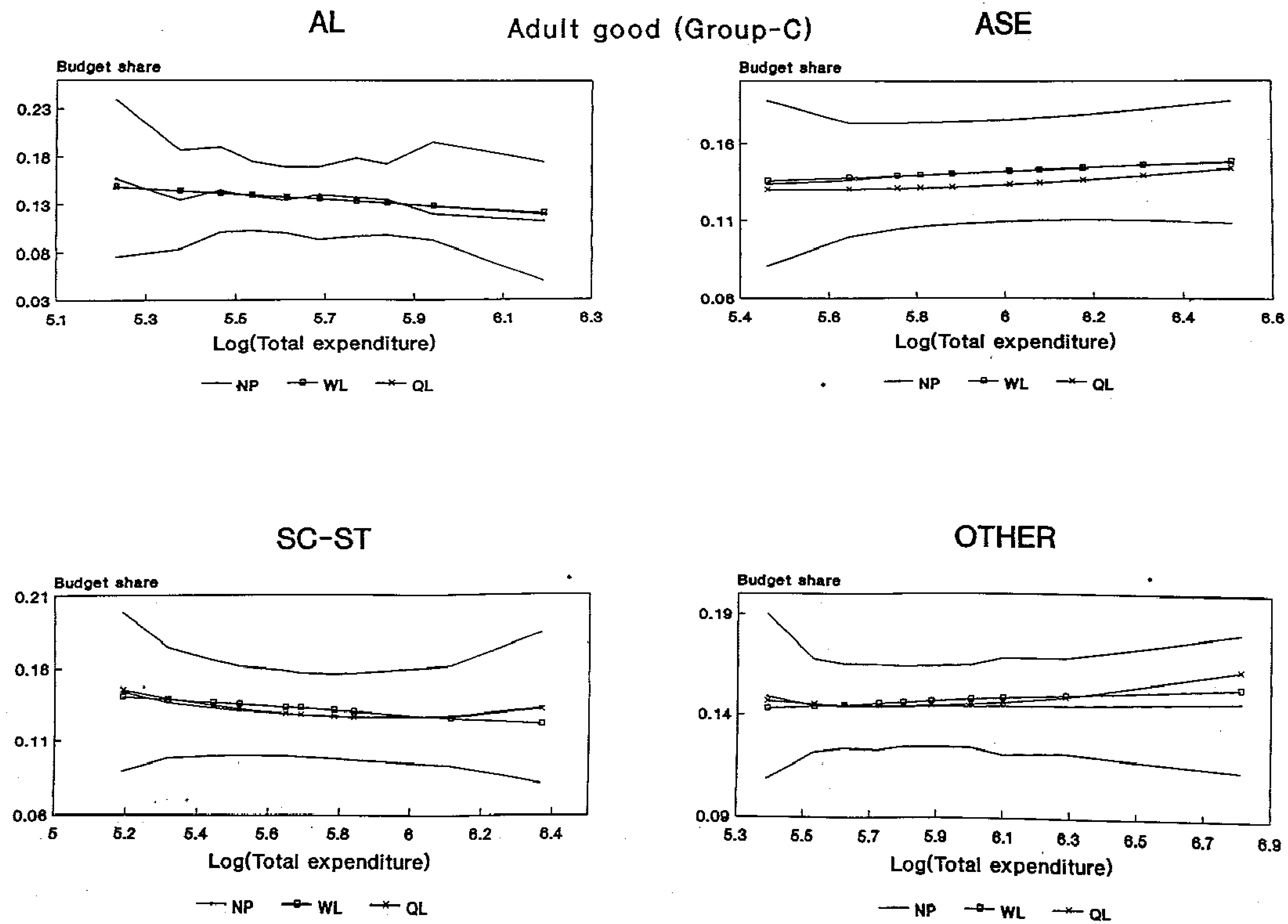


Figure B.9

Parametric and Nonparametric Curves with Confidence Bands

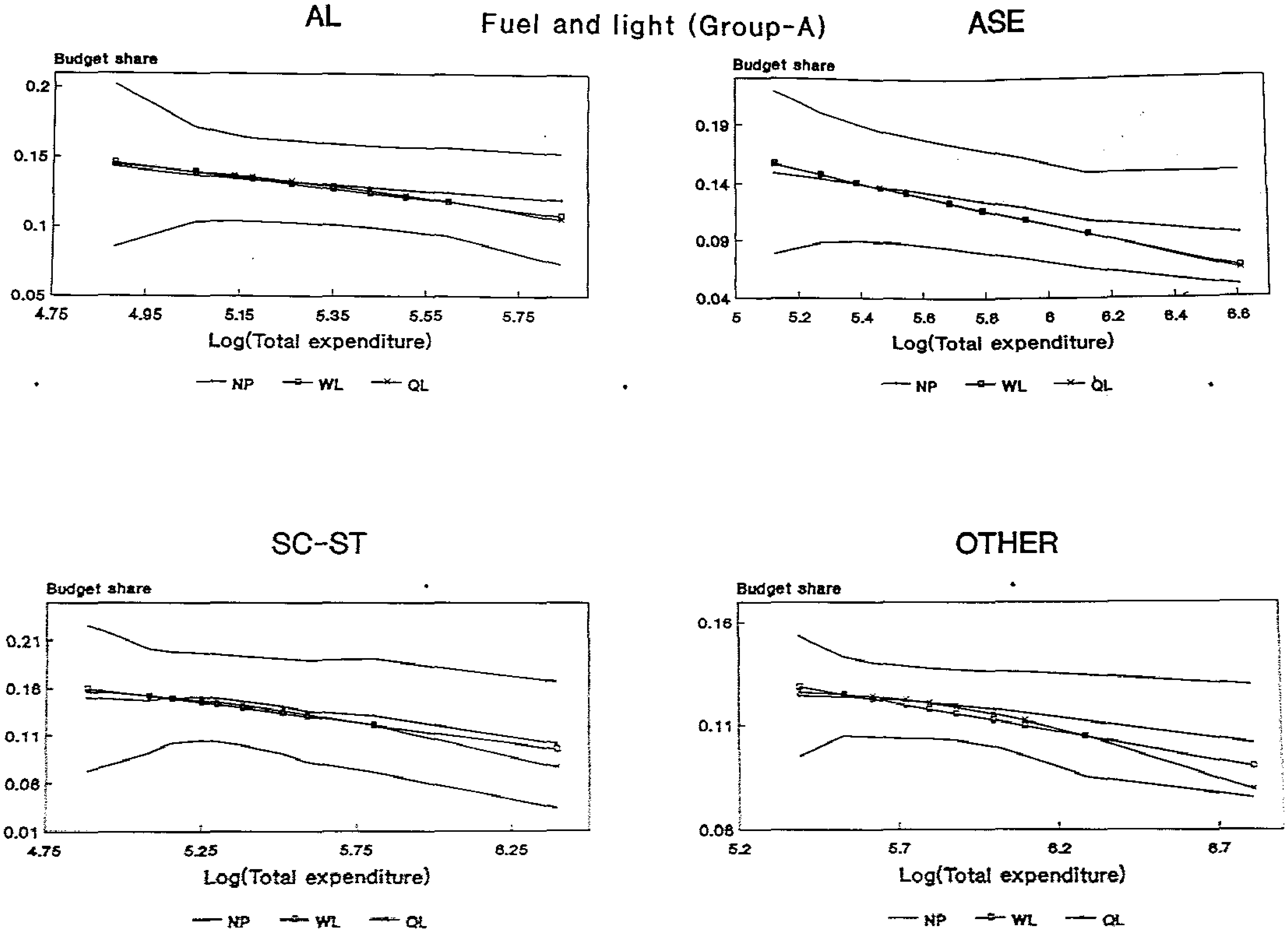


Figure B.10

Parametric and Nonparametric Curves with Confidence Bands

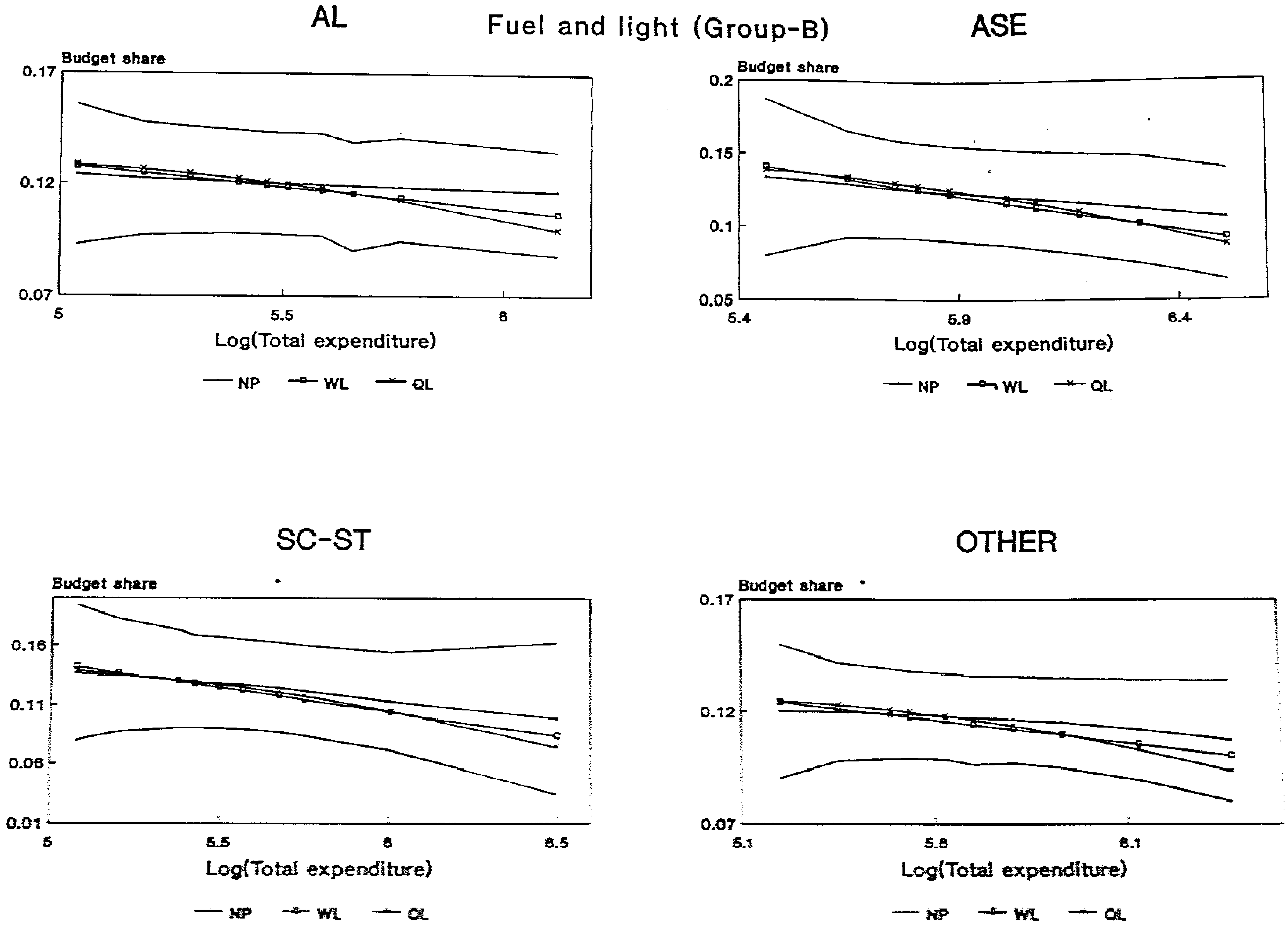
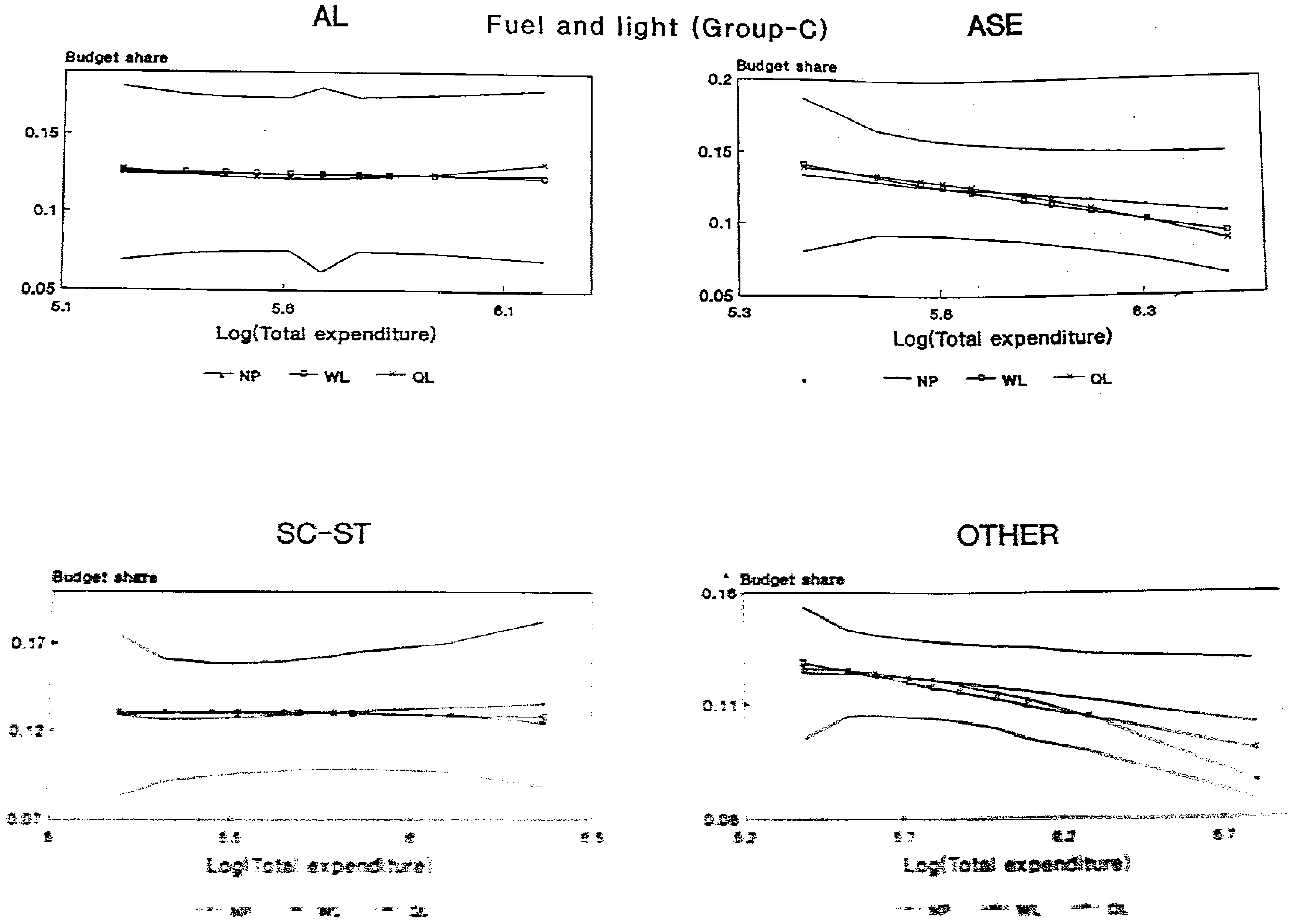


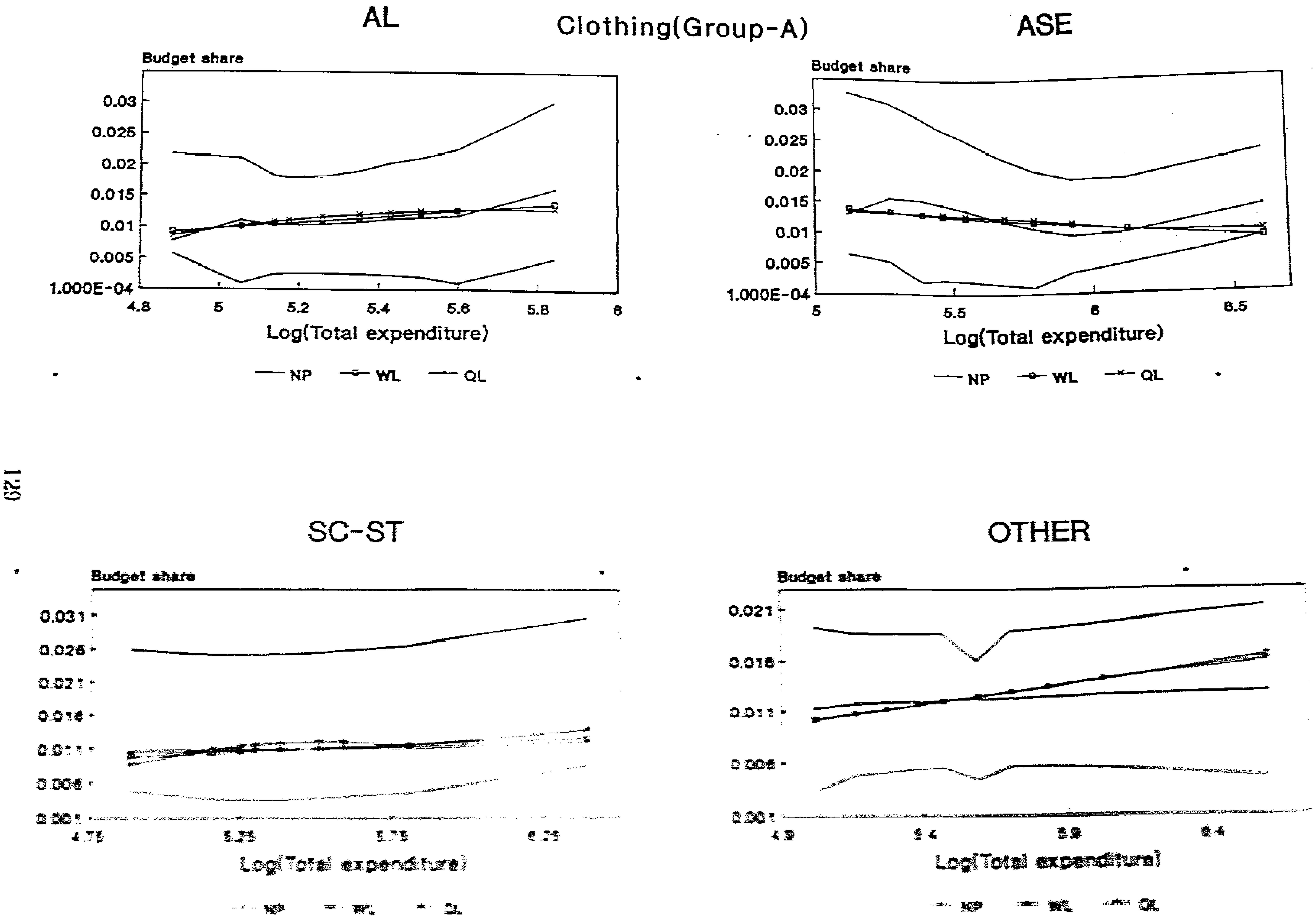
Figure B.11

Parametric and Nonparametric Curves with Confidence Bands

Fuel and light (Group-C)



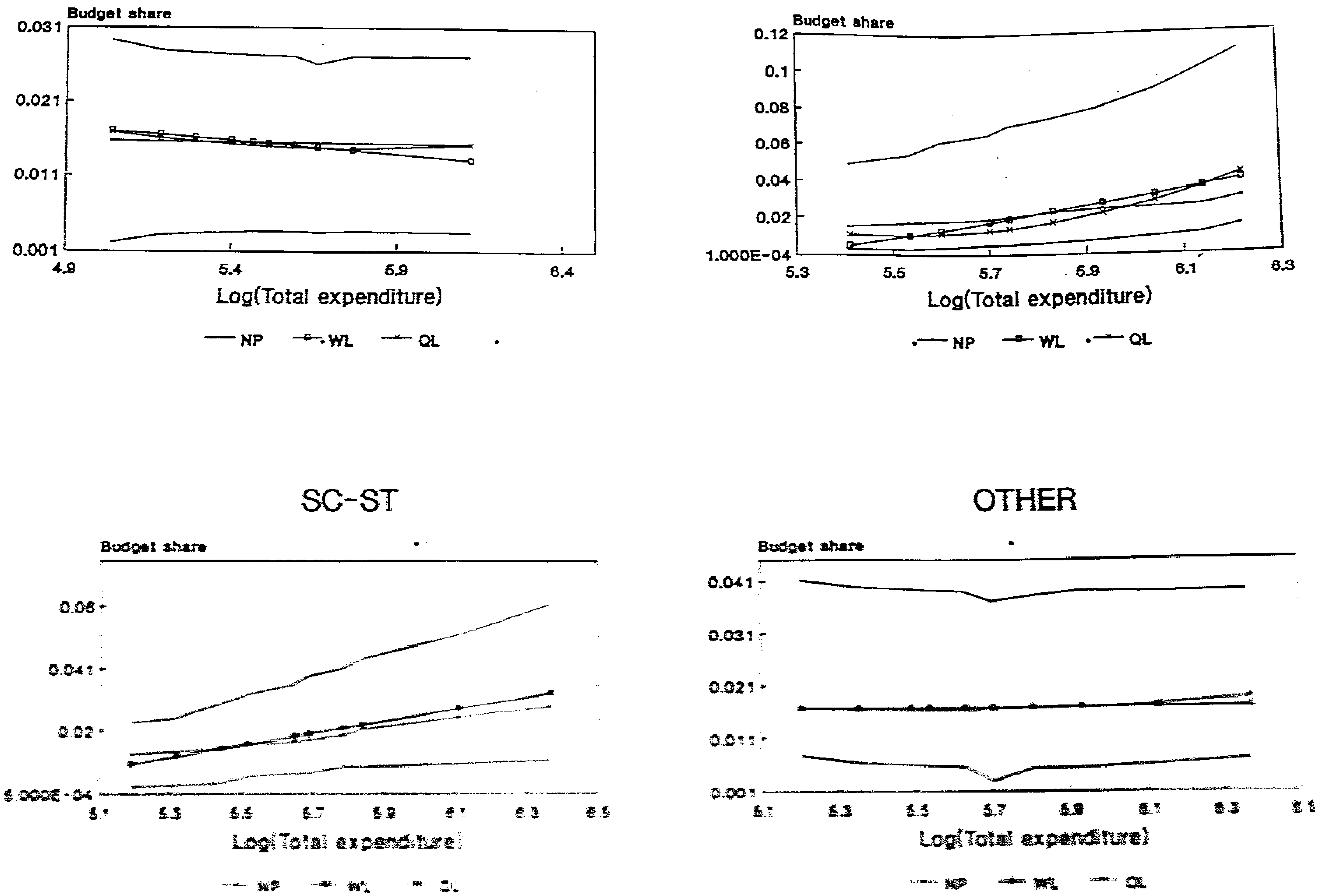
Parametric and Nonparametric Curves with Confidence Bands



Parametric and Nonparametric Curves with Confidence Bands

Clothing(Group-B)

AL | ASE



Parametric and Nonparametric Curves with Confidence Bands

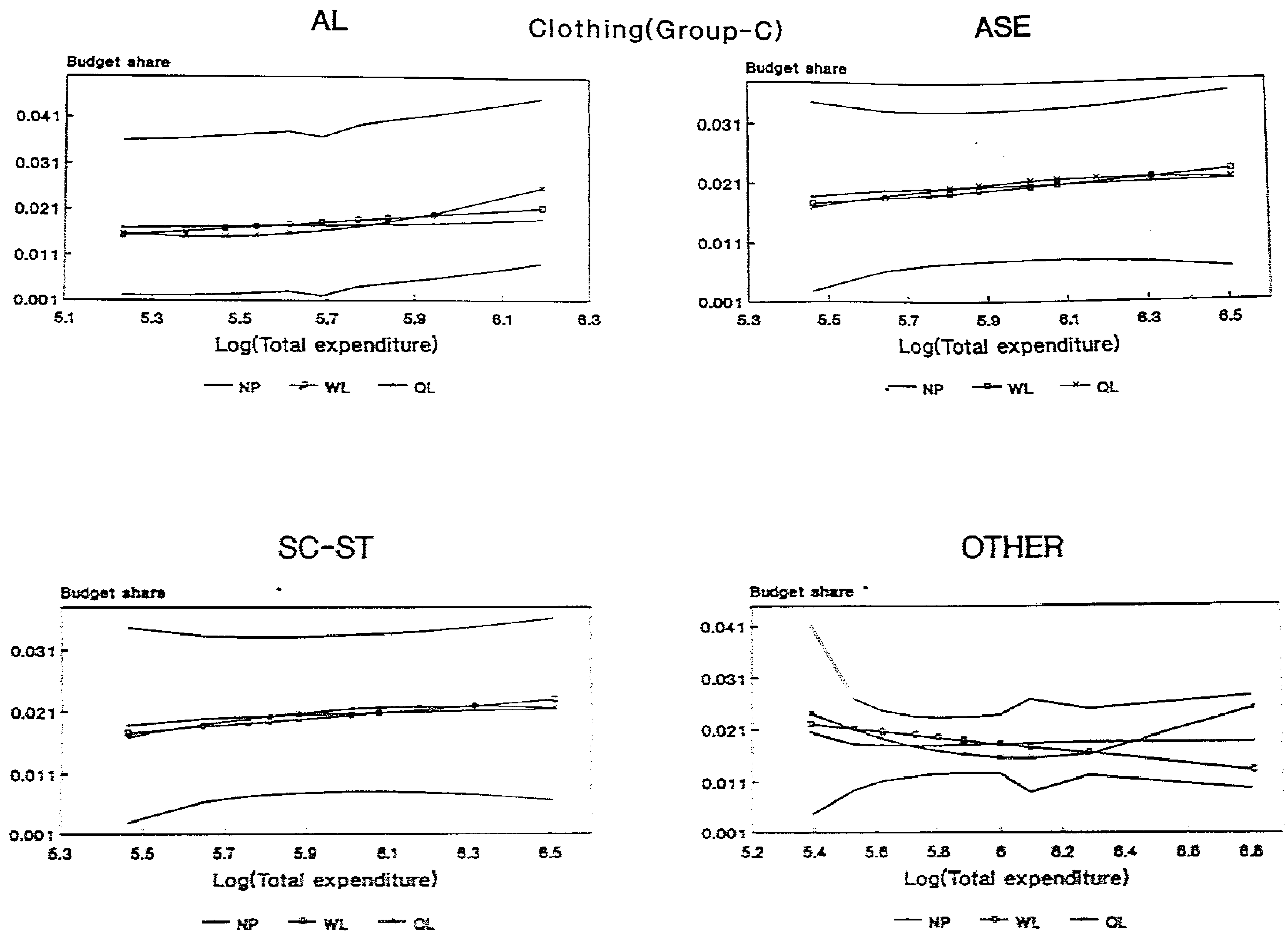


Figure B.15

Appendix C

Tables

Table B.1A: Parameter estimates corresponding to Table 5.1A by occupational groups and social categories within these occupational groups.

Coefficients of	Occupational group AL						Occupational group ASE					
	WL form			QL form			WL form			QL form		
	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
						For Engel *equivalence scale*						
intercept	.47	.39	.44	-.16	-.33	-.30	.66	.68	.69	-.02	-.18	-.29
	(7.100)	(7.996)	(11.292)	(.299)	(1.074)	(1.134)	(6.243)	(17.542)	(19.422)	(1.779)	(.695)	(1.226)
$\ln y$	-.026	-.015	-.023	.192	.234	.233	-.063	-.065	-.068	.551	.206	.244
	(2.184)	(1.676)	(3.237)	(1.039)	(2.231)	(2.581)	(3.369)	(9.896)	(11.098)	(2.518)	(2.515)	(3.306)
$(\ln y)^2$	-	-	-	-.019	-.022	-.022	-	-	-	-.051	-.021	-.025
				(1.185)	(2.381)	(2.945)				(2.817)	(3.319)	(4.239)
$d^*_{11-}-2$	.014	.012	.013	.015	.013	.015	.020	.013	.015	.025	.014	.015
	(3.746)	(4.215)	(5.981)	(3.466)	(4.679)	(6.453)	(3.900)	(7.964)	(9.014)	(4.642)	(8.299)	(9.554)
d^*_{5-14}	.020	.013	.016	.022	.013	.016	.017	.014	.014	.016	.014	.015
	(7.096)	(6.216)	(9.367)	(7.156)	(6.252)	(9.373)	(4.258)	(8.710)	(9.836)	(4.008)	(8.889)	(10.005)

Table B.1A: Continued.

Coefficients of	Occupational group AL						Occupational group ASE					
	Linear form			Quadratic			Linear form			Quadratic form		
	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
For Rothbarth *equivalence scale*												
intercept	-183.27	-217.11	-208.11	349.88	526.65	504.57	-332.99	-495.25	-471.24	1266.60	1326.00	1294.60
	(12.87)	(18.50)	(23.01)	(3.09)	(7.49)	(8.62)	(9.66)	(28.94)	(30.89)	(6.63)	(12.43)	(14.19)
$\ln y$	40.30	46.54	44.88	-146.15	-212.72	-203.87	66.09	92.88	89.02	-468.04	-483.88	-474.61
	(15.33)	(21.68)	(27.05)	(3.71)	(8.76)	(10.06)	(10.83)	(31.78)	(33.99)	(7.40)	(14.44)	(16.43)
$(\ln y)^2$	-	-	-	16.23	22.52	21.63	-	-	-	44.41	45.48	44.79
				(4.74)	(10.72)	(12.31)				(8.48)	(17.26)	(19.58)
$d^a{}_{15+} - 2$	3.86	5.50	4.81	3.79	3.78	3.52	5.92	3.88	4.18	1.83	2.61	2.49
	(4.78)	(8.29)	(7.39)	(4.23)	(3.78)	(6.99)	(3.57)	(5.18)	(6.09)	(1.20)	(3.78)	(3.94)
$d^c{}_{0-14}$	-1.11	-1.11	-1.15	-1.01	-1.16	-1.13	-2.68	-2.04	-2.11	-1.64	-2.57	-2.44
	(1.82)	(2.17)	(2.93)	(1.69)	(2.38)	(2.99)	(2.04)	(2.92)	(3.37)	(1.41)	(4.03)	(4.30)

Figures in parentheses are the absolute t-values.

Table B.1B: Parameter estimates corresponding to Table 5.2B for the overall sample

Coefficients	For Engel *equivalence scale*		For Rothbarth *equivalence scale*	
of	WL	QL	Linear	Quadratic
(1)	(2)	(3)	(4)	(5)
intercept	.68	-.41	-367.29	914.82
	(32.63)	(3.26)	(46.19)	(20.32)
$\ln y$	-.07	.29	72.77	-352.40
	(18.17)	(7.09)	(51.73)	(23.83)
$(\ln y)^2$	-	-.03	-	35.09
		(8.72)		(28.86)
$d^a_{15+} - 2$	.02	.02	3.75	1.51
	(14.76)	(16.26)	(8.60)	(3.67)
d^c_{0-14}	.02	.02	-1.73	-1.91
	(16.72)	(17.01)	(4.65)	(5.57)

Figures in parentheses are the absolute t-values.

Table B.2A: Parameter estimates corresponding to Table 5.2A by occupational groups and social categories within these occupational groups.

Coefficients of	Occupational group AL						Occupational group ASE					
	WL form			QL form			WL form			QL form		
	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	For Engel *equivalence scale*											
intercept	.49	.43	.47	-.12	-.24	-.23	.71	.69	.69	-1.02	-.15	-.23
	(7.56)	(8.72)	(12.10)	(.22)	(.80)	(.90)	(6.71)	(17.78)	(19.39)	(1.58)	(.57)	(1.00)
$\ln y$	-.03	-.02	-.03	.18	.21	.22	-.07	-.07	-.07	.51	.20	.23
	(2.62)	(2.44)	(4.07)	(1.00)	(2.02)	(2.42)	(3.83)	(10.17)	(11.03)	(2.35)	(2.40)	(3.10)
$(\ln y)^2$	-	-	-	-.02	-.02	-.02	-	-	-	-.05	-.02	-.03
				(1.17)	(2.24)	(2.75)				(2.69)	(3.22)	(4.06)
$d^a{}_{15+} - 2$	.02	.01	.02	.02	.02	.02	.02	.01	.02	.03	.02	.02
	(3.92)	(4.83)	(6.58)	(4.04)	(5.23)	(7.02)	(4.29)	(8.30)	(9.50)	(4.97)	(8.62)	(10.00)
$d^c{}_{0-5}$	.01	.003	.01	.01	.003	.01	.01	.01	.01	.002	.01	.01
	(3.53)	(.89)	(2.49)	(2.49)	(.96)	(2.52)	(.37)	(3.72)	(5.38)	(.31)	(3.82)	(3.70)
$d^c{}_{6-10}$	.03	.02	.03	.03	.02	.03	.02	.02	.02	.02	.02	.02
	(5.74)	(6.13)	(8.44)	(5.76)	(6.12)	(8.45)	(2.82)	(5.95)	(6.84)	(2.27)	(6.16)	(7.04)
$d^c{}_{11-14}$	.03	.02	.02	.03	.02	.02	.04	.02	.02	.04	.02	.02
	(4.30)	(3.67)	(5.33)	(4.21)	(3.66)	(5.27)	(3.74)	(5.89)	(6.97)	(3.58)	(5.79)	(6.80)

Table B.2A:Continued.

Coefficients of	Occupational group AL						Occupational group ASE					
	Linear form			Quadratic			Linear form			Quadratic form		
	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
	For Rothbarth *equivalence scale*											
intercept	-182.40	-219.10	-208.73	362.59	523.73	506.09	-339.05	-497.40	-473.58	1253.10	1322.30	1288.00
	(12.71)	(18.37)	(22.78)	(3.19)	(7.44)	(8.65)	(9.75)	(29.02)	(31.01)	(6.53)	(12.37)	(14.08)
$\ln y$	40.13	46.88	44.97	-150.44	-211.93	-204.45	67.25	93.34	89.52	-462.12	-482.89	-472.67
	(15.16)	(21.50)	(26.75)	(3.81)	(8.72)	(10.09)	(10.90)	(31.85)	(34.02)	(7.31)	(14.38)	(16.32)
$(\ln y)^2$	-	-	-	16.58	22.47	21.68	-	-	-	44.15	45.43	44.66
				(4.84)	(10.69)	(12.35)				(8.40)	(17.21)	(19.48)
$d^a{}_{15+} - 2$	3.77	5.32	4.68	3.27	3.63	3.39	5.74	3.73	4.03	1.76	2.43	2.33
	(4.65)	(7.91)	(9.06)	(4.07)	(5.50)	(6.69)	(3.43)	(4.90)	(5.78)	(1.14)	(3.47)	(3.65)
$d^c{}_{0-5}$	-1.04	-.25	-.55	-.91	-.50	-.62	-1.43	-.97	-.95	-1.02	-1.44	-1.39
	(1.20)	(.33)	(.96)	(1.07)	(.68)	(1.12)	(.62)	(.92)	(.98)	(.51)	(1.48)	(1.58)
$d^c{}_{6-10}$	-1.96	-2.43	-2.38	-2.05	-2.35	-2.36	-2.13	-2.32	-2.30	-.90	-3.51	-3.17
	(1.89)	(2.74)	(3.50)	(2.02)	(2.77)	(3.63)	(.86)	(1.92)	(2.10)	(.41)	(3.17)	(3.18)
$d^c{}_{11-14}$	.68**	-.15	.17**	1.14**	-.06	.42**	-.63	-4.07	-4.45	-4.48	-3.22	-3.28
	(.47)	(.13)	(.19)	(.81)	(.05)	(.50)	(1.90)	(2.68)	(3.20)	(1.53)	(2.31)	(2.60)

Figures in parentheses are the absolute t-values.

** These parameters do not have the expected sign.

Table B.2B: Parameter estimates corresponding to Table 5.2B for the overall sample

Coefficients of	For Engel *equivalence scale*		For Rothbarth *equivalence scale*	
	WL	QL	Linear	Quadratic
(1)	(2)	(3)	(4)	(5)
intercept	.70	-.32	-370.55	908.48
	(33.82)	(2.54)	(46.35)	(20.12)
$\ln y$	-.07	.27	73.36	-350.55
	(19.34)	(6.46)	(51.83)	(23.64)
$(\ln y)^2$	-	-.03	-	34.96
		(8.21)		(28.70)
$d^a{}_{15+} - 2$	.02	.02	3.54	1.36
	(15.76)	(17.12)	(8.06)	(3.30)
$d^c{}_{0-5}$	.01	.01	-.08	-.78
	(4.42)	(4.83)	(.14)	(1.51)
$d^c{}_{6-10}$	.02	.02	-3.16	-3.22
	(13.57)	(13.69)	(4.83)	(5.35)
$d^c{}_{11-14}$	.03	.02	-2.44	-1.59
	(11.25)	(11.01)	(2.90)	(2.04)

Figures in parentheses are the absolute t-values.

Table B.3A: Parameter estimates corresponding to Table 5.5A by occupational groups and social categories within these occupational groups.

Coefficients of	Occupational group AL						Occupational group ASE					
	WL form			QL form			WL form			QL form		
	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
For Engel *equivalence scale*												
intercept	.47	.39	.44	-.18	-.33	-.30	.66	.67	.69	-1.26	-.17	-.28
	(7.11)	(8.01)	(11.29)	(.33)	(1.06)	(1.13)	(6.18)	(17.51)	(19.36)	(1.90)	(.66)	(1.19)
$\ln y$	-.03	-.02	-.02	.20	.23	.23	-.06	-.07	-.07	.58	.20	.24
	(2.19)	(1.69)	(3.24)	(1.07)	(2.21)	(2.58)	(3.30)	(9.87)	(11.03)	(2.63)	(2.47)	(3.27)
$(\ln y)^2$	-	-	-	-.02	-.02	-.02	-	-	-	-.05	-.02	-.03
				(1.22)	(2.36)	(2.84)				(2.93)	(3.27)	(4.20)
$d^a{}_{15+} - 2$	.02	.01	.01	.02	.01	.02	.01	.01	.02	.03	.01	.02
	(3.77)	(4.23)	(5.98)	(3.89)	(4.69)	(6.45)	(3.87)	(7.99)	(9.04)	(4.66)	(8.32)	(9.58)
$md^c{}_{0-14}$	.02	.01	.02	.02	.01	.02	.01	.01	.01	.01	.01	.01
	(4.83)	(4.98)	(6.95)	(4.75)	(4.96)	(6.89)	(1.99)	(5.19)	(5.50)	(1.59)	(5.42)	(5.70)
$fd^c{}_{0-14}$	.02	.01	.02	.02	.01	.02	.02	.02	.02	.02	.02	.02
	(5.71)	(4.11)	(6.81)	(5.71)	(4.17)	(6.87)	(3.83)	(6.99)	(8.20)	(3.84)	(7.02)	(8.24)

Table B.3A: Continued.

Coefficients of	Occupational group AL						Occupational group ASE					
	Linear form			Quadratic			Linear form			Quadratic form		
	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
For Rothbarth *equivalence scale*												
intercept	-183.08	-217.37	-208.18	346.56	525.42	503.21	-339.63	-494.18	-470.04	1264.00	1317.60	1290.80
	(12.85)	(18.51)	(23.02)	(3.05)	(7.47)	(8.59)	(9.69)	(28.92)	(30.82)	(6.56)	(12.35)	(14.15)
$\ln y$	40.27	46.60	44.90	-144.96	-212.32	-203.40	66.42	92.68	88.80	-467.19	-481.11	-473.25
	(15.32)	(21.70)	(27.06)	(3.67)	(8.74)	(10.03)	(10.86)	(31.76)	(33.92)	(7.33)	(14.35)	(16.39)
$(\ln y)^2$	-	-	-	16.12	22.49	21.59	-	-	-	44.34	45.25	44.67
				(4.70)	(10.69)	(12.28)				(8.47)	(17.17)	(19.53)
$d^a_{15+} - 2$	3.89	5.49	4.81	3.41	3.78	3.53	5.89	3.67	4.16	1.84	2.58	2.47
	(4.81)	(8.26)	(9.39)	(4.26)	(5.78)	(7.00)	(3.55)	(5.13)	(6.05)	(1.19)	(3.74)	(3.92)
md^c_{0-14}	-1.61	-1.50	-1.54	-1.40	-1.43	-1.39	-4.05	.21**	-.65	-1.83	-1.26	-1.34
	(1.97)	(2.14)	(2.88)	(1.73)	(2.13)	(2.70)	(1.95)	(.20)	(.71)	(.99)	(1.36)	(1.60)
fd^c_{0-14}	-.61	-.72	-.76	-.63	-.90	.88**	-1.72	-3.72	-3.39	-1.51	-3.78	-3.41
	(.74)	(1.03)	(1.42)	(.77)	(1.35)	(1.70)	(.99)	(3.84)	(3.92)	(.99)	(4.24)	(4.34)

Figures in parentheses are the absolute t-values.

**These parameters do not have the expected sign.

Table B.3B: Parameter estimates corresponding to Table 5.5B for the overall sample

Coefficients of	For Engel *equivalence scale*		For Rothbarth *equivalence scale*	
	WL	QL	Linear	Quadratic
(1)	(2)	(3)	(4)	(5)
intercept	.68	-.41	-367.24	914.80
	(32.63)	(3.26)	(46.19)	(20.32)
$\ln y$	-.07	.29	72.76	-352.39
	(18.16)	(7.09)	(51.72)	(23.83)
$(\ln y)^2$	-	-.03	-	35.09
		(8.72)		(28.86)
$d^{a}{}_{15+} - 2$	.02	.02	3.74	1.51
	(14.76)	(16.26)	(8.59)	(3.69)
$md^{c}{}_{0-14}$	.02	.02	-1.36	-1.55
	(11.24)	(11.44)	(2.54)	(3.15)
$fd^{c}{}_{0-14}$	.02	.02	-2.08	-2.24
	(12.40)	(12.60)	(4.01)	(4.70)

Figures in parentheses are the absolute t-values.

Table B.4A: Parameter estimates corresponding to Table 5.6A by occupational groups and social categories within these occupational groups.

Coefficients of	Occupational group AL						Occupational group ASE					
	WL form			QL form			WL form			QL form		
	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	For Engel *equivalence scale*											
intercept	.50	.43	.47	-.13	-.24	-.24	.71	.68	.70	-1.09	-.14	-.23
	(7.59)	(8.73)	(12.12)	(.25)	(.80)	(.92)	(6.62)	(17.09)	(19.67)	(1.66)	(.52)	(.98)
$\ln y$	-.03	-.02	-.03	.19	.21	.22	-.07	-.07	-.07	.53	.19	.23
	(2.66)	(2.46)	(4.10)	(1.02)	(2.02)	(2.44)	(3.78)	(10.10)	(11.44)	(2.43)	(2.34)	(3.07)
$(\ln y)^2$	-	-	-	-.02	-.02	-.02	-	-	-	-.05	-.02	-.03
				(1.20)	(2.24)	(2.77)				(2.77)	(3.16)	(4.03)
$d^a_{15+} - 2$	.02	.01	.02	.02	.02	.02	.02	.01	.02	.03	.02	.02
	(3.95)	(4.83)	(6.60)	(4.11)	(5.25)	(7.04)	(4.17)	(8.33)	(9.54)	(4.87)	(8.64)	(10.03)
md^c_{0-5}	.01	.002	.01	.01	.002	.004	.001	.01	.01	-.001**	.01	.01
	(.86)	(.48)	(2.41)	(.82)	(.50)	(2.49)	(.05)	(8.33)	(3.34)	(.12)	(1.94)	(3.40)
fd^c_{0-5}	.02	.004	.01	.02	.004	.01	.01	.01	.04	.01	.01	.01
	(2.59)	(.82)	(2.41)	(2.59)	(.90)	(2.49)	(.45)	(3.22)	(3.34)	(.54)	(3.24)	(3.40)
md^c_{6-10}	.03	.03	.03	.03	.02	.03	.02	.01	.02	.02	.02	.02
	(4.35)	(5.01)	(6.60)	(4.34)	(4.56)	(6.66)	(2.09)	(3.85)	(4.41)	(1.86)	(4.12)	(4.69)
fd^c_{6-10}	.03	.02	.02	.03	.02	.02	.02	.02	.02	-.02**	.02	.02
	(3.91)	(4.12)	(5.82)	(4.34)	(4.11)	(5.84)	(1.86)	(4.77)	(5.48)	(1.81)	(4.80)	(5.45)
md^c_{11-14}	.03	.02	.02	.03	.02	.02	.03	.02	.02	.02	.02	.02
	(3.11)	(3.00)	(4.21)	(3.04)	(2.97)	(4.14)	(2.02)	(4.05)	(4.51)	(1.77)	(3.97)	(6.36)
fd^c_{11-14}	.04	.02	.02	.03	.02	.02	.05	.02	.03	.05	.02	.02
	(3.49)	(2.45)	(3.86)	(3.43)	(2.51)	(3.14)	(3.42)	(4.71)	(5.81)	(3.00)	(4.65)	(5.72)

Table B.4A: Continued.

Coefficients of	Occupational group AL						Occupational group ASE					
	Linear form			Quadratic			Linear form			Quadratic form		
	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All	SC-ST	OTHER	All
(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
For Rothbarth *equivalence scale*												
intercept	-182.71	-219.82	-208.97	360.63	523.99	505.44	-332.85	-496.80	-472.43	1253.30	1316.70	1284.10
	(12.71)	(18.41)	(22.79)	(3.17)	(7.44)	(8.63)	(9.52)	(28.96)	(30.84)	(6.53)	(12.32)	(14.03)
$\ln y$	40.21	47.01	45.02	-149.80	-212.16	-204.27	66.33	93.21	89.30	-462.82	-481.19	-471.41
	(15.15)	(21.54)	(26.77)	(3.79)	(8.73)	(10.08)	(10.70)	(31.79)	(33.97)	(7.29)	(14.33)	(16.27)
$(\ln y)^2$	-	-	-	16.54	23.59	21.67	-	-	-	43.94	45.29	44.56
				(4.82)	(5.45)	(12.38)				(8.37)	(17.15)	(19.42)
$d^a_{15+} - 2$	3.72	5.28	4.67	3.21	-.75	3.38	5.64	3.65	3.98	1.74	2.37	2.30
	(4.55)	(7.86)	(9.04)	(3.97)	(.72)	(6.66)	(3.38)	(4.10)	(5.73)	(1.13)	(3.38)	(3.60)
md^c_{0-5}	-.92	-.67	-.73	-.67	-.31	-.59	-.03	-.001	-.24	1.48**	-.98	-.91
	(.72)	(.02)	(.88)	(.53)	(.31)	(.75)	(.01)	(1.001)	(.18)	(.50)	(.76)	(.72)
fd^c_{0-5}	-1.21	.09**	-.47	-1.19	-3.46	-.73	-2.68	-1.30	-1.21	-3.41	-1.41	-1.54
	(.96)	(.88)	(.59)	(.95)	(3.07)	(.94)	(.82)	(.85)	(.87)	(1.10)	(1.01)	(1.27)
md^c_{6-10}	-2.83	-3.54	-2.77	-1.05	-3.33	-2.20	-.08	-.13	-48**	.30**	-2.21	-1.90
	(2.05)	(3.00)	(3.79)	(2.05)	(3.07)	(3.87)	(.59)	(.05)	(.09)	(.09)	(1.47)	(1.38)
fd^c_{6-10}	-1.22	-1.14	-1.23	-1.49	-1.05	-1.26	-3.47	-4.82	-4.48	-2.84	-4.97	-4.43
	(.83)	(.94)	(1.31)	(1.03)	(.91)	(1.40)	(1.11)	(2.83)	(2.95)	(1.03)	(3.18)	(3.21)
md^c_{11-14}	-.67	-.52	.27**	-.23	.77**	.60**	-13.69	-.96	-2.57	-10.38	-.01	-1.20
	(.37)	(.38)	(.25)	(.13)	(.58)	(.57)	(3.03)	(.47)	(1.37)	(2.60)	(.01)	(.70)
fd^c_{11-14}	2.53**	-.97	.07**	3.01**	-1.09	.19**	1.34**	-6.80	-5.95	2.13**	-6.14	-5.10
	(1.22)	(.61)	(.05)	(1.47)	(.72)	(.16)	(.29)	(3.40)	(3.24)	(.53)	(3.39)	(3.65)

Figures in parentheses are the absolute t-values.

**These parameters do not have the expected sign.

Table B.4B: Parameter estimates corresponding to Table 5.6B for the overall sample

Coefficients	For Engel *equivalence scale*		For Rothbarth *equivalence scale*	
of	WL	QL	Linear	Quadratic
(1)	(2)	(3)	(4)	(5)
intercept	.70	-.32	-370.90	908.83
	(33.79)	(2.51)	(46.30)	(20.11)
$\ln y$	-.07	.27	73.32	-350.69
	(19.32)	(6.43)	(51.77)	(23.64)
$(\ln y)^2$	-	-.03	-	34.97
		(8.17)		(28.70)
$d^a{}_{15+} - 2$	.02	.02	3.35	1.36
	(15.82)	(17.16)	(8.05)	(3.30)
$md^c{}_{0-5}$	.003	.004	.15**	-.76
	(1.60)	(1.98)	(.18)	(1.01)
$fd^c{}_{0-5}$	.01	.01	-.17	-.69
	(4.49)	(4.72)	(.22)	(.95)
$md^c{}_{6-10}$	.02	.02	-2.24	-2.55
	(9.80)	(9.98)	(2.54)	(3.14)
$fd^c{}_{6-10}$	.02	.02	-4.13	-3.89
	(10.02)	(10.01)	(4.53)	(4.64)
$md^c{}_{11-14}$	.03	.02	-2.18	-.85
	(8.87)	(8.55)	(1.97)	(.84)
$fd^c{}_{11-14}$	.02	.02	-2.71	-2.38
	(7.95)	(7.92)	(2.36)	(2.25)

Figures in parentheses are the absolute t-values.

**This parameter do not have the expected sign.