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THE STRUCTURE OF HOUSEHOLD CONSUMPTION IN FINLAND, 1966-1990

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ABSTRACT: The structure of household consumption is examined in nine component categories using data from six Household Budget Surveys, in 1966-1990. The study discusses and presents econometric methods (EQML) to estimate demand models at the micro (household) level. Methods solve for an 'errors-in-variables' problem in a novel way and allow for heteroskedasticity in the errors. Budget share equations which are based on a flexible functional form (QAIDS) are used to analyse the age profiles and Engel curves in consumption. Similarly, the life-cycle profiles and cohort paths in consumption and the effects of household composition are examined. The results show a useful decomposition of the above demographic effects and the effects due to change in prices and improved living standards on the evolution of consumption. In the final part of the study estimates for the price and expenditure elasticities of demand are presented both including and not including the acquisition of durable goods.

KEY WORDS: Microeconometrics, heteroskedasticity, errors-in-variables, household consumption, allocation models, Engel curves, age profiles, life-cycle effects, elasticities.

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TIIVISTELMÄ: Kotitalouksien kulutusrakennetta tutkitaan käyttäen kuuden Kotitaloustiedustelun yhdistettyä aineistoa vuosilta 1966-1990. Kulutus on luokiteltu yhdeksään pääryhmään. Työssä tarkastellaan ja esitellään ekonometrisiä menetelmiä (EQML), joita sovelletaan kotitaloustasolla täsmennettyjen kysyntämallien estimoinnissa. Menetelmät esittävät tuoreen ratkaisun selittävien muuttujien mittavirheongelmaan ja ottavat samalla huomioon mallin virhetermin mahdollisen heteroskedastisuuden. Budjettiosuusyhtälöitä, jotka nojautuvat joustavaan funktioesitykseen, käytetään kulutuksen Engelin käyrien ja ikäprofiilien analysoinnissa. Lisäksi esitetään tuloksia kulutusrakenteen elinkaari- ja kohorttiurista sekä kotitalouden koostumuksen vaikutuksesta. Tuloksilla pystytään erottelemaan miten yhtäältä demografisten tekijöiden ja toisaalta hintojen muutos ja elintason nousu ovat vaikuttaneet kehitykseen. Työn lopussa esitetään kysynnän hinta- ja menojoustojen estimaatteja, jotka on laskettu sekä ottaen mukaan kestokulutushyödykkeiden hankinnat että ilman niitä.

ASIASANAT: Mikroekonometria, heteroskedastisuus, mittavirheongelma, kotitalous, kulutusrakenne, Engelin käyrät, ikäprofiilit, elinkaari, kysynnän joustot.

FOREWORD

Analysis of household budgets has been a major occupation in empirical economics. An appealing feature of econometric research into consumer demand is the close and intimate relationship between theoretical specification and appropriate estimation technique. This is most apparent when analysis takes place at the individual or micro level. Modern purposes of the analysis take a direct welfare analytic approach by adopting a flexible representation of preferences. The advantages are that untenable restrictions on behaviour are avoided, the elasticities are measured not assumed, and the economic effects of tax reforms can be evaluated using a consistent welfare theoretic framework.

In the study modern econometric methods and allocation models of household demand have been used to examine the evolution in the structure of consumption in 1966-1990. The examination has been based on the age profiles and Engel curves in consumption. The study presents useful and interesting material on the life-cycle profiles and cohort paths in consumption. In addition, the authors examine the effects of household composition on consumption and provide estimates for the elasticities of demand both including the acquisition of durables and without them. The model of non-durable consumption provides a steady platform to consolidate and probe on to give the research a welfare-theoretic orientation and finally aim at tax-reform analysis.

Analysis of tax-reforms at the individual level has been one of the priorities in Government Institute for Economic Research. This study by Ilpo Suoniemi and Risto Sullström is a part of a long-run project to construct empirical models to analyse the economic effects of indirect taxation and public provision of welfare services. It is team work which builds on the earlier studies by Risto Sullström in the University of Helsinki. The Government Institute for Economic Research has recently integrated the separate lines of Finnish research under its auspices to facilite more rapid progress in this crucially important research area which has been slacking in Finland after a very promising start in the early sixties.

On behalf of Government Institute for Economic Research I want thank the researchers, especially Risto Sullström who has been able participate in the study as an associate member of our team. The efforts in preparing the equalized collection of household surveys by the people in Statistics of Finland are gratefully acknowledged.

Helsinki, 31st May 1995

Seppo Leppänen

ESIPUHE

Empiirisen taloustieteen eräs pääsuunta on kotitalouksien kulutusrakenteen ja siihen vaikuttavien tekijöiden tutkimus. Ekonometrisessa kysyntätutkimuksessa teoriamallien täsmällinen muoto ja estimointitekniikat pysytään usein yhdistämään tiiviiksi kokonaisuudeksi. Näin on erityisesti, jos tarkastelu tapahtuu yksilötasolla. Moderniin hyvinvointiteoriaan nojaavien tutkimusten uutena sovellusalueena on verouudistusten taloudellisten vaikutusten arviointi. Jos tutkimukset perustuvat joustavien funktioesitysten käyttöön, näillä laskelmilla on lisäarvona se, että niiden kulmakivinä olevat joustoarviot ja analyysin päätelmät määräytyvät aineiston, ei mallin oletusten perusteella.

Tässä tutkimuksessa käytetään uusimpia ekonometrisia välineitä ja kysyntämalleja kotitalouksien kulutusrakenteen kehityksen selvittämiseksi ajanjaksolla 1966-1990. Tarkastelu perustuu kotitalouksien Engelin käyrien ja kulutuksen ikäprofiilien käyttöön. Tutkimuksessa esitellään kulutuksen elinkaari- ja kohorttiuria. Nämä antavat hyödyllistä tietoa siitä, miten kulutusrakenne on muovautunut yhtäältä taloudellisten tekijöiden, hinnat ja elintason nousu, ja toisaalta demografisten ja elinkaaritekijöiden vaikutuksesta. Lisäksi tutkitaan kotitalouden koostumuksen merkitystä kulutusrakenteeseen ja raportoidaan kysynnän hinta- ja menojoustoja. Joustolaskelmat esitetään sekä sisällyttämällä kestävien kulutustavaroiden hankinnat kulutukseen että ilman niitä. Käytetyt mallit tarjoavat vankan pohjan jatkaa hyvinvointitarkasteluja tähtäimenä verotuksen taloudellisten vaikutusten arviointi.

Verotuksen ja verouudistusten yksilötason vaikutusten arviointi on eräs Valtion taloudellisen tutkimuskeskuksen kulmakiviä. Ilpo Suoniemen ja Risto Sullströmin tutkimus on osa laajaa hanketta laatia empiirisiä laskentamalleja välillisen verotuksen ja yhteiskunnallisen palvelutuotannon arviointiin. Tämä on yhteistyötä, joka pohjaa Risto Sullströmin aiempiin Helsingin yliopistossa tekemiin tutkimuksiin. Valtion taloudellinen tutkimuskeskus on ottanut siipiensä suojaan aiemmin erillään versoneet tutkimusaiheet saadakseen yhdistelemällä aikaan ripeämpää kehitystä tällä tärkeällä tutkimussaralla. Onhan yksilöaineistoihin perustuva tutkimus ollut Suomessa laiminlyötyä kuusikymmenenluvun lupaavan alun jälkeen.

Valtion taloudellisen tutkimuskeskuksen puolesta kiitän tekijöitä, erityisesti Risto Sullströmiä, joka on osallistunut työhön henkilöstömme liitännäisjäsenenä. Samoin kiitän Tilastokeskuksen henkilöstöä niistä ponnistuksista, joita on vaadittu yhdenmukaistettujen kotitaloustiedustelujen valmistamiseksi.

Helsinki, 31 toukokuuta 1995

Seppo Leppänen

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Chapter 1

Introduction

Analysis of household budgets has been a major occupation in empirical economics. This work has its origins in the famous studies of Engel [1857] who found out the celebrated law that the share of total expenditure spent on food seems to decrease as the income available to total consumption is increased. The estimation and analysis of these Engel curves was taken up by Allen and Bowley [1935]. On the other hand, demand analysis represents an area where important advances have been made in the econometric methodology. Indeed an appealing feature of economic research into consumer demand is the close and intimate relationship between theoretical specification and appropriate estimation technique. This is most apparent when empirical analysis takes place at the individual or micro level.

Household budget data has been collected at regular intervals for the purposes of finding suitable weights for the component categories of consumption in forming the consumer price index. Other original research interests, see Engel [1895] that occupy with the measurement of consumer demand include finding out the additional cost of a child, or more generally an 'equivalence scale measure.' These are used to correct for differences in household size and composition when welfare of different households is being compared. A similar yardstick is often needed to adjust poverty lines or welfare cash transfers for differences in the needs of households having varying size and composition. More modern purposes of the analysis take a direct welfare analytic approach to examine the economic effects of tax reforms that imply changes both in the indirect and direct (labour) taxation and subsidies given to households, see Baker et. al. [1990].

There has been two major strands in the empirical demand analysis.[1] The first adopts a purely empirical approach. This is governed mainly by empirical convenience and goodness of statistical fit where usually ad hoc functional forms are used to analyze the demand for individual commodities. This approach was adopted by Prais and Houthakker [1955] in their famous study of consumption patterns in the United States. The

[1] In this study we do not cover the by now enormous literature on consumer demand which utilizes time series data except for those individual studies that made important methodological contributions which bear on our work. For a more complete review see Deaton and Muellbauer [1980b] and the excellent reviews by Deaton [1986] and Blundell [1988].

main interest of these studies has been to isolate the effects of individual price increases on consumption often culminating in reporting the price and income elasticity measures. A positive feature of this approach is that it is relative simple to estimate Engel curves that connect expenditure share of a commodity, or a component category of commodities to total expenditure by the method of ordinary least-squares. Additional functional forms for Engel curves to be used in these studies have been presented by Törnqvist [1941], Working [1943], and Leser [1963]. Other covariates that account for differences in, for example family size and composition and the age of household head can be added on a similar, ad hoc basis.

To take up negative aspects, the estimators obtained by the first method do not necessarily possess the desired regularity properties of demand. These include adding-up (to total expenditure) of demand, homogeneity of demand, and negativity of the own price substitution effects and symmetry of cross-price effects. These are the regularity properties that characterize the allocation system of equations that is obtained by maximizing a well-behaved utility function.

The second approach starts from a well-specified utility function as the studies pioneered by Klein and Rubin [1947] and Stone [1954a], [1954b], which use the linear expenditure system (LES) a tradition brought to peak by the work by Lluch et.al. [1977] where extensive use is made of budget data. One may also use an alternative characterisation of preferences. This can be done by using an indirect utility function, the quadratic extension of the LES by Pollak and Wales [1978] who estimated a demand system using budget data from two time periods, and the Indirect Translog System, Christensen et.al. [1975]. Equivalently, one may start with an expenditure function, the Almost Ideal Demand System by Deaton and Muellbauer [1980a], or some other aggregator function, such as the distance or profit functions to arrive at a complete specification of an allocation model of total consumption explaining how expenditure is distributed among its component categories.

Modern approaches to the econometric analysis of the consumption structure of households adopt a flexible representation of preferences, see Christensen et.al. [1975] using a second order approximation to an underlying aggregator function. The motivation and properties relating to the use of this method are extensively discussed by Diewert [1974]. The empirical advantage of using flexible representation for functional form is that untenable restrictions on behaviour are avoided. In effect the elasticities are measured not assumed. This is in stark contrast to using rigid forms like the LES or CES which are internally consistent but less fortunate in the particular assumptions entertained. In these cases welfare improving directions for tax changes are governed almost entirely by the properties of the theory model and not necessarily those in the data.

The gains associated with flexible functional forms are achieved at the cost of the increased computational burden of more complex and less parsimonious models. Furthermore, since the models are based on local approximations they are completely giving up global regularity in functional form. The regularity requirements consist of the monotonicity and curvature conditions in rational neoclassical economic behaviour.

If there is little variation in relative prices as is usually the case in having a single cross-section to operate on, the previous two methods produce results that can judged on similar merits. In this study the last approach is used. We use a functional form for the expenditure function which is flexible in the sense that it can be seen as to present a second order approximation in relative prices for the expenditure function. Specifically, the functional form is derived as a quadratic extension of the Almost Ideal Demand System (AIDS) originally introduced by Deaton and Muellbauer [1980a], where consumption structure is represented by giving a system of equations in budget share form. These equations are obtained by derivating the logarithm of the expenditure function w.r.t. the price variables that are expressed in the logarithmic form. The corresponding Engel curves are quadratic extensions of the functions presented by Working [1943]. This means that the Engel curve which relates the expenditure share of a component category of consumption to total consumer outlay has additional flexibility in the form of allowing a second order term in real expenditure. The extra term allows for a commodity which is a luxury at low levels of total expenditure to turn into a necessity at higher levels of total expenditure to reflect increased scope for substitution as the spectrum of consumption possibilities available to the consumer is widened.

The derived system of demand functions (QAIDS) is based on a functional relationship for the expenditure function. If the monotonicity and curvature conditions of neoclassical economic behaviour hold at the estimates the functional form allows for a theoretically consistent way of evaluating tax-reforms by direct calculation of welfare-based efficiency measures, for example the equivalent variation, see King [1983], Baker et.al. [1990], and Suoniemi [1994]. In addition the QAIDS allows for exact aggregation over consumers, in the sense defined by Lau [1982]. This result is due to Gorman [1981] who characterized the functional forms for the Engel curves which are allowed by the theory to satisfy the conditions of Lau.

Furthermore, we introduce additional explanatory variables that allow for the budget share equations to depend on other predetermined explanatory factors, i.e. we use a wider variety of conditioning factors other than just price and total expenditure. These covariates take account of the demographic characteristics, such as the age and gender of household head, geographic location of households, the household size, and factors related to household composition, the number of children and old-aged persons. In the present study we proceed a step further allowing the slope coefficients of the logarithmic total real expenditure variable to depend on a set of household characteristics, see Blundell, et.al. [1993]. We discuss some characterizations and interpretations that are possible for our model in more detail below. The above modifications are standard in empirical work and the former may be seen as a necessity in the case of analyzing micro data, see Deaton [1986]. Because we have so many complicating covariates it is clear that elasticity calculations and examination of results should be done in a multivariate framework.

The data that are used in the study are drawn from six cross-section surveys made in Finland in the years 1966, 1971, 1976, 1981, 1985, 1990, having 33 240 individual observations in all. The data have been manipulated by Statistics Finland to provide an 'equalized' collection of cross sections with variables which have comparable definitions and content. We kindly thank them for their efforts with the data. In this study expenditures are grouped into nine broad categories. To give a complete picture how the structure of consumption evolved during the time period 1966-1990 we have included purchases of durables and housing costs within the consumption categories that we study. We have augmented this data set by price variables that have been calculated using Consumer Price Index data. The price variables are formed on the basis of the time period when the individual observation is collected. Previous studies that have used comparable data in Finland are Riihelä and Sullström [1993], and Sullström [1995].[2]

In the 24 year time period covered by our data labour moved from rural to urban areas, and the after-war baby boom generation have grown from youth to middle-aged with a simultaneous reduction in the average family size. These major influences as well as the impact on the individual living standards brought along massive changes in the Finnish society. While the focus in analysing the change has often been on the supply side and the key areas of economic activity as the labour and financial markets, and on aggregate demand many shifts have occurred in the composition of demand. These changes took place as incomes increased, relative prices changed and the age structure and family composition was reformed, and new goods and services were introduced.

The main substantive mission is to give an analytical study of the evolution of the age and income profiles in consumption over the sample period. These effects are examined by estimating and reporting the results on a series of models with increasing degrees of parsimonity in order to find out which effects conveniently summarize the data without setting unreasonable restrictions on the fit.

For these purposes we add two supplementary variables to the model. The first one is needed mainly to test our model for an early and interesting "relative income hypothesis" in consumption behaviour which was originally put forth by Duesenberry [1949], related ideas have been propagated also by Veblen [1899]. Loosely speaking the hypothesis suggests that consumer's consumption habits should reflect his (or her) social reference group. Relative deprivation theory which is a common theme in the psychological and sociological literature but has not made much impact into the economic literature suggests that when an individual's income fall below the comparison level, he feels relatively deprived. Alternative interpretations to the above phenomenon might involve the concept of positional goods, i.e. goods whose consumption is dependent on the consumer's position in the income distribution rather than on his actual income level.

To examine these ideas we introduce a positional variable into our model. The variable is the signed distance of the household from the median consumer. The median is estimated using the population mean of logarithmic total expenditure which is adjusted for the size of household. The variables are based on fitted values by instruments, and the mean is calculated separately for each survey. Härdle and Jerison [1988] have found that Engel curves are more stable across cross-sections if they have been normalized with mean income. This should give some additional credence to our choice of the auxiliary variable.

Similarly, we introduce another auxiliary variable to capture some cohort effects in

[2]On Finnish studies on demand for individual commodities which have used micro data one could mention Nyberg [1967], and Suoniemi [1990].

slowly changing consumer environment where new commodities are introduced and habits and preferences evolve. The variable that we use is the logarithm of the household head's age calculated in a given year, here 1981. This variable allows for a slowing creeping effect in relation to the survey years. On the other hand, using only the calender age at the time of the survey neglects the gradual overturn of population, and having in the sample people that are observed to be at same age but have in fact been grown-up and moulded in widely differing economic and social environments. The basic explanatory variables include the logarithmic calender age of household head and a quadratic term in this variable. Since the natural range of the age variable is bounded then taken together the latter variables allow for the effect of age to be flexible, either monotonously decreasing or increasing, or to have the shape of either a well or a hump.

To give a complete picture how the structure of consumption evolved during the time period 1966-1990 we have included purchases of durables and housing costs within the nine consumption categories that we study. However, consumption of durable goods tends to exhibit different patterns from consumption of nondurables and services. The former often resemble capital goods, see Deaton and Muellbauer [1980b], Chapter 15. Therefore their inclusion may be detrimental to obtaining "theoretically" correct price coefficients. In addition theoretical considerations imply that one should include the service flow from durables into consumption and modify price variables to reflect that. This by far exceeds the limits that our data constrain us to work within. For these reasons we present some results on the price elasticities of demand for nondurables leaving out the category, Beverages and Tobacco since here some addictive behaviour may be present.

The econometric tools that we use in this paper introduce some relatively novel aspects that may have added methodological interest. Allocation models are customarily estimated using Zellner's [1962] Seemingly Unrelated Regressions (SURE) model. Implicitly one introduces random disturbance terms to the individual equations. If the system of equations is estimated, say by SURE-method all the equations contain the same set of explanatory variables and the linear system which is obtained by dropping one equation is just identified. Therefore the results are identical with an equation by equation treatment by OLS (or 2SLS if instruments are used for the endogenous right-hand side variables). Homogeneity restrictions can now be tested by OLS in an equation by equation manner. In contrast, the symmetry restrictions involve restrictions across equations and resort to a proper application of SURE is needed (or 3SLS, Zellner and Theil [1962]).

The above method assumes that the covariance structure across individual equations is homoskedastic. Particularly when using microdata homoskedasticity is a untenable assumption resulting in inefficient estimators and distorted statistical inference procedures. In fact, heteroskedasticity is unavoidable in efficient consumption share equation estimation as shown for example through the consistent stochastic specification by Chavas and Segerson [1987]. Random individually varying coefficients models produce covariance structures that fall into the heteroskedastic framework.

In this study we develop an econometric model and an estimation method which accommodates parametric heteroskedasticity in a single equation Estimated Quasi Maximum Likelihood (EQML). Similarly we account for some specific features in the sampling framework used in collecting the actual data. The motivation for this is the finding by Low (1983) that similarly accommodated generalized least squares may outperform the Zellner's estimator even though single equation estimator ignores the correlation across share equations. Naturally the relative performance of the alternative models depends on the severity of the covariance vis-a-vis the heteroskedasticity. Under some specific assumptions we are able to evaluate efficiency gain of the parametric heteroskedastic model relative to a homoskedastic single equation model. Furthermore, the econometric structure of our model incorporates the use of preliminary fits by instruments for some of the right hand side variables in a novel way.

The statistical-econometric sampling model of the data has been endowed with the following features. First, one accounts for data imperfections encountered in collecting the consumption data. An important problem concerns the error-free measurement of the various subcomponents of consumption. In particular, the total consumption expenditure should correspond to the theoretical concept which is exogenous to the allocation decision rather than to the error prone actual expenditure measure which reflects the relatively short bookkeeping periods used in collecting the actual data. This is a point argued already by Summers [1959]. Deaton [1986] argued that this is particularly important in cross section work where occasional large purchases affect "both sides of the Engel curve."

We treat nominal total expenditure similarly as in an 'errors-in-variables' problem and utilize a two-stage estimation procedure where a preliminary fit is used to project the error-prone variables on a linear subspace spanned by the instruments. In effect total expenditure is replaced by its conditional expectation and the expectation should be taken in relation to a set of exogenous variables that households use efficiently to forecast the future values which in turn affect the consumption decision in a dynamic life-cycle framework, see Bierens and Pott-Buter [1989]. These variables should account for wealth, not neglecting human wealth variables, and conditions in the financial and labour markets.

Our approach has some similarities with Blundell et. al. [1993] who use instrumental variables to estimate a system of demand equations. The above considerations, however, lead us to use a richer set of instruments together with a nonlinear forms of the variables and time varying parameters for the six surveys present in our data to obtain the conditional expectation of total expenditure. Furthermore, all variables that are functionally related to total real expenditure are replaced by the conditional expectations but do not have separate fits by the instruments, as conventionally done. Here we use the properties of the conditional expectation and distributional assumptions to solve the 'errors-in-variables' problem. The modifications involve several aspects of the model, such as treatment of nonlinear transformations in conditional expectations, and forming preliminary fits of the budget shares in the Stone index used in defining the real expenditure measure.

At the second stage of our two-stage estimation procedure we substitute the pre-fitted, smoothed values of real expenditure for the actual values in our model. In fact all variables that are functionally related to the total real expenditure are replaced by conditional expectations. At the second stage we have to take into account that we are substituting preliminary estimates of the theoretical counterparts for error-ridden endogenous explanatory variables rather than true no-error-ridden variables. Zellner [1970] proposed a similar estimation method which utilizes information on the specification for theoretical variables in structural estimation of the method. In our case this is done by modifying the error terms in the model correspondingly and making the necessary modifications in the variance of the augmented disturbance terms. Here we lean on standard instrumental variable assumptions. The 'quasi likelihood function' that we obtain is maximized to obtain estimators for the structural parameters of the model.

The estimated covariances of those parameters estimated at the initial stage are utilized at the final stage to guarantee correct inferences in the final model. If this is not done the covariances of parameter estimates are estimated biasedly. Our modifications are made to prevent this from happening since our quasi likelihood function can be seen as a correct approximation to the second order in the estimable parameters of the allocation model. We use also the functional relationship between our endogenous explanatory variables to get compensating efficiency gains at the second stage of estimation.

Finally, we allow for heteroskedasticity in the model disturbance term. This is done in a simple and economical but simultaneously in a relatively powerful way by connecting the fit of the budget share equation and the corresponding variance of the error by a functional relationship that is governed by a single estimable parameter per equation. One may motivate the specific functional form in the study as arising from an approximation at the mean of a stochastic parameter model. Furthermore, we account for the sampling structure and data collection methods which vary from survey to survey by estimating an additional variance component parameter separately for each survey in the data. The procedure has a natural counterpart in the well-known random effect approach to modelling proper panel data.

Because the induced disturbances at the second stage of estimation have a relatively complicated structure we chose to use an EQML method to estimate the parameters separately for each equation. This has some complicating implications. For example, one cannot directly impose parameter restrictions across equations as would be needed in testing for symmetry in the price parameters as required by a model that is based on utility maximizing behaviour on the part of the household. Furthermore, the adding-up constraints of the model parameters are not necessarily valid at the estimates that we obtain by using a statistical model for heteroskedasticity. However, we are able to use instead a Waldian test for these restrictions using the unrestricted form of model as the base line.[3] Similarly, one can form a linear function of the unrestricted estimators which satisfies the above constraints. It can be shown that this estimator is the *best unbiased linear transformation* of the unrestricted estimators in the sense that it has under the null hypothesis the smallest asymptotic covariance matrix in the set of estimators that

[3]In models that are linear in the structural parameters and are estimated by SURE there are no differences in estimators asymptotically if restrictions are imposed directly or formed using unrestricted estimators.

are linear functions of the unrestricted estimators and satisfy the linear constraints.

We considered that recycling some of the material would be helpful for those readers who do not plan to read through the whole study. Therefore, for example some the material in Chapter 4 which is quite heavy reading and contains mainly technical material is repeated in other chapters in hopefully more accesible form. We beg for patience by those readers who will consider this both as unnecessary and irritating.

The study is organized as follows. In Chapter 2 we examine time series consumption data in Finland and give a description of the evolution of demand using this source of data. In the following chapter we give a brief summary of the surveys and household budget data that are used in this study. Chapter 4 introduces econometric methodology that we employ giving some properties of the specific estimation (EQML) and testing procedures that are used. Chapter 5 gives some preliminary results on instrumenting of the total expenditure variable and tests of heteroskedasticity and some assessment on the efficiency gain produced by our method.

In Chapter 6 the evolution of Engel curves and the age profiles in consumption over the sample period 1966-1990 are examined by estimating and reporting the results on a series of models with varying degrees of parsimonity. This approach is selected in order to find out which effects conveniently summarize the data without setting unreasonable restrictions on the fit. Here we will find out that diagnostic methods have to be used in a liberal and relaxed manner to avoid from producing by far too complicated models. In comparing Engel curves and the age profiles in the consumption that are obtained by using the different models we resort mainly to graphical methods.

To augment the examination we present in this chapter some material on the cohort and life-cycle effects of consumption by supplementary figures that give the total, marginal effect of the age of the household head. We label these as life-cycle profiles in consumption since in calculating them we make predictions of all the other variables on the basis of the age variables that we allow to vary over the natural range of values. The age profiles in consumption that are presented in Section 6.3 can be interpreted as representing ceteris paribus effects, since in calculating them we hold other variables affecting the fit constant. In practice if we observe a typical household all through its life-cycle we see changes in other variables too. Children are born into the family, they age and finally leave to start their own independent life as consumers. The income available to a household typically increase at first and finally may have a down-turn at old age. Simultaneously, over time there is economic growth present which is reflected in higher living standard and higher levels of consumption. One may with good reason argue that showing ceteris paribus effects w.r.t. age in individual surveys is a good description over only a limited range of values. Chapter 7 presents results on how household composition and some selected additional covariates affect the structure of consumption.

In the final part we turn into examining the elasticities of demand. Here we use models which are more constructive for the purpose of estimating the elasticities of demand. In Chapter 8 we report expenditure and price elasticities for the nine categories that include housing costs and purchases of durables to give a complete picture how the structure of consumption evolved during the time period we cover 1966-1990. The results are compared with the descriptive measures that we obtained for elasticities in Chapter 2 using time series data. Recognizing that consumption of durable goods exhibits different patterns from consumption of nondurables and services and their inclusion may be detrimental to obtaining correct price coefficients we present in Chapter 9 elasticities that have been obtained by not including durables and leaving out the somewhat troublesome category, Beverages and Tobacco. The last chapter offers some conclusions.

Chapter 2

Looking at Consumption

Laurila's [1982] extensive study on consumption in Finland, provides an excellent overview on the long-run tendencies in consumption structure, from the turn of the century to the middle of the 1970's. There one can find how the expenditure, the household consumption, and the prices of the various commodity categories have evolved, and also a well-formulated discussion about the factors that have influenced the matters in progress. The construction of time series data in the study for years before 1948, when the systematic data collection according to the System of National Accounts (SNA), was started, is especially valuable. Starting with the year 1960 there has been made available in Finland National Accounts time series based on the new SNA. We use the above sources of data as a starting point for our analysis of household demand, and for comparison with the our principal analysis conducted using data from budget surveys in 1966-1990. The data obtained from Household Budget Surveys are described in Chapter 3.

We select nine component categories of consumption into consideration. These nine categories are: (1) Food, (2) Beverages and Tobacco, (3) Clothing and Footwear, (4) Housing and (related) Energy, (5) Household Appliances, (6) Health Care, (7) Transport and Communication, (8) Education and Entertainment, and the residual category (9) Other Goods (and services).[1]

Over the years 1900-1990 there have been great changes in the consumption pattern and the characteristics of individual commodities, eg. in their quality, durability, and purpose of use. In the time period the Finnish society has been reformed from a closed agrarian society into an open, active one with many industries some of them new-born. The average growth rates in the real GDP and real Private Consumption have been

[1] We use the same labels for the corresponding categories also below while we analyse and consider micro data obtained from the Household Budget Surveys, although exact correspondence between the time series and budget surveys is not present in our data. The differences are examined in detail in connection with the description of the budget surveys, see Chapter 3. Furthermore, there is no possibility to obtain a full correspondence between Laurila's and National Accounts time series data since the level in the categorisation of the component subcategories that we have available is rather limited. The necessary rearrangements of the component subcategories within the larger categories of consumption have been made concerning the time series data constructed by Laurila. Details are available upon request.

3.5 and 3.2 per cent per annum, respectively in the period 1900-1990. The historical developments span the phase of declaring independence (1917) and the two World Wars (in 1914-1918 and 1939-1945) with rebuilding phases after them. In 1918 there broke out a bitter civil war in Finland which created sharp political front lines in the Finnish society. On the other hand, during and after the Second World War a substantial part of the population had to be relocated and rehabitated, since large areas of the country were invaded and were subsequently lost.

To give an indication of the massive changes in household consumption consider the category, Food. While the budget share of Food was 52.1 per cent in 1900, the corresponding value was a low 15.9 percentages in 1990 at the aggregate level. In contrast, in the category, Transport and Communication the value of the budget share increased from 3.0 per cent in 1900 to 18.4 in 1990. In Table 2.1 one can observe that for the basic commodities, such as Food, Clothing and Footwear, the budget shares have been decreasing. On the other hand, durables and services, such as Transport and Communication, Health Care, Education and Entertainment, and Other Goods and Services have increased their share in the household budget.

Table 2.1. Budget shares of time series data in selected years.

Component category	1900	1925	1938	1960	1990
1. Food	0.5208	0.4681	0.3515	0.3029	0.1594
2. Beverages and Tobacco	0.0712	0.0475	0.0648	0.0640	0.0702
3. Clothing and Footwear	0.1203	0.1332	0.1340	0.1074	0.0542
4. Housing and Energy	0.1287	0.1496	0.1666	0.1838	0.1816
5. Household Appliances	0.0529	0.0596	0.0706	0.0691	0.0692
6. Medical and Health Care	0.0075	0.0101	0.0161	0.0237	0.0411
7. Transport and Communication	0.0342	0.0447	0.0793	0.1081	0.1841
8. Education and Entertainment	0.0176	0.0319	0.0478	0.0540	0.1079
9. Other Goods	0.0467	0.0553	0.0693	0.0870	0.1323

Traditionally, price and income elasticities have been utilized to measure the effects on commodity demand while there are changes in prices and income. We started by fitting a simple log-linear function on the consumption data over the period 1900-1990, considering each component category separately. The function that we use should be considered as a filter on the data rather than any model for demand although it is based on a traditional functional form that conveniently produces the elasticities directly as the estimated parameters of the model. As the dependent variable we have the expenditures (in fixed prices) in the particular category of consumption considered. We use two explanatory variables, the relative price of the category in question and the real total expenditure. The relative price is taken in relation to an aggregate price index which is formed by all consumption categories. The relative prices of the other categories than the one under examination are ignored here. For descriptive purposes there is really no need to consider more complicated models.

The above functional form is then used to form a smoothing operator, a filter, on the consumption data. The smoothing operator has estimable parameters which are continuously updated in the fitting process referring to a constant term and our price and expenditure variables.[2] This is obtained by estimating the simple loglinear function by the method of weighted least squares repeatedly with a moving window of observations. The window is centred on the particular (pivot) observation we consider and the pivot observation and the window are moving through the whole time range.[3] The weight function is based on the density function of the normal distribution which is centred on the pivot observation and the distance of the observations to be weighted is calculated using the time scale of the observations. The weights get determined so that the observations close to the pivot are assigned more weight.[4] In the process of smoothing the consumption data we obtain as a by-product yearly estimates for the 'price and expenditure elasticities'.

The results for the category Food are given on Figure 2.1, and for the other categories in Appendix 1 (Figure A1.1).[5] The smoothing implicit in the panels for the elasticities is done by both including all the observations and also by omitting the war years in 1917-1919 and 1938-1945 (the dotted lines).[6] Figure 2.1 provides also a graphical description of the evolution in the budget shares and relative prices ('1938'=1.000) in the component categories of consumption. As opposed to the following chapters, the price indices considered here are obtained as the implicit deflators which are formed by diving each expenditure series, measured in current prices by the corresponding one, in fixed prices.

[2]We consider that it is out-of-place here to make experiments by more complicated time series models, such as the Kalman filter.

[3]The starting and end portions of the data are treated accordingly in the process with unsymmetric windows which collapse to one-sided windows when the pivot observation lies at the end points.

[4]The fitting process is programmed using GAUSS, Aptech Systems, Inc., with program code and details, eg. how the window lenght is set, available upon reguest.

[5]When the window lenght is widened or the number of observations effectively used in the individual fits is increased, the oscillation in the estimates is somewhat dampened, and vice versa.

[6]This is obtained by setting the corresponding weights for the observations to be omitted equal to zero.

Figure 2.1. Budget share of Food in 1900–1990

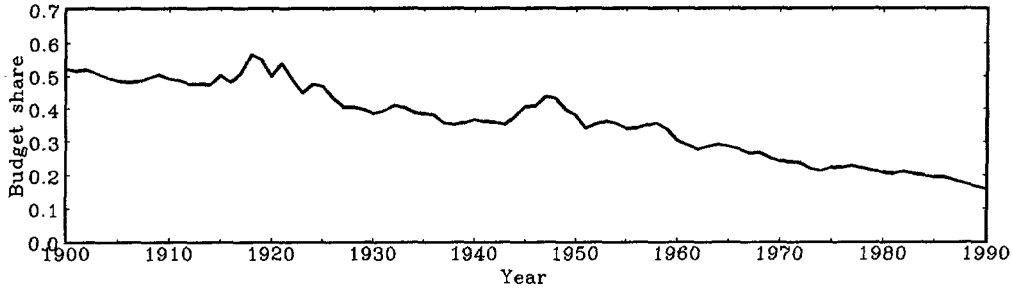


Figure 2.1. Expenditure elasticity of Food in 1900–1990

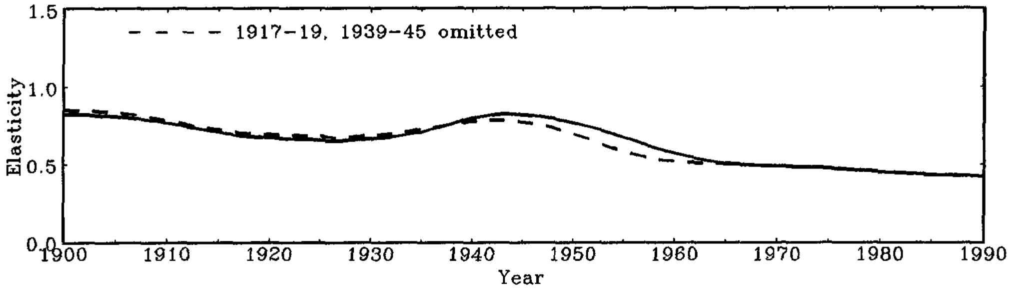


Figure 2.1. Price elasticity of Food in 1900–1990

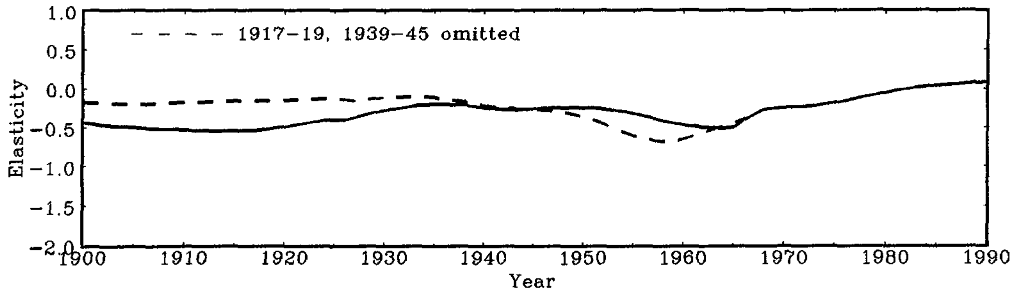
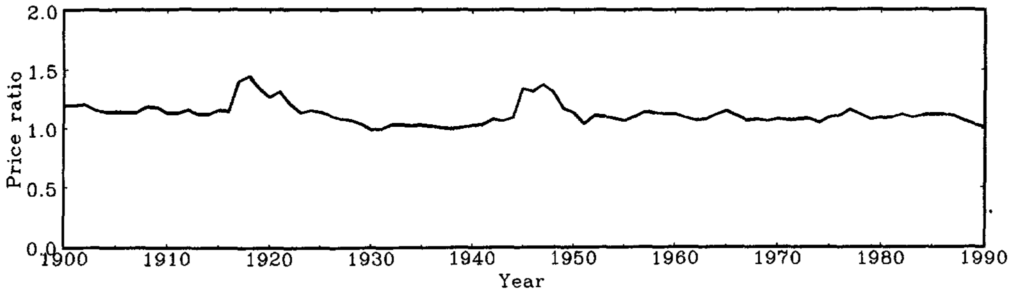


Figure 2.1. Relative price of Food in 1900–1990



One can observe in Figure 2.1 that the curve showing the time evolution in 'expenditure elasticity' is a declining one in the category, Food. However, from 1930 to 1945 Food seems to get more elastic w.r.t. total expenditure which could relate to the economic hardships experienced during of the Great Depression in the 1930's and the war years. Since then the values of the expenditure elasticity of Food have been approaching zero. Any declining trend for the price elasticities cannot be found. However, in the middle of the 1960's there seems to occur a sharp turn upwards in the path of the price elasticities. The curves corresponding to the two smoothing operators (with the war years included, and not included) that we use for description touch each other at this moment. So, one could argue that in the food market effects due to the war were not over until then although the direct rationing of food supplies was discontinued already at the beginning of the 1950's. However, the Finnish trade in imports, was deregulated in a quick transition in the beginning of the 1960's, with the restrictions on personal cars being the last to be lifted. Figure 2.1 shows clearly the massive decline in the budget share of Food. In the war years the share had increased somewhat. The relative prices of Food have stayed on a steady level. Exceptions can be found in the periods of war.

The elasticities of the category Beverages and Tobacco vary more than those of Food (Figure A1.1). The values of the expenditure elasticity have been increasing up to the 1930's but after abolishing the Prohibition (in 1932) the values start to decrease. Another phase where decline has occured was after some liberalisation of the trade in alcoholic beverages in the 1960's. After the Second World War the rationing of Tobacco ended in 1949 and in the 1960's a large move to American type cigarettes occured. The values of the price elasticities in the category Beverages and Tobacco increased into the 1930's and then decreased until the late 1970's. A sharp movement upwards took place in the war time, 1939-1945. The relative prices of Beverages and Tobacco have generally been on an increasing trend path, due to the needs to finance increased government expenditure. The increase in the relative prices has been fastest in the late 1910's (the prohibitionary law of alcohol coming into force in 1919) and in the war time, 1939-1945.

There has been a rapid increase in the share of Transport and Communication (nearly 20 per cent in 1990) due to the urbanisation and the need to communicate over wider distances. In the 1960's the remaining import restrictions on personal cars were lifted and the expenditure elasticy for the category has a sharp turn downwards with a rapid increase in the number of cars in Finland. At the same time the price elasticities are observed to increase in absolute value, a classical effect observed in rationed markets. On the other hand, after the Second World War a state subsidized lending system (ARAVA) was started to speed rehabitation, and in the sixties the share of Housing and Energy has catched up the current level. After that the baby-boomers entered the housing markets in the early 1970's, and rent controls were introduced. These developments may lie behind the simultaneous decrease in the price elasticities observable in Figure A1.1.

Table 2.2 provides the 'estimates of price and expenditure elasticities' for component categories in the those years when survey data have been collected (1966, 1971, 1976, 1981, 1985 and 1990).

Table 2.2. Estimates of price and expenditure elasticities in the survey years.

Component category	Elasticity	1966	1971	1976	1981	1985	1990
1. Food	expenditure	0.500	0.485	0.471	0.449	0.434	0.426
	price	-0.401	-0.231	-0.158	-0.029	0.035	0.081
2. Beverages and	expenditure	0.952	0.972	0.905	0.841	0.799	0.752
Tobacco	price	-0.719	-0.698	-0.766	-0.698	-0.538	-0.308
3. Clothing and	expenditure	0.595	0.592	0.722	0.973	1.221	1.436
Footwear	price	0.254	0.154	0.363	0.764	1.102	1.237
4. Housing and	expenditure	1.120	1.142	1.107	1.066	1.050	1.094
Energy	price	-0.000	-0.362	-0.629	-0.684	-0.627	-0.363
5. Household	expenditure	1.043	1.110	1.119	1.097	1.080	1.090
Appliances	price	0.053	0.293	0.171	0.352	0.551	0.920
6. Medical and	expenditure	1.435	1.370	1.256	1.109	0.961	0.740
Health Care	price	-0.822	-0.595	-0.412	-0.227	-0.053	0.204
7. Transport and	expenditure	1.702	1.609	1.492	1.368	1.311	1.283
Communication	price	-1.100	-1.727	-1.352	-0.924	-0.701	-0.461
8. Education and	expenditure	1.434	1.586	1.638	1.607	1.525	1.415
Entertainment	price	-0.520	0.454	0.354	0.213	0.143	0.016
9. Other Goods	expenditure	1.219	1.173	1.154	1.149	1.155	1.182
	price	0.210	0.280	0.277	0.291	0.310	0.288

Finally, we estimate the loglinear function using all data by standard OLS, to give average 'elasticities' in the period, 1900-1990. Table 2.3 provides the estimation results of the static model.

Table 2.3. Time series estimates of a simple regression in 1900-1990.

Component category	Price elasticity	Expenditure elasticity	R^2	DW
1. Food	-0.330	0.627	0.988	0.259
2. Beverages and Tobacco	-0.432	0.978	0.927	0.122
3. Clothing and Footwear	0.742	0.983	0.968	0.712
4. Housing and Energy	-0.198	1.032	0.987	0.323
5. Household Appliances	-0.118	1.019	0.992	0.628
6. Medical and Health Care	-0.900	1.539	0.994	0.425
7. Transport and Communication	-0.669	1.678	0.995	0.252
8. Education and Entertainment	-1.360	1.556	0.988	0.234
9. Other Goods	-0.606	1.299	0.994	0.262

One can find that the household consumption is 'inelastic' w.r.t the total expenditure in the categories, Food, Beverages and Tobacco and Clothing and Footwear but with two categories, Housing and related Energy, and Household Appliances receiving near unitary values. The other categories are 'elastic' in relation to the total expenditure. Only the category, Clothing and Footwear obtains a postive estimate in the 'price elasticity'. The values of R^2 are high and the Durbin-Watson test statistics have very low values in each category. The latter statistics indicate heavy first order autocorrelation in the consumption variables. In fact, in all cases the values of the Durbin-Watson test statistics are substantially lower than the corresponding values of R^2. Here one can observe a prime example of integrated variables, i.e. time series having unit roots (or even roots outside the unit circle) in the lag-polynomial.[7]

Above we have presented very simple estimations that give at most an analytic description of the time series data. Our reading of the literature and own experience points to that estimating complete specifications of demand systems on aggregate data is not a rewarding exercise. Even ignoring the interaction of total expenditure coefficients with the other variables the aggregate models exclude many important explanatory factors. In particular, care should be taken in interpreting the estimated demand elasticities and tests of theory restrictions based on them using aggregate data. Comparisons of estimates either across differing time periods or even across countries are not on a consistent basis.

There exists conditions under which the macro equations consistently estimate the price responses of demand, see Stoker [1984]. Examination of micro data, however, has shown that these conditions are rarely met in the data, see Browning [1987] and Blundell et.al. [1993]. The models used to analyse micro data contain evolving demographic characteristics that show up in the aggregate level as the average size of demographic groups. If these characteristics are slowly changing their effects may well be captured by a stochastic trend component which shows up as autocorrelation or misspecified dynamics. In fact, above we observed that if our descriptive loglinear models are estimated over the whole sample period there is substantial autocorrelation present with the Durbin-Watson test statistic strongly suggesting that the series are integrated. Estimation of parameters may be biased unless this is accounted for.

When the distributional conditions of Stoker [1984], such as mean scaling, are not met in the population it is possible that demand equations based on aggregate data will be inhomogenous without indicating the presence of money illusion. This is often observed in the analysis of time series data, see eg. Deaton and Muellbauer [1980a]. Tests for detecting distributional effects have been developed by Stoker [1986]. The continuous updating of elasticity estimates that we employ here may be a partial solution to the above problem of capturing the slowly changing random time component of consumption. But we are still not quite sure how the elasticities we obtain here relate to our estimates from micro data and what is the real merit in comparing them.

[7] It should be noted that the time series variables are up to the year 1948 based on the generated series that are *constructed* by Laurila [1982]. The excessive autocorrelation observed may be accounted in part by this.

Chapter 3

Household Budget Data

The main source of data for the present study consists of household budget data collected through surveys conducted by Statistics Finland. The surveys have been done at regular five year intervals since 1966. They form the only source to obtain information on the consumption behaviour of individual households, and the distribution of consumption expenditures. In addition to the consumption data a large amount of information is collected on the households in budget surveys. Income data, data about uptake of publicly provided welfare services (education, health and social services), and data about household characteristics. The cross section data of the individual surveys have been manipulated by Statistics Finland to give variables having comparable definitions and content. We kindly thank them for producing the extensive data set which consists of an 'equalized' collection of budget data.

3.1 Budget surveys

The 1966 budget survey is the first one to be based on representative random sampling covering the whole population in Finland.[1] After that five extensive household surveys,

[1]The 1966 household budget survey is the seventh official family budget inquiry in Finland. The earlier ones were conducted in 1908-09, 1920-21, 1928, 1950-51, 1955-56, and 1959-60. The first study was performed on 380 skilled urban workers' households in 1908-1909. The surveys of 1920-21, 1950-51 and 1955-56 had sample sizes of 554, 538 and 532 families, respectively. These consisted only of employees (workers or/and white collar employees, and civil servants) living in towns and cities. The single person households were included only in the last mentioned survey. Farmers were included for the first time in the 1928 survey. The total number of families in the sample was 1224, of which 270 were farmers. The 1959-60 survey (size 1120) was targeted on households living in the countryside, both farmers and employees. The three first surveys were based on a bookkeeping period having a length of one year, and they were based on samples which were not random nor representable in the modern sense. The fourth survey consisted of four bookkeeping periods each of two weeks on food expenditure and a one year long bookkeeping on other goods. The fifth survey were based on three bookkeeping periods again two weeks long, and a yearly interview on the acquisitions of other goods. The 1959-60 survey introduced the monthly bookkeeping period. Since the war the household budget studies have become more elaborate with respect to both the number of variables collected and using a modern random sampling framework. (Household survey for 1966. Textvolume. Statistics Finland. Statistical

in 1971, 1976, 1981, 1985 and 1990 have been produced, and recently also a compatible collection of all six surveys. This 'equalized' collection of budget data is used in the present study.

Table 3.1. Household Surveys in Finland.

Survey year	1966	1971	1976	1981	1985	1990
Final sample size:						
Yearly interview	4805	8817	7971	7368	8200	8258
Bookkeeping	3868	3512	3348	7368	8200	8258
Equalized survey	3260	2986	3348	7368	8200	8258
Non-response (per cent)						
Yearly interview	9.4	22.5	11.2	2.5	2.9	3.2
Bookkeeping	21.7	38.0	30.9	22.8	27.5	26.5
Bookkeeping period	one month	one month	one month	two weeks	two weeks	two weeks

The latest six budget surveys are described in Table 3.1 with the information obtained from Statistics Finland, the Household Surveys, and Djerf, et.al. [1993]. There one can observe that the 1966, 1971 and 1976 surveys consist of two samples which are of different size. The larger ones are based on data collected on a yearly basis using both data from public registers (tax and income data) and from an interview. The aim of these is to give suplementary information about the components of income and purchases of durables, as well as information relating to the composition and size of the households and demographic and socio-economical variables. In principle (see the exceptions below) the surveys are targeted to cover all households in the country. People excluded from the survey live in institutions, for example hospitals, prisons, and some educational institutes. The definitions of a household as well as that of the head of household accords to the recommendations of the United Nations, see below.

The independent importance of the collected income data, however, has declined since 1977, when the surveys collecting data for Income Distribution Statistics were started. Because of the substantial nonresponse in the monthly bookkeeping (for example 30.9 per cent of the sample in 1976), the length of the bookkeeping period was shortened into two weeks starting with the 1981 budget survey. Since then the nonresponse has been at somewhat lower level.

The random sampling methods differ somewhat in each survey. One reason for this is that there are naturally no registers available in Finland on individual households which is an economic concept conforming to the United Nations' recommendations, or in any other country for that matter. A two-stage stratified sampling was used in the 1966 survey. The sample units were the municipality in the initial stage and the 'household' was defined to consist of "a group of individuals living together and sharing the principal means". The household were formed at the second stage of the sampling. In the 1971 survey sampling was carried out on a population of 'dwelling units' which were obtainable directly from the population registers. After the initial stage the households were formed

Surveys No. 51. Helsinki 1973).

around the dwelling units which were sampled by systematic random sampling. In most cases the dwelling units which form a less dense partition of individuals were divided into the corresponding households.

The units in the 1976 survey were collected by using a two-stage stratified cluster sampling. At the first stage, the sampling population, a set of previously chosen municipalities were constructed within a more extensive framework of a master population formed by districts. Dwelling units were again used as the second-stage sampling population, and a sample was drawn by systematic random sampling from a centrally kept population register. Subsequently, the households were formed using them. However, in the 1981 survey the sampling population was changed to consist of all persons living in Finland (15 years or older in 1981 and 1990, and one year or older in 1985). After selection into the sample the person determines the household she (or he) belongs to. To obtain estimates at the population level the data includes a weighting variable (WEIGHT) which is calculated as the inverse of the probability of the household to be included in the sample with the sampling strata and clusters, and the various stages in the sampling process (household size) accounted for. Non-response by some of the units selected in the sample is also accounted for, see Laaksonen [1988]. This is most severe in the household groups consisting of single members, households in cities, particularly in the capital, and at the low and top ends of the income distribution.

Consumption expenditure consists of the market value of goods and services that the households have acquired or received during the period of study. Consumption expenditure, however, excludes the acquisition of goods used in production and also investments. The benefits from public services that are free of charge or the part which is subsidized are excluded from the expenditures since 1976. As the principal rule, the moment when acquisition is made determines the registration of the acquisition, not the moment when payment is made. However, some goods and services, such as rents in housing costs, electricity and telephone charges are registered according to the payment principle. Data on these are normally collected using a one month long period of time.

Table 3.2 provides some information about the quality of collected data. The aggregate estimates of consumption expenditure at the population level which are obtained from the 'equalized budget surveys' are compared with the 'corresponding' figures obtained from National Accounts in 1976, 1981, 1985 and 1990. The figures are given in percentages in relation to the values in National Accounts consumption data.[2]

Note here that the definitions of the household sector differ in the two data sets. The data obtained from budget surveys do not account for that part of population living in institutions. In addition, the household consumption in National Accounts contains some expenditures by institutions that are not part of the public or firm sectors in the economy. The break down of consumption into the component categories follows the one given in National Accounts. The variables do not include transfers received from other households.

[2]Djerf et.al. [1993] present similar comparisons concerning the 1990 survey using eight component categories of consumption.

Table 3.2. Household Surveys compared with the data from National Accounts, in 1976, 1981, 1985, and 1990.

	Component category	in 1976 per cent	in 1981 per cent	in 1985 per cent	in 1990 per cent
1	Food	89.1	95.8	91.3	94.0
11	Bread and grain products	84.7	90.1	84.6	86.7
12	Meat	92.4	99.5	89.7	93.1
13	Fish	87.6	101.9	96.3	126.4
14	Milk, cheese and eggs	84.2	95.6	92.7	93.7
15	Fats and edible oils	93.1	93.2	79.9	94.1
16	Fruit and vegetables	114.7	113.3	111.0	109.2
17	Potato	96.0	100.1	66.8	68.6
18	Sugar	93.3	116.6	83.9	77.7
19	Other types of food	72.9	76.9	79.7	73.7
2	Beverages and Tocacco	43.5	48.9	44.9	47.1
21	Beverages	38.6	42.2	39.3	43.2
22	Tobacco	54.4	64.0	57.4	56.2
3	Clothing and Footwear	107.9	106.5	109.7	104.6
31	Clothing	110.1	106.6	112.2	105.7
32	Footwear	98.7	106.2	99.4	99.6
4	Housing, Heating, Light and Power	101.4	94.3	99.4	117.1
41	Housing	110.4	104.2	109.9	127.0
42	Housing energy	74.1	68.5	67.0	77.9
5	Household Furniture, Fitments and Services	84.7	83.1	97.0	89.8
51	Furniture, objects of art and carpets	71.7	70.4	94.7	75.8
52	Textiles and other fitments	71.1	80.0	75.3	119.6
53	Household machines	117.6	110.9	143.9	104.0
54	Household equipment	78.8	72.3	84.6	68.5
55	Household articles, services	90.0	87.7	84.9	102.2
56	Repair of household articles	99.4	103.0	96.6	76.4
6	Medical and Health Care	62.6	61.3	82.1	74.0
61	Drugs and pharmaceutical preparations	41.9	46.2	52.7	51.1
62	Therapeutical equipment	189.5	208.1	260.8	172.1
63	Doctor's fees	110.5	99.9	138.1	105.1
64	Hospital and sanatorium fees	22.5	15.7	30.4	47.8
7	Transport and Communication	91.7	95.8	97.2	97.0
71	Acquisition of transport equipment	140.7	160.0	144.8	144.0
72	Running costs of private vechiles	78.0	76.5	79.8	83.3
73	Purchased transport services	58.9	54.3	53.3	48.9
74	Communication	88.0	98.3	110.6	107.6
8	Recreation, Education, Cultural Services	83.5	74.2	78.7	73.5
81	Equipment and appliances	104.3	93.8	100.6	102.9
82	Recreation and cultural services	72.0	69.1	67.4	60.0
83	Books, newspaper and periodicals	99.9	78.6	90.2	78.5
84	Education	37.7	18.9	20.0	23.5
85	Nursing services	40.5	46.2	53.1	50.6
9	Other Goods and Services	50.6	66.3	70.8	67.3
91	Personal hygiene and care	91.7	96.0	97.2	99.2
92	Other articles	87.1	93.1	96.4	119.1
93	Restaurant, cafe, hotel expences	54.8	69.5	73.5	66.1
94	Other financial services	24.9	14.5	13.8	16.3
	Total Expenditure	83.5	85.3	87.8	88.2

To account for better comparability in the alternative sources of data we have rearranged some subcategories of consumption for the data shown in Table 3.2.[3]

In most cases, the figures from bugdet surveys 'underestimate' the data from National Accounts. The underreporting or in a few cases overreporting in the component categories can be made to conform to variables that are calculated in budget shares of consumption rather than in expenditure by simply diving the correponding figures by the values of total expenditure given by the last row in the Table 3.2.[4] Figures given in the last row have been on an upward trend increasing from 83.5 percentage points (in 1976) to near ninety points in the 1990 survey. Recall that in 1981 the major bookkeeping period used in collecting the data was shortened from one month to a two-week period, to enhance the quality of collected data. There had been some indication of fatigue when longer time periods were used (Table 3.1). Table 3.2 suggests that estimates for consumption have improved at the aggregate level. On the other hand, shortening of the bookkeeping period leads inevitably to more zero observations and increase in the variance of expenditures if the length is arithmetically accounted for in the calculations (Table 3.3). These aspects will be examined in more detail in Sections 5.1 and 5.2.

Table 3.3. Zero observations in the surveys.

Category	1966	1971	1976	1981	1985	1990	All data
Food	1	0	0	1	11	18	31
Beverages & Tobacco	526	341	533	1533	1657	1580	6170
Clothing & Footwear	176	218	254	243	883	711	2485
Housing & Energy	18	1	0	0	4	10	33
Household Appliances	57	26	52	189	338	135	797
Medical & Health Care	553	492	81	193	359	317	1995
Transport & Communication	158	104	65	110	78	56	571
Recreation & Education	21	7	4	30	15	12	89
Other Goods	309	176	200	539	735	671	2630

At the main level of categorization 'underestimation' occurs in the categories, Beverages and Tobacco, (2), Other Goods and Services, (9), Recreation, Education and

[3]'Meals' which are included in the budget surveys in the category Food, has been temporarily moved into the subcategory 'Restaurant, cafe and hotell expences' (code 93 in Table 3.2). National Account figures for 'flowers, plants, mould and fertilizers' in the subcategory 'Equipment and appliances' (in category 8) is moved into the subcategory 'Household articles and services' (category 55) and the subcategory 'Domestic help' (in category 5) into the subcategory 'Nursing services' (category 85).

[4]Note that in the present study we will use the budget shares to study the allocation of total expenditure among the component categories of household consumption.

Cultural Services, (8) Medical and Health Care, (6). The discrepancy is particularly remarkable in the case of alcoholic beverages and tobacco. The result is no surprise to us and quite typical of the budget studies, or other survey data, and is observed in other countries as well. The only category that gets consistently survey estimates that are 'too high' is Clothing and Footwear, (3). If one examines the correspondence from the point of view of using the budget shares, one finds that underestimation is no longer so serious. However, the 'overestimation' of consumption in the category Clothing and Footwear gets more serious.

3.2 Variables

3.2.1 Consumption and price variables

The nine component categories of consumption that are examined in more detail using budget data are formed differently from the categories given by National Accounts. However, they are given the same names as before. Their composition is explained in Table 3.4 and most categories are self-explaining. Total expenditure is determined as the total sum of expenditures in the component categories of consumption

The category Food, (1), includes here meals and drinks taken outside home.[5] The category, Housing and (related) Energy, (4), includes all kind of expenditure in housing, such as rents in rented dwellings, or imputed housing benefits obtained from owner-occupied dwelling, or housing services in kind, received as compensation in turn of money wages. The category, Household Furniture, Fitments and Services, (5), includes subcategories like Furniture, Household equipments, Non-durable household goods, Household services, and also repair of household articles, and the relevant insurance costs.[6]

In the category, Medical and Health Care, (6), the items include only the out-of-pocket part of the costs partly subsidized. Expenditure in the subcategory, 'Personal hygiene and care', is included in the category, Other Goods and Services, (9). The category, Transport and Communication, (7), consists of four more extensive subcategories. Also transport services received free as a transfer or in compensation in turn of money wages are included in the category (7).[7]

The category, Recreation, Education and Cultural Services (8) is a less clearly defined one. There are included durable or semi-durable goods, but also services like tickets to cultural and sport events. The subcategory Education includes School payments, Payments for professional cources, Nursery fees, etc.[8]

[5] In Table 3.2. where the bugdet studies are compared with the data from National Account, these items were temporarily placed in the subcategory 93, 'Restaurant, café, hotel expences', under the old category (9) Other goods and services.

[6] This category includes also the subcategory 'flowers, plants, mould and fertilizers' which in the comparisons with the data from National Accounts were temporarily moved into the subcategory, Recreation, etc. in the corresponding category (8).

[7] Package holidays, and the foreing currency that households exhange for use abroad during holidays are included in the category, Other Goods and Services, (9).

[8] Generally schooling is free in Finland.

Table 3.4. Description of the nine component categories of consumption.

Survey code	Description
K1-86	**Total expenditure**
K11,12,15	**Food** (1)
K11	Bread and grain products, Meat, Fish, Milk, Cheese and eggs, Fats and edible oils, Fruit and vegetables, Potato and potato products;
K12	Sugar and sugar products, Coffee, tea and cocoa, Chocolate and sweets, Ice-cream, Spices and other foodstuffs, Unclassified consumption of food;
K15	Meals, consumed abroad.
K13-14	**Beverages and Tobacco** (2)
K131	– Non-alcoholic beverages,
K132	– Alcoholic beverages;
K14	Tobacco.
K2	**Clothing and Footwear** (3)
K3	**Housing, Heating, Light and Power** (4)
K31	Housing costs of – Private apartment in housing corporations, – Privately owned house, – Rented house and Free dwelling (in kind), – Repairs, made by tenants;
K32	Week-end house;
K33	Heating, light and power (Housing energy).
K4	**Household Furniture, Fitments and Services** (5)
K41	Furniture, works of art and carpets, Textiles and other fitments, Household machinery;
K42	Household equipment: – Kitchen utensils, Tableware, Household tools and utensils, Polishing pastes, Cleaners, Washing materials and equipment, – Non-durable household goods, Plants, bulps, cut flowers, etc.;
K43	Household services and Domestic help.
K5	**Medical and Health Care** (6)
K51	Drugs and pharmaceutical preparations;
K52	Therapeutical Equipments;
K53	Doctor's fees, Laboratory, Medical examination and treatment charges;
K54	Hospital and sanatorium charges.

Table 3.4. Description of the nine component categories of consumption.

K6	**Transport and communication** (7)
K61	Acquisition of personal vechiles:
	– Expenditure on cars and motorcycles;
K62	Running costs of personal vechiles:
	– Maintenance and repair costs,
	– Fuel and lubricants,
	– Garage fees, driving tuition, insurance, etc.;
K63	Purchased transport services:
	– Travelling in home and abroad,
	– Transport and storing of household articles;
K64	Communication:
	– Postal, telephone and telegram charges;
K65	Transport services, etc. as perquisities.
K7	**Recreation, education and cultural services** (8)
K71	Equipment, appliances:
	– Radios and TVs, Record players, Stereos, etc.,
	– Large durables: Boats, Yatchs, Musical instruments, etc.,
	– Hobby articles: Sport, Hunting, Camping, Photography, etc.;
K72	Recreation and cultural services:
	– Theatres, Operas, Concerts and Cinemas,
	– TV-licences, Sport events, Fees for sport,
	– Hire of hobby and sport articles;
K73	Books, Newspapers and Periodicals;
K74	Education:
	– School payments, Payments for professional cources;
K75	Nursery and kindergarten services.
K8	**Other goods and services** (9)
K81	Personal hygiene and care;
K82	Other personal articles:
	– Watches and jewellery,
	– Articles like umbrellas, pipes, pocket knives, etc.,
	– Printing and drawing material;
K83	Package holidays;
K84	Other services:
	– Banking services and postal transfer charges, etc.,
	– Membership fees, Catering, Death expences, etc.;
K85	Unclassified consumption;
K86	Foreign currency.

For natural reasons the category, Other goods and services, (9) is the most heterogeneus one. It includes subcategories such as 'Personal hygiene and care', some expensive commodities such as Jewellery but also Hotel expenses, Camping site fees, Package holidays, Banking service and postal transfer charges, Death expences, Catering services, party membership dues and similar other dues, passport, and licence costs, advertisement in newspapers, legal and financial services as well as unspecified other consumption. The above lot is very colourful, indeed. In retrospect, it may have been useful to move some of the subcategories into those categories to which they have some resemblance, such as Package holidays, and (possibly) Foreign currency into (7), and Personal hygiene and care into (6).[9]

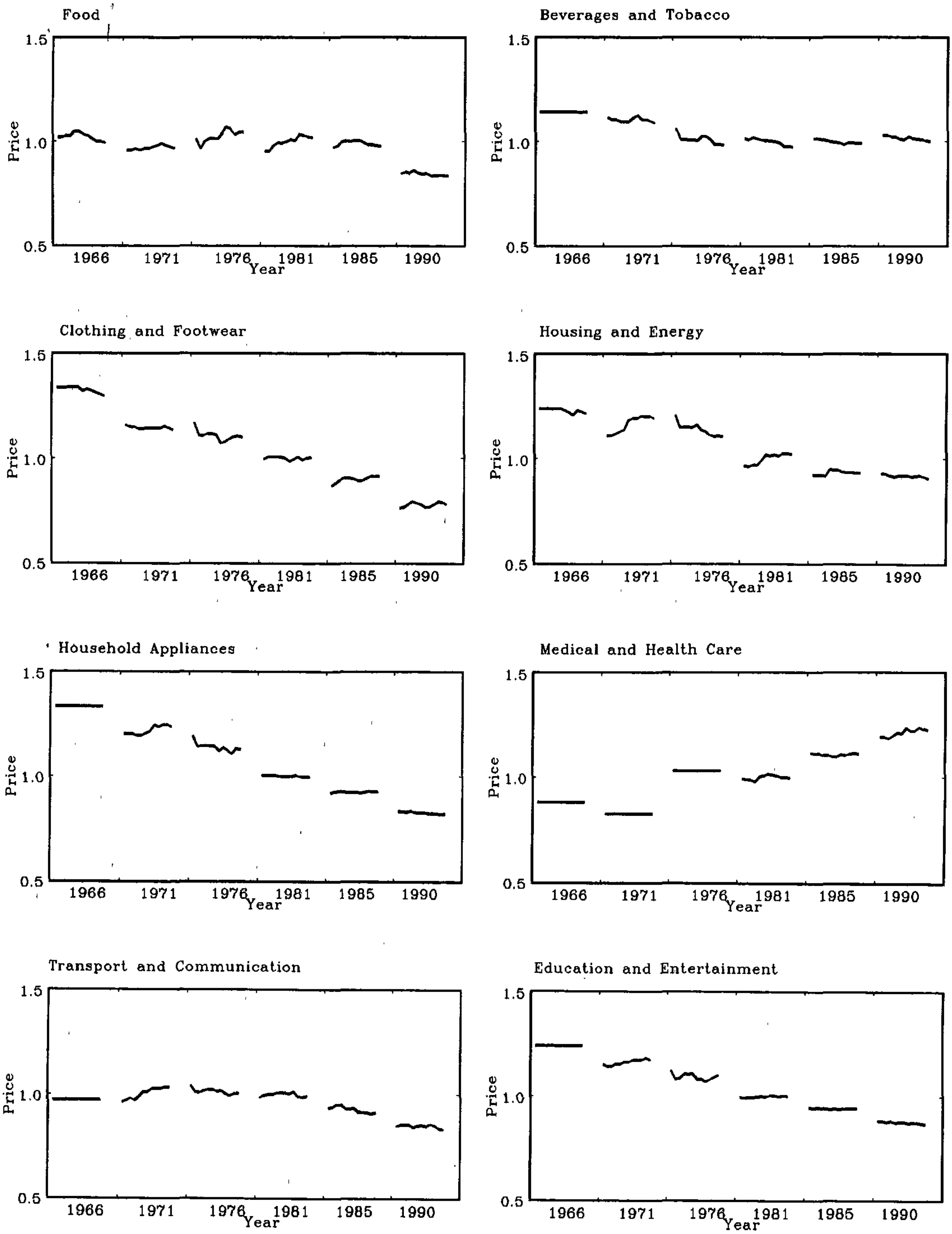
A deficiency in the household budget surveys is lack of price information. Households only appraise the expenditure not any unit price.[10] On the other hand, there are available Consumer Price Index data as continuous time series on large number of commodities starting from 1981.[11] These series are constructed at the monthly level.

[9]The main differencies between the categories of the present study and the earlier studies of Riihelä and Sullström [1993], and Sullström [1995] are as follows. First, the latter studies exclude acquisitions of durable goods. Second, the category Food does not include meals and drinks outside home but instead non-alcoholic beverages are included. Third, the category Housing and Energy, covers only consumption on housing energy. Fourth, the exchanged foreign currency is a component of the subcategory of Purchased transport services in the category (7). In the last part of the present study (Chapter 9) we present some results on the allocation of total expenditure among the component categories when acquisitions of durable goods and housing costs other than expenditure on energy are excluded from the component categories using the same definitions as in the above studies. In addition, in Riihelä & Sullström (1993) and Sullström (1995) the price indices for the nine component categorys were calculated from price indices formed at the subcategory level by using the formula for the Stone price index, with the average budget shares as weights. This was done to remove the influence of durable subcategories and housing costs from the category prices.

[10]Demand models generally assume that households at a given moment of time observe the same prices everywhere. This is how we do but ignoring spatial variation in prices is not necessarily a good assumption, see Deaton [1987]. However, *if unit prices of individual goods were observed,* either directly or calculated by dividing the expenditure by the amount of quantity purchased, one could not use them without accounting for the errors-in-variables problem. In the latter case the problems are obvious and in the former case prices easily get confounded with the characterics (quality) of the good. In the former case it might be preferable to assume that the households face the same 'hedonic prices' and instead consider only the spatial variation, or variation due to taxes.

[11]However, earlier the information is not so finely tuned and we had to resort to some (rather arbitrary) constructs as a substitute for better data. For the surveys in 1971 and 1976 the monthly price index of the category, Medical and Health Care is not available. At that time the category was included as a subcategory in Other Goods and Services. Therefore, the prices of the latter are used for both variables. The monthly price index data in 1966 is based on an old categorization of consumption which provides price indices only for four categories, 'Food', 'Housing and Energy', 'Clothes and Footwear', and a broad category 'Other expenditures.' We have used the last one as a substitute for our categories, Medical and Health Care, Transport and Communication, Education and Recreation, and Other Goods. The monthly price index of the category, Beverages and Tobacco is based on the price index of 'Alcoholic beverages'. The indices in 1981 prices are obtained in 1966, 1971 and 1976 by setting the July value of the monthly index (with various base years) as to conform to the average value in the prices of year 1981 (1981='1.000').

Figure A2.1. Relative prices in the survey years



We augment our data with Consumer Price Indices by utilizing the specific information on at which time period the expenditure data has been collected. In the model the price variables, LP1-LP9, are in the logarithmic form with the index values 1.000 in 1981. This is close to the middle of our research period 1966-1990.

We set up a correspondence between the two-week bookkeeping periods and monthly price indices by linear interpolation in those surveys where the two weeks period was in effect, in the 1981, 1985 and 1990 surveys (Table A2.3). In the earlier surveys the bookkeeping periods correspond to the calendar months and in this case no interpolations are needed. The variation in prices is due to the variation both between surveys and within a survey. Therefore, our price variables are household specific only up to the survey year and the bookkeeping time period in the survey. The number of individual observations in bookkeeping periods varies but is generally over 200.[12]

Figure 3.1 provides the relative prices of the first eight categories in the survey years. The time series are based on monthly price indices obtained by dividing with the consumer price index relating to the residual category (9), Other Goods. One can observe that most of the variation in relative prices takes place in the time between the surveys but the variation in the prices is rather modest within the individual surveys, see Section 6.1. Note in addition the effect of using the same price index in some categories as a subsitute for better data in the earlier years, see footnote 3.11.

3.2.2 Demographic and socio-economic variables

In addition to the consumption data, in budget surveys a large amount of information is collected on the households, income data, data about uptake of publicly provided welfare services (education, health and social services), and data on household characteristics. The cross section data of the individual surveys have been manipulated by Statistics Finland to give variables having comparable definitions and content. In the present study we use a wide variety of factors as explanatory variables in the estimated models. Some of these involve demographic characteristics, eg. the age (AGE) and gender (FEMALE) of the household head.[13]

The age of the household head is in this study of primary importance since our main mission is to give an analytical description on how the structure of consumption evolved in the time period, 1966-1990 while the baby-boom generation have grown from their youth to middle-aged. The explanatory variables include the logarithmic age of the household head (LAGE) and a quadratic term in the variable (LAGESQ). Since the natural range of age is bounded then taken together with estimated coefficients these variables allow for the effect of age to be either monotonously decreasing or increasing, or to have either the shape of a well or a hump. The first two cases occur when the local extreme value of the above binome in logarithmic age occurs outside the natural range

[12]The data has twelve different (monthly) bookkeeping periods for each survey in 1966-1976 and twenty-six (or twenty-eight) bookkeeping periods for each survey from the year 1981 onwards.

[13]The *household* consists of persons living together and having a common provisioning economy. *The head of a household* is determined as the person who has the largest income in the household.

of the age variable.

A useful supplementary variable is the logarithm of the *age of household head in a given year* (LCOHAGE), in our case we select arbitrarily the year 1981.[14] This variable allows for a slowing creeping effect w.r.t. the survey year which may be a useful device to capture some cohort effects in slowly changing consumer environment where new commodities are introduced and habits and preferences evolve. On the other hand, using only the calender age at the time of the survey neglects the gradual overturn of population, and having in the sample people that are observed to be same age but have in fact been grown-up and moulded in widely differing economic and social environments.

Some of the factors are related the size and composition of the household, eg. the number of persons (HHSIZE), the number of children (CHILDREN), and old-aged persons (OLDAGE). Children are defined to be persons living in a family and under eighteen-years old, and old-aged persons are over 65 years old in the survey year. Additional variables include the geographic location of households and the community type (RURAL). The variables relevant for the present study are:

Label	Description	Details
AGE	Age of household head	years
HHSIZE	Household size	number of persons
CHILDREN	Number of children in a household	number of children
OLDAGE	Old-aged ($age \geq 65$ $years$)	number of persons
FEMALE	Gender of household head	0 = male
	Socioeconomic status of household head:	Proxy for labour supply
FARMER	farmer	
SELFEMPL	self-employed or entrepreneur	
WHCOLLAR	white-collar employee	
BLCOLLAR	blue-collar employee	
RETIRED	not working	
SPOUSENW	Spouse not working, or no spouse	0 = in work
	Education of household head:	Proxy for human wealth
EDUCL	lower degree	
EDUCM	middle degree	
EDUCH	higher degree	

[14]In selecting this year one has to guard against the unexpected effects which may result if logarithms are taken from variables having some low values with respect to the bulk of data.

Label	Description	Details
	Dwelling:	Proxy for real wealth
SMHOUSE	Small house	
FLAT	Block of flats	
SDHOUSE	Semi-detached house	
TENUOWN	Tenure: owner	
TENURENT	Tenure: renter	
TENURKIN	House in kind	
CENTHEAT	Central heating	
BATHROOM	Equipped with bathroom	
	Indicators of real wealth:	
WEHOUSE	Week-end House	
CAR	Owns one or several cars	
	Region:	
SOUTH	The South of Finland	
MIDDLE	The Middle of Finland	
NORTH	The North of Finland	
RURAL	Type of community: rural	0 = town, or city
	Seasonal variables:	
WINTER	Winter	
SPRING	Spring	
SUMMER	Summer	
AUTUMN	Autumn	
	Survey dummies:	
D66	Dummy for the survey in 1966	
D71	Dummy for the survey in 1971	
D76	Dummy for the survey in 1976	
D81	Dummy for the survey in 1981	
D85	Dummy for the survey in 1985	
D90	Dummy for the survey in 1990	
D6676	Dummy for the survey in 1966-1976	one month data collection period

The descriptive statistics of the variables used in our model: means, standard deviations, and the range of values in the sample, are given in Appendix 2 (Table A2.1). There are provided also the corresponding statistics for our consumption variables and some variables that are used as instruments, see Section 5.1. The variables that have not been defined so far are given below:

Label	Description	Details
	Consumption variables:	
Wj	Budget share of category (j),	j = 1,...,9
LPj	Logarithm of the price index (j),	j = 1,...,9
LNC	Logarithm of total expenditure	current prices
LNX	Logarithm of total expenditure	fixed prices
LNXR	Logarithm of total expenditure adjusted for the # of eq. adults	fixed prices
CONSUMP	Total expenditure (FIM)	current prices
NDCONS	Total expenditure (non-durables)	current prices
	Additional instruments:	
LNSQM	Area in dwelling,	in m^2 's
DISPINC	Disposable income	current prices
LNY	Logarithm of disposable income	
LNYSQ	LNY*LNY	
WWATER	Dwelling: warm water available	
WC	Dwelling: equipped with WC	

Some additional variables that we use are constructed by preliminary fits and we turn to considering them.

3.2.3 Generated variables

The Engel curves in household demand are defined in relation to total real expenditure. The functional form of the QAIDS-model that we use, see (4.6) in Chapter 4.1, employs the logarithm of real expenditure and some interaction (product) terms with other variables. Furthermore, in the QAIDS -model one allows for a second order term in the logarithmic real expenditure.

In empirical demand analysis the total consumption expenditure should correspond to the theoretical concept which is exogenous to the allocation decision rather than to the error-prone measure of expenditure based on actual purchases. The latter one reflects the relatively short bookkeeping periods used in collecting the actual data, eg. with plenty of zero purchases occurring for some items, and other data imperfections. One would expect that there is a positive correlation between the total expenditure in a bookkeeping period and recording of purchases of individual items which has unpleasant implications for econometric estimation resulting in biased parameter estimates.

In the econometric model of consumption we substitute for the endogenous R.H.S. variables, the logarithm of total expenditure (in current prices), and the budget shares, w_i that are used to define the Stone price index,[15] with preliminary fits using a set of

[15]The Stone price index is defined by $\log P_S = \sum w_i \log q_i$, where q_i stand for the price of component

instruments which are considered predetermined. One projects the error-ridden variable on a subspace spanned by the instruments. In constrast to using the conventional method of instrumental variables to solve the errors-in-variables problem the preliminary fits are in this study used to estimate the conditional expectation of the total real expenditure variable. The expectation should correspond to the solution for an intertemporal optimization problem, and it is subsequently used by the household as the proper *a priori startingpoint for the current allocation of expenditure* among the component categories of consumption, see Bierens and Pott-Buter [1989], and Sections 4.2 and 5.1. The intertemporal allocation problem which is implicit in the process concerns the consumption, saving and labour supply decisions of the consumer.

Since our aim is to estimate the conditional expectation, we choose to use a rich set of instruments, i.e. those variables that span the subspace on which the projection is taken, together with a different form (time varying parameters) for the survey years (six) present in our data. Calculating six regressions rather than just one it is hoped that 'a better fit' is obtained since the 'total consumption function' obtained by conditioning on the available instruments may drift over time, due to changing labour and financial market conditions.

In all we use 70 variables as instruments in the preliminary fits (Section 5.1) to obtain a generated variable (ILNC) for the logarithmic total expenditure, in current prices. The instruments which are considered predetermined to the current allocation of the total expenditure are chosen with the above considerations in mind, to include variables on labour supply decisions and indicators on real wealth. Above we have mentioned our additional regressors WWATER, WC, and logarithmic area of the dwelling (LNSQM) and the quadratic term (LNSMQ2) which are used to capture permanent income type effects on total consumption. We rely heavily on the area variable which is allowed to have an interaction (product) term with 13 other instruments, 11 of them indicator variables (Table A2.2). In addition, all exogenous variables of the allocation model have been included among the instruments. In fact, it is not obvious how the conditional expectation of total consumption is identified independently of the corresponding equations defining allocation among the component categories without making separability assumptions which are possibly incorrect.[16]

We solve these problems by using time-varying parameters, and several nonlinear terms and interaction terms (products) among the variables, see Section 5.1, to define the 'total consumption function.' In contrast, we consider the models which describe the current allocation of the total expenditure as parsimonous simplifications of the more complicated ones. In the study the problem of possible over-fitting by the instruments is not seen as worrying by us since there are so many obserations available (33 420).

The next step is to make a similar operation with the budget shares as the object variables to obtain generated variables (IW1,-IW9). In doing this two additional variables are added to the list of instruments to account for the cross section Engel curves

categories, see Section 4.1.

[16]In our data we have observed that if a variable enters the total consumption function it is highly likely to enter at least some of the equations defining consumption in a component category.

in consumption. These are the fitted values of the logarithmic total expenditure (ILNC) and its quadratic term (ILNCSQ).

Subsequently, the fitted values of the logarithmic nominal expenditure are deflated with the Stone price index to obtain a logarithmic real expenditure variable (ILNX). The weights in the index formula are calculated using the fitted values (IW1,-IW9),[17] and price variables are calculated continuously for the sample periods using the specific information on which period the expenditure data was collected using Consumer Price index data, as described above. Finally, we make an additional adjustment in this variable to measure real consumption per the number of 'equivalent adults' in the household by subtracting the logarithm of the OECD-scale (OECDSC) from the real expenditure variable.[18]

In our model the real expenditure variable is replaced with a preliminary fit to obtain an estimate for the conditional expectation of the logarithmic total expenditure variable, denoted by $\tilde{m}$. To ease interpretation of the estimation results of our model we subtract a 'typical value' from the variable before we move on to construct other transformations of the real expenditure variable.[19] Note that subtracting a constant value from any variable in a model where the conditional mean is linear in parameters has no effect on the estimated coefficient, only the constant term in the model is modified accordingly.[20]

We have good reasons for doing this. First, all the interaction variables formed in combination with the real expenditure variable are equal to zero *at the typical value* and now the effects of those variables (household size and composition) that form product terms with the expenditure variable can be directly read from the coefficients which do not involve the product terms.

Second, since we have in the model a quadratic term in the real expenditure variable the slope of the Engel curve in consumption is in our model not given directly by the coefficient of the logarithmic expenditure variable since the derivative of the second order term enters the formula.[21] However, this additional term is zero at the typical value and now the slope of the Engel curve is directly given by the coefficient of the modified variable (ILNXR) at this value. The corresponding t-value gives the statistical significance of the slope not being zero, and equivalently of a *possible local extreme value* (minimum or maximum) *not occuring at the typical value*. Similarly, the coefficient of the second order term gives directly the second derivative of the Engel curve *at the typical value*, an estimate of the curvature, or how rapidly the slope is changing at this point.

[17]The weights are truncated below at zero and the fitted values for the other budget shares are proportionally adjusted so as to sum to one in cases with negative values of some budget share fits.

[18]The OECD-scale is calculated as follows: the first adult in the household gets weight 1, and each additional adult gets a weight 0.7. Furthermore, the children (under 18 years of old) get weight 0.5.

[19]The typical value is equal to 10.3 which is slightly above the sample mean (Table A2.1) and lies between the estimated population means in the 1985 and 1990 surveys.

[20]Since we use an additional quadratic term of this variable the coefficients do get modified but the overall fit remains the same and we have effectively only reparametrised the model, see below.

[21]This means that we allow for commodities to be, say luxuries at low values of total expenditure and necessities after some values of the total expenditure to reflect the increasing substitution possibilities available to the consumer as the spectrum of consumption possibilities is widened (Section 4.1).

The corresponding t-value gives the statistical significance of the Engel curve being linear *at the typical value.*

The second order term in our expenditure variable has to be treated a little differently from the other transformations after performing the arithmetic operation. Recall that we are using fitted values from a preliminary regression to form the generated real expenditure variable. In our case one will end up having several generated regressors sharing common preliminary estimators $\tilde{\psi}$ for the parameters of the preliminary regression rather than the actual parameters ψ characterizing the conditional expectation. In this study we use the distributional properties of the unbiased estimators (normality and the four first moments) to develop the analysis, see Section 4.2. In the operations considered so far, products with exogenous variables, the unbiasedness of the parameter estimators guarantees that the transformed variables form unbiased estimators of the corresponding conditional expectations. This is not the case with the quadratic term. One must allow for the calculable bias in the estimation of the squared term $\tilde{m}^2$ and correct for it. By the well known formula, $\mathcal{E}y^2 - Var(y) = (\mathcal{E}y)^2$. Therefore, one substitutes for $\tilde{m}^2$ a variable $\tilde{m}^2 - \omega^2$ which is based on the fit of the conditional expectation using preliminary estimates $\tilde{\psi}$, and the values of the instruments, and on an estimator ω^2 for the variance of the fit at the values of the preliminary instruments, for details see Section 4.2. We have earlier subtracted a typical value from the expenditure variable which is little above the mean in the data. The above substitution formula to get our generated second order term (ILNXSQ) indicates that we will have in the data a considerable number of observations with *the quadratic term having negative values* (Table A2.1)! But note, *this is as it should be* because we know that some of the 'true values' in our second order variable (with the typical value subtracted) are zero and the only way to accommodate that our generated variable is unbiased is to allow some negative values for it.[22] In the following chapters we will find the merit of doing these tricks on our variables rather than using the straightforward method of instrumental variables to solve the errors-in-variables problem.

The variable LNRELX which is called 'relative consumption' builds both on early remarks by Veblen [1899] which have become popular in psychological and sociological literature under the heading 'relative deprivation' theory and on the 'relative income hypothesis' in consumption behaviour which was put forth by Duesenberry [1949]. Loosely speaking the hypothesis suggests that a consumer's consumption habits should reflect his (or her) social reference group (Section 6.1).

The variable is constructed using the fitted values of real total expenditure (ILNXR). It measures the signed distance of the household from the median household. The median is estimated using the population mean of logarithmic total expenditure, and the

[22] Some readers may wonder whether the subtraction of the typical value is causing some difficulties here. It is not so since the variance operator is unaffected by the addition operation and in fact, the above formula connecting the variance and the two first moments gets modified in just the correct way, not even the constant term of the model is affected by allowing for the variance term. However, the constant term and the coefficient of the first order term are affected by subtracting the typical value to produce the reparametrization considered above. One can use simple algebra to show this.

variables are adjusted for the number of equivalent adults in the household.[23] Furthermore, the calculations are based on instrumented values and the mean is formed separately for each survey available (Section 4.2).[24]

In the following we give the complete list of the generated variables and the variables that are related to the household size and composition, and are used to form interaction variables with the expenditure variable, see Table A2.1:

Name	Description	Details
	Generated variables:	
IWj	Fit of budget share in category (j),	j = 1,...,9
LPSTONE	Stone price index, using IWj's	
LRELPj	LPj - LPSTONE, relative price	j = 1,...,9
ILNC	Fit of LNC	
ILNX	ILNC - LPSTONE, generated real expenditure	
ILNXR	Fit of LNX - 10.3, adjusted for the number of equivalent adults	
ILNXSQ	ILNXR*ILNXR - VAR(ILNXR)	
LNRELX	ILNXR - mean(ILNXR)	
	Product variable:	
ILNXSIZE	HHSIZE*ILNXR	
ILNXCH	CHILDREN*ILNXR	
ILNXFEM	FEMALE*ILNXR	

We conclude by explaining some additional price variables in Table A2.1. In some of the models of the present study (Section 6.1) it will turn out that it is not sensible to include a full set price variables in the model. Therefore, we form a price variable which is separate for each consumption category. The variable is the 'logarithm of relative price' which is obtained by dividing the corresponding component price index with the Stone price index which we use in this study to define real expenditure, and then taking the logarithm. The variables are, LRELP1,-LRELP9.

[23]The mean of logarithms is in our case quite near the median because the distribution of logarithms deviates only slightly from normality.

[24]Note that since we adjust total expenditure using a rough equivalence scale, we should arrive at a more reasonable outcome than by utilizing unequalized values of expenditure.

Chapter 4

Methods

Allocation models are customarily estimated using Zellner's [1962] Seemingly Unrelated Regressions (SURE) model. This assumes that the covariance structure across individual equations is homoskedastic. Particularly when using microdata homoskedasticity is an untenable assumption resulting in inefficient estimators and distorted statistical inference. In contrast, heteroskedasticity is unavoidable in efficient consumption share equation estimation as shown for example through the consistent stochastic specification by Chavas and Segerson [1987]. Random individually varying coefficients models produce covariance structures that fall into the heteroskedastic framework.

An alternative interpretation of the conditional model of consumer demand that we employ is given by Bierens and Pott-Buter [1989]. They start with an intertemporally additive indirect utility function using a life-cycle consumption model. The consumer estimates his unknown future income stream by a conditional expectation. Next they formulate the corresponding Euler equation under uncertainty and find that the conditional expectation of total expenditure should replace the actual value in the formulation of demand equations. The conditional expectation is taken relative to prices, interest rates, household composition and indicators for wealth variables. The error covariance matrix is no longer singular in their model. In addition the errors are in general heteroskedastic. The error terms correspond in the model to randomly varying preferences and unobservables, such as real and human wealth.

Below we develop a model and an estimation method which accommodates parametric heteroskedasticity in a single equation Estimated Quasi Maximum Likelihood (EQML). The motivation for this is the finding by Low (1983) that similarly accommodated generalized least squares may outperform the Zellner's estimator even though single equation ignores the correlation across share equations. Naturally the relative performance of the alternative models depends on the severity of the covariance vis-a-vis the heteroskedasticity. Under some specific assumptions we are able to evaluate efficiency gain of the (EQML) vis-a-vis a homoskedastic single equation model (Section 5.3). Furthermore, the parametric heteroskedasticity structure of our model incorporates the formulation of Bierens and Pott-Buter [1989] where the conditional expectations are substituted for some of the right hand variables variables and additionally some specific features in the sampling framework used in collecting the actual data.

4.1 Model for allocation of consumer expenditure

In the econometric analysis of the structure of household consumption we utilize a flexible representation of preferences. The empirical advantage of using a flexible representation for functional form is that untenable restrictions on behaviour are avoided. In effect the elasticities are measured not assumed. These gains are associated with the increased computational burden of more complex and less parsimonious models.

Specifically, the functional form is derived as a quadratic extension of the Almost Ideal Demand System (AIDS) originally introduced by Deaton and Muellbauer [1980a]. The system of demand functions (QAIDS) is based on a functional relationship for the expenditure function. Specifically, the logarithm of the expenditure function, calculated per the number of members in the household (in equivalent adults), n, is given by[1]

$$\log(e_h(q,u_h)/n) = \log A(q) - \frac{1}{B_1(q)u_h + B_2(q)}, \tag{4.1}$$

where $\log A$ is a quadratic form in logarithmic prices,

$$\begin{aligned}
\log A(q) &= \sum_k \alpha_k \log q_k + \frac{1}{2}\sum_k\sum_l \gamma^*_{kl} \log q_k \log q_l, \\
\log B_1(q) &= -\sum_k \beta_{1k} \log q_k, \quad \log B_2(q) = \sum_k \beta_{2k} \log q_k.
\end{aligned}$$

There are theoretical restrictions on the functional form which are implied by expenditure function defining rational expenditure minimizing behaviour. Homogeneity properties of the expenditure function imply that A is a degree one homogenous function in prices q and B_1 and B_2 are homogenous of degree zero. This implies that the following restrictions should hold for the parameters:

$$\sum_k \alpha_k = 1, \tag{4.2}$$

$$\sum_l \gamma^*_{kl} = 0, \quad \forall\, k = 1,\cdots,m, \tag{4.3}$$

$$\sum_k \beta_{ik} = 0, \quad \forall\, i = 1,2. \tag{4.4}$$

By Shephard's lemma the budget shares of the commodities are given by partial differentiation of the logarithmic form

[1] The functional form which is written here in a slightly different form was originally discovered by Deaton [1986].

$$\begin{aligned} w_k(q,u) &= \frac{\partial \log e(q,u)}{\partial \log q_k} \\ &= \alpha_k + \sum_l \gamma_{kl} \log q_l - \frac{\beta_{1k}}{B_1(q)u + B_2(q)} + \frac{(\beta_{2k}+\beta_{1k})B_2(q)}{(B_1(q)u+B_2(q))^2} \qquad (4.5) \\ w_k(q,\bar{m}) &= \alpha_k + \sum_l \gamma_{kl} \log q_l + \beta_{1k}\bar{m} + (\beta_{2k}+\beta_{1k})B_2(q)\bar{m}^2, \qquad (4.6) \end{aligned}$$

where $\bar{m} = \log(M/n) - \log A(q)$, the logarithm of real expenditure with nominal expenditure M deflated by a price index $A(q)$, and adjusted for the number of household members n. Above we have redefined $\gamma_{kj} = \frac{1}{2}(\gamma^*_{kj} + \gamma^*_{jk})$ for all k, j in terms of the original parameters in (4.1).

The above functional form permits exact aggregation over consumers in the sense of Lau [1982]. The necessary result on the allowable forms for the Engel curves is provided by Gorman [1981]. On the other hand, since the logarithm of the expenditure function is defined with a quadratic form in logarithmic prices the budget shares have a flexible representation to the first degree in logarithmic prices. The Engel curves of consumer demand are defined in terms of real expenditure and allow in the above model (4.6) a quadratic term in the logarithmic real expenditure thereby generalizing the ordinary Working-Leser functional form, see Working [1943] and Leser [1963]. In the special case of $B_2(q) = -\lambda B_1(q)$ the formula reduces to the AIDS-form of the expenditure function as originally introduced by Deaton and Muellbauer [1980a]. In the latter, special case, a commodity, say k, is a luxury if $\beta_{1k} > 0$ and a necessity if $\beta_{1k} < 0$. In contrast, the model (4.6) allows for a commodity which is a luxury at low levels of total expenditure to become a necessity at higher values for this variable. The increased level of flexibility is particularly useful in analyzing micro data as opposed to the case of aggregate time-series data and can be seen as reflecting increased scope for substitution as the spectrum in the consumption possibilities available to the consumer is widened. Similarly, in the special case of $B_2(q) = \lambda$, and independent of the prices, the model (4.6) reduces to the special quadratic form introduced by Blundell, et.al. [1993].

Empirical data satisfies the budget condition, $\sum_k w_k = 1$. Therefore,

$$\sum_k \alpha_k = 1, \qquad (4.7)$$

$$\sum_k \gamma_{kl} = 0, \quad \forall\, l = 1, \cdots, m, \qquad (4.8)$$

$$\sum_k \beta_{ik} = 0, \quad \forall\, i = 1, 2. \qquad (4.9)$$

In empirical analysis this results in that one dependent variable and the corresponding equation are linearly dependent on the others and it is conventionally dropped from the analysis. Parameters related to the abandoned equation are recovered using the above restrictions. In linear models the result is independent on the choice which variable is dropped Powell [1969] (SURE) and Barten [1968] (FIML). Returning to the homogeneity restrictions (4.2)-(4.4) one notes that by construction the data satisfies all of these expect for the middle one (4.3). This parameter restriction forms the surviving testable linear hypothesis of the homogeneity property.

In addition one has from the hypothesis of rational behaviour the 'symmetry restrictions' that are implied by the fact that the matrix of the second derivatives of the function $\log e$ w.r.t the logarithmic prices is by construction symmetric, cf. $\gamma's$ vs. the original $\gamma^{*'}s$.

$$\gamma_{kl} = \gamma_{lk}, \quad \forall\, k, l = 1, \cdots, m. \tag{4.10}$$

We return to the concavity properties of the expenditure function further on in the report but note that since the model is based on a local approximation of the expenditure function in prices to provide flexibility it is less fortunate in giving up completely global regularity, i.e. concavity in functional form. These imply the monotonicity and curvature conditions in rational neoclassical economic behaviour.

In the analysis presented in this study quite a few modifications are made to the basic model given by (4.6). Some of these have become relatively standard in empirical work but others are encountered less often or are even novel. Start from the more familiar ones. First, the fixed terms α_k in the budget share equations (4.6) are made to depend on some predetermined explanatory factors, i.e. we use a wider variety of conditioning factors other than just price and total expenditure. These factors involve demographic characteristics, such as the age and sex of household head, size of the household, and geographic location of households, and factors related to household composition, the number of children, and old-aged persons. We use some additional conditioning variables which are considered predetermined here although they capture some effects that are related to the dynamic allocation decision. The motives for this are provided by Bierens and Pott-Buter [1989]. We return to some characterizations and interpretations that are possible for our model in more detail below, see also Deaton [1986].

Second, the function $A(q)$ which defines an implicit price index involved in calculating the real expenditure component of the model is replaced with a Stone price index, an index obtained simply by $\log P_S = \sum_l w_l \log q_l$. This makes the original AIDS-form linear in the parameters. We in turn neglect the B_2 function in front of the quadratic real expenditure term, and reparametrize β_{2k} for earlier $\beta_{2k} + \beta_{1k}$,[2] and write the estimable linear form as an approximation

$$w_k(q, \tilde{m}) = \alpha_k + \sum_l \gamma_{kl} \log q_l + \beta_{1k}\tilde{m} + \beta_{2k}\tilde{m}^2 + \varepsilon_k, \tag{4.11}$$

where $\tilde{m} = \log(M/n) - \log P_S$, logarithmic real expenditure with nominal expenditure M deflated by a Stone price index, and adjusted for the number of equivalent adults in the household.

[2]The function, B_2 is nearly constant if the relative prices do not change too much. The change in relative prices, however, changes gradually the slope of Engel curves. In a future study we plan to give a more complete treatment of the share equations incorporating the full nonlinear model.

To get a simplified formula for elasticities in the model (4.11), substitute the Stone price index for the earlier index $A(q)$, in the real total expenditure part of the formula. In our case, this procedure corresponds to calculating the uncompensated price elasticities with the formula,

$$\begin{aligned}\eta_{kl} &= \frac{\partial \log x_k(q,m)}{\partial \log q_l} = -\kappa_{kl} + \frac{\partial \log w_k(q,m)}{\partial \log q_l} \\ &= -\kappa_{kl} + \frac{\gamma_{kl} - (\beta_{1k} + 2\beta_{2k}\tilde{m})\hat{w}_l}{\hat{w}_k}, \qquad (4.12)\end{aligned}$$

for $k, l = 1, \cdots, m$, and where $\tilde{m} = \log(M/n) - \log P_S$, the logarithm of real expenditure, and κ defines the Kroenecker's function,[3] $\kappa_{ij} = 1$ if $i = j$, and zero otherwise.[4]

The corresponding expenditure elasticities are given by

$$\begin{aligned}\eta_k &= \frac{\partial \log x_k(q,m)}{\partial \log m} = 1 + \frac{\partial \log w_k(q,m)}{\partial \log m} \\ &= 1 + \frac{\beta_{1k} + 2\beta_{2k}\tilde{m}}{\hat{w}_k}, \qquad (4.13)\end{aligned}$$

for $k = 1, \cdots, m$.

The compensated price elasticities can in the present case be interpreted as referring to compensation made in terms of real income. They are given by, $k, l = 1, \cdots, m$,

$$\begin{aligned}\tilde{\eta}_{kl} &= \eta_{kl} + \eta_k \hat{w}_l \\ &= -\kappa_{kl} + \hat{w}_l + \frac{\gamma_{kl}}{\hat{w}_k}. \qquad (4.14)\end{aligned}$$

In the present study real expenditure variables are used in describing the Engel curves of the model (4.11). These are defined by substituting the Stone price indices for the theoretically correct $A(q)$ indices. The approximation produces an error to the real expenditure term which has been calculated in case of the standard AIDS -model by Pashardes [1993], and Suoniemi [1990]:

$$\begin{aligned}\log P_S - \log A(q) &= \frac{1}{2}\log \mathrm{q}^{\mathrm{T}}\Gamma \log \mathrm{q} + (\mathrm{m} - \log \mathrm{A(q)})\beta_1^{\mathrm{T}} \log \mathrm{q} + \varepsilon^{\mathrm{T}} \log \mathrm{q}^{\mathrm{T}} \qquad (4.15) \\ &= \frac{\frac{1}{2}\log q^T \Gamma \log q + (m - \log P_S)\beta_1^T \log q + \varepsilon^T \log q}{1 - \beta_1^T \log q}. \qquad (4.16)\end{aligned}$$

Above we have have used the self-explaining vector notation,

$$w(q, \bar{m}) = \alpha + \Gamma \log q + \bar{m}\beta_1 + \bar{m}^2\beta_2 + \varepsilon, \qquad (4.17)$$

and have denoted $\bar{m} = m - \log A(q)$, in this simplified case with $\beta_2 = 0$.

[3] Apologies for the alternative notation which earlier has been reserved for δ.

[4] Note that the formula 4.11 relates to a consumer with "median taste", i.e. the case where individual error terms ε_i reflecting individual taste differences have been set to zero.

Pashardes' formula (4.15) gives an omitted variable to the R.H.S. of (4.17), recall that $\beta_2 = 0$,

$$(\log P_S - \log A(q))\beta_1 = \left(\frac{1}{2}\log \mathrm{q}^{\mathrm{T}}\Gamma \log \mathrm{q} + (\mathrm{m} - \log \mathrm{A(q)})\beta_1^{\mathrm{T}} \log \mathrm{q} + \varepsilon^{\mathrm{T}} \log \mathrm{q}\right)\beta_1 \quad (4.18)$$

Pashardes [1993] has observed using the standard form of AIDS that the estimated own price and the cross-price coefficients are positively biased if the commodities involved are either both necessities or both luxuries, i.e. $\beta_{1k}\beta_{1l} > 0$. In the opposite case, the adding-up condition ensures that the other cross-price coefficients are understated in a similar fashion. Furthermore, he argued that the bias is more severe if the elasticities are estimated using micro data rather than aggregate data.

This can be seen by starting with (4.15) and rearranging the elements in the corr-rection vector (4.18) to get a new 'coefficient matrix' for the vector of price variables, for example $(m - \log A(q))\left(\beta_1^T \log q\right)\beta_1 = (m - \log A(q))\left(\beta_1\beta_1^T\right)\log q$. The needed result can be (informally) motivated by assuming $m - \log A(q) > 0$, and arguing that the coefficient matrix Γ gets estimated in terms of original parameters as

$$\tilde{\Gamma} = \Gamma + \beta_1\left(\frac{1}{2}\Gamma \log \mathrm{q} + (\mathrm{m} - \log \mathrm{A(q)})\beta_1\right)^T. \quad (4.19)$$

The notation on the R.H.S. of the above formula which refers to variables corresponds here to some mean values in those variables.

If the substitution effects are low, $\log q^T \Gamma \log q \approx 0$ and the first correction term in the R.H.S. of (4.18) vanishes. Pashardes calculated a simple modification to the estimates which he found out to be empirically adequate in calculating the uncompensated price elasticities. In fact, the modification in (4.19) corresponds to (4.12) where one substitutes the Stone price index for the theoretically correct $A(q)$ indices before derivating the real expenditure part of the formula (4.11), with $\beta_2 = 0$. In matrix notation,

$$\frac{\partial \tilde{w}(q,m)}{\partial \log q} = \tilde{\Gamma} - \tilde{\beta}_1 \tilde{w}^T \quad (4.20)$$

$$= \Gamma - \tilde{\beta}_1\left(\tilde{w} - (m - \log A(q))\beta_1 - \frac{1}{2}\Gamma \log \mathrm{q}\right)^T. \quad (4.21)$$

Dropping out the last term in the parenthesis on the R.H.S. of (4.21), recall that $\log q^T \Gamma \log q \approx 0$, produces almost exactly the 'theoretically correct formula' which is based on (4.6) and is using $A(q)$, with no quadratic term in the real expenditure variable, and is given by

$$\frac{\partial w(q,m)}{\partial \log q} = \Gamma - \beta_1\left(\hat{w} - (m - \log A(q))\beta_1\right)^T. \quad (4.22)$$

The fits of the two models $\tilde{w}$, and $\hat{w}$ are likely to be quite similar. In the standard AIDS -model the Stone index formula (4.12) and the 'theoretically correct formula' (4.22) differ by the term $(m - \log A(q))\beta_1\beta_1^T$, which is given in the 'correct parameters and variables.' One can argue that the price elasticities are estimated more accurately in the former case as opposed to using the full nonlinear formula with 'biased parameter estimates'.

Note, however, that the parameters β_1 have a tendency to have biased estimates. Start with the formula that we prefer (4.16) to develop the analysis little further on from the point where Pashardes [1993] concludes. Next add the corresponding omitted variable to the R.H.S. of (4.17), and in contrast to the previous case recombine the corrrection term with the real expenditure variable which is written with the Stone price index.[5] Similarly, as before one can argue that the coefficient matrix Γ, and vector β_1 get estimated in terms of the original parameters (and the means in variables) as,

$$\hat{\Gamma} = \Gamma + \frac{1}{1-\beta_1^T \log q}\beta_1 \left(\frac{1}{2}\Gamma \log q\right)^T, \tag{4.23}$$

$$\hat{\beta}_1 = \frac{1}{1-\beta_1^T \log q}\beta_1. \tag{4.24}$$

The estimated parameters $\hat{\beta}_1$ are biased away from zero (inflated in absolute value) if $\beta_1^T \log q > 0$. Substitute (4.23) and (4.24) into the 'theoretically correct formula' (4.22) to get an estimate which is obtained by using the biased parameter estimates

$$\frac{\partial \tilde{w}(q,m)}{\partial \log q} = \Gamma - \frac{1}{1-\beta_1^T \log q}\beta_1 \left(\tilde{w} - (m - \log A(q))\beta_1 - \frac{1}{2}\Gamma \log q\right)^T. \tag{4.25}$$

The bias in (4.25) in relation to (4.22) which is calculated with the correct parameters is equal to

$$-\frac{\beta_1^T \log q}{1-\beta_1^T \log q}\beta_1 \left(\tilde{w} - (m - \log A(q))\beta_1 - \frac{1}{2}\Gamma \log q\right)^T + \beta_1 \left(\frac{1}{2}\Gamma \log q\right)^T. \tag{4.26}$$

For comparison, consider the formula (4.20) which is based on the Stone index, and substitute in the parameters $\hat{\Gamma}$, and $\hat{\beta}_1$. Because (4.20) and (4.22) differ by the term $(m - \log A(q))\beta_1\beta_1^T$, the following term is subtracted from the above bias (4.26)

$$\frac{m - \log A(q)}{(1-\beta_1^T \log q)^2}\beta_1\beta_1^T. \tag{4.27}$$

This is again positive at those indices where the commodities involved are either both necessities or both luxuries, i.e. $\beta_{1k}\beta_{1l} > 0$. If the 'Stone index formula' (4.20) is used to calculate the cross price coefficients the bias is in this case diminished compared with the 'true formula' (4.22) if the corresponding element in (4.26) is also positive. We cannot provide any formal proof that would show whether the calculation of the price coefficients by either the procedure implicit in the Stone formula or (4.22) would dominate the other even if we allow for a low value in the term, $\beta_1 \log q^T \Gamma \approx 0$. The sign of the component

[5]This modification is motivated by the fact that in the micro data it is reasonable to expect much higher sample variation in the real expenditure variable rather than in the price variables.

elements given by (4.26) is partly determined by the sign of the expression $\beta_1^T \log q$. On the other hand, the sign of the elements in $\beta_1 (\tilde{w} - (m - \log A(q))\beta_1)^T = \beta_1 \alpha^T$ is determined by whether the good involved by the row is a luxury, i.e. $\beta_i > 0$, or a necessity, and whether any amount of the good invoved by the column is consumed at the 'minimum level' of real expenditure that the model allows, i.e. $\alpha_j > 0$. One would expect to have 'smaller' parameters α for the necessities than for the luxuries where the Engel curve is downward sloping. If both goods are luxuries, $\beta_i \alpha_j > 0$, and $\beta_1 \log q^T < 0$ the 'Stone index formula' may give estimates that have a smaller bias.

If the expenditure elasticities do not differ too much from one the individual elements in (4.27) are quite small, and in this case the two formulas give practically identical results.

If compensated elasticities are calculated using the Stone formula (4.14) the biased estimates $\tilde{\beta}_1$ cancel out in calculations. Therefore, (4.19) suggests that the estimates we obtain are quite accurate since as they are calculated referring to compensation in relation to real income, they directly involve only the matrix $\tilde{\Gamma}$

$$\tilde{\Xi} \;=\; -I + ew^T + D^{-1}(\hat{w})\tilde{\Gamma},$$

where D refers to the diagonal matrix with the vector of diagonal elements given in the argument, e is a vector of ones, and

$$\tilde{\Gamma} = \Gamma + (m - \log A(q))\beta_1\beta_1^T + \frac{1}{2}\beta_1 \log q^T \Gamma. \tag{4.28}$$

The matrix $\tilde{\Gamma}$ differs from the correct component only by the last term which is expexted to be approximately zero. If the 'theoretically correct formula' (4.22) is used to calculate the compensated elasticities we in fact add the component (4.27) to the formula. In this case one would expect the bias to increase.

In our opinion there remains, however, another potentially more severe problem towards biased estimation *if the observed budget shares are used in the calculation of the Stone price index.* This a reason why we do not leave out the error terms ε from the above formulae (4.15)-(4.18). In this case the explanatory variables related to the real expenditure and the disturbances are no longer uncorrelated and one obtains biased estimates. Therefore one should instrument either the budget shares in the Stone price index or the composite real expenditure variable. The latter is customarily done (also by Pashardes) in the UK studies.

If the quadratic term in (4.11) is included the formula (4.15) gets involved

$$\begin{aligned} \log P_S - logA(q) \;&=\; (m - logA(q))\beta_1^T \log q + (m - logA(q))^2 \beta_2^T \log q \\ &+\; \frac{1}{2} \log q^T \Gamma \log q + \varepsilon^T \log q. \end{aligned} \tag{4.29}$$

where we have used the full formula (4.11), in this case $\beta_2 \neq 0$.

Substitute in the R.H.S. of (4.29) $m - \log P_S - (\log A(q) - \log P_S)$ for $\bar{m} = m - \log A(q)$, to obtain

$$\log P_S - \log A(q) \;=\; \left(2(\log P_S - \log A(q))(m - \log P_S) + (\log P_S - \log A(q))^2\right)\beta_2^T \log q$$

$$+ \quad \beta_1^T \log q(\log P_S - \log A(q))\frac{1}{2}\log q^T \Gamma \log q + \varepsilon^T \log q$$
$$+ \quad (m - \log P_S)\beta_1^T \log q + (m - \log P_S)^2 \beta_2^T \log q. \qquad (4.30)$$

The above formula defines a quadratic equation in the variable $\log P_S - \log A(q)$. One can solve it for the positive root but in this case one cannot form a solution for the correction without the square-root term present.[6] This means that the development of the analysis along the lines of the standard AIDS-model is out of our reach.

Similarly as before the formula (4.30) gives an omitted variable to the R.H.S. of (4.17), equal to

$$(\log P_S - \log A(q))\beta_1 \quad +$$
$$\beta_2^T \log q \left(2(\log P_S - \log A(q))(m - \log P_S) + (\log P_S - \log A(q))^2\right) \beta_2 \quad . \qquad (4.31)$$

Return to considering the full QAIDS-model (4.6), and calculate the elasticities in the case where one reiterates the effects of the estimated $A(q)$ component, parameters α and γ all through the real total expenditure term in the original formula. This corresponds to the "theoretically correct formula" which is based on (4.6)

$$\eta_{kl} = -\kappa_{kl} + \frac{\gamma_{kl} - (\beta_{1k} + 2(\beta_{2k} + \beta_{1k})B_2(q)\bar{m})\, d\log A_l}{\hat{w}_k}$$
$$+ \quad \frac{\beta_{2l}(\beta_{2k} + \beta_{1k})B_2(q)\bar{m}^2}{\hat{w}_k}, \qquad (4.32)$$

where

$$d\log A_l = w_l(q, \bar{m}) - \beta_{1l}\bar{m} - (\beta_{2l} + \beta_{1l})B_2(q)\bar{m}^2.$$

for $k, l = 1, \cdots, m$, and $\bar{m} = \log(M/n) - \log A(q)$.

The corresponding Stone formulae for the expenditure elasticities are given previously by (4.13). In contrast, the "theoretically correct formula" for real expenditure retains the component $B_2(q)$, and is given by

$$\eta_k = 1 + \frac{\beta_{1k} + 2(\beta_{2k} + \beta_{1k})B_2(q)\bar{m}}{\hat{w}_k}, \qquad (4.33)$$

for $k = 1, \cdots, m$.

The compensated elasticities have a rather complicated formula

$$\tilde{\eta}_{kl} = -\kappa_{kl} + \hat{w}_l \qquad (4.34)$$
$$+ \quad \frac{\gamma_{kl} + (\beta_{1k} + 2(\beta_{2k} + \beta_{1k})B_2(q)\bar{m})\,(\beta_{1l} + (\beta_{2l} + \beta_{1l})B_2(q)\bar{m})\,\bar{m}}{\hat{w}_k}$$
$$+ \quad \frac{\beta_{2l}(\beta_{2k} + \beta_{1k})B_2(q)\bar{m}^2}{\hat{w}_k}, \qquad (4.35)$$

[6] Details are available upon request.

for $k, l = 1, \cdots, m$. Naturally the corresponding 'Slutsky -matrix' is a symmetric one[7] but if the term $B_2(q)$ is not allowed for in the calculations, see the last row on the R.H.S. of (4.35), the 'simplified version' of the Slutsky -matrix is no longer symmetric.

The elasticities of our model are not constant but depend on the values of the other covariates. Because we have many complicating covariates in the models it is clear that elasticity calculations and examination of results should be done in a multivariate framework. The empirical advantage of using flexible representation for functional form is that untenable restrictions on behaviour are avoided. This is in stark contrast to using rigid forms like the LES or CES which are internally consistent but less fortunate in the particular assumptions entertained. In these cases, for example welfare improving directions for tax changes are governed almost entirely by the properties of the theory model and not necessarily those in the data.

In (4.11) we have implicitly introduced random disturbance terms ε_k as additional components of the α_k.[8] If the system of equations is estimated conventionally, say by the SURE-method all the equations contain the same set of explanatory variables and the linear system defined by (4.11) is just identified. Therefore the results are identical with an equation by equation treatment by OLS. Homogeneity restrictions (4.3) can now be tested by OLS, separately in each equation. In contrast, the symmetry restrictions (4.10) involve restrictions across equations and resort to a proper application of SURE (or 2SLS, in case of endogenous regressors) is needed. The gains associated with flexible functional forms are achieved at the cost of the increased computational burden of more complex and less parsimonious models. Furthermore, since the models are based on local approximations they are completely giving up global regularity in functional form. Therefore concavity of the expenditure function cannot be guaranteed globally by linear restrictions of the parameters.

The above modifications are standard in empirical work and the former may be seen as a necessity in the case of analyzing micro data, see Deaton [1986]. Introducing demographic variables to the parameters α_k in the QAIDS allows for exact aggregation

[7]In the present study the 'Slutsky -matrix' is defined as $D(\hat{w})\tilde{\Xi}$, where the matrix $\tilde{\Xi}$ consists of the compensated elasticities.

[8]These terms gain in importance if one proceeds to welfare calculations with a well-behaved estimated expenditure function. These explicitly involve distributional characteristics, since various relevant concepts, e.g. equivalent and compensated variation, King [1983], and the *society's standard-of-living and welfare indices*, as in Suoniemi [1994], are nonlinear in relation to the stochastic disturbance terms. This necessitates some modifications that are needed in empirical calculations to guarantee that the distributional features of the original data survive the smoothing implicit in the econometric estimation of the parameters of model (4.1). King [1987] recommends that the (or a fraction of them) residuals of estimated budget share equations, eg. $w_{hk} - \hat{w}_{hk} = \hat{\varepsilon}_{hk}$ in (4.6), are taken to represent the individual characteristics of the micro level household reflecting eg. differences in preferences or in household production and not errors in collecting the data. These residuals are then taken as such to represent differences in the α_k terms in (4.1). A preferable method would be to endow the 'errors' with the distributional features of the data and characterize them with some distributional assumptions, eg. $\varepsilon_k \sim N(0, \sigma_k^2)$ in agreement with the data and *not to condition on the particular sample available.* The variance component may naturally be heteroskedastic if necessary for realistic representation of the data as deemed necessary in our data.

over consumers, if the coefficients γ_{kl} and those present in the zero-order homogenous price functions, B_1 and B_2 are independent of the above characteristics, see Lau [1982] and Gorman [1981]. In the present paper we proceed a step further allowing the components of the B_1 function, i.e. the parameters β_{1k} to depend on a set of household characteristics.[9] Note that this extension of the model effectively allows exact aggregation only within those subgroups where the slope variable has a constant value. These subgroups are implicitly defined by the choice of the latter factors.

4.2 Econometric model

The statistical-econometric sampling model of the data has been endowed with the following features. First, one accounts for data imperfections encountered in collecting the consumption data. An important problem concerns the error free measurement of the various subcomponents of consumption. In particular, in equation (4.11) total consumption expenditure should correspond to the theoretical concept which is exogenous to the decision how expenditure are distributed among the component categories rather than to the error prone actual expenditure measure which reflects the relatively short bookkeeping periods used in collecting the actual data, see Section 3.1. For example one observes plenty of zero purchases occurring for some items and other similar data imperfections (Table 3.3). This point has been argued already by Summers [1959] and is likely to be particularly important in cross-section work where occasional large purchases affect both sides of the Engel curve, see Deaton [1986]. At the individual level one should observe that there is a positive correlation between total consumption expenditure in a bookkeeping period and recording of purchases of individual items which has unpleasant implications for econometric estimation. One would expect to find too strong positive response of demand for an individual consumption category to total expenditure but with several regressors which are not mutually orthogonal the sign of the bias is no longer a priori known.[10]

We treat nominal total expenditure similarly as in an 'errors-in-variables' problem and utilize a two stage estimation procedure (EQML) which is related to the conventional method of instrumental variables. The variable is projected on a subspace spanned by a set of instruments to form a conditional expectation. Furthermore, total expenditure should correspond to the conditional expectation which is the solution for an intertemporal optimization problem where the household uses information efficiently in forecasting the future values of all relevant variables, see Bierens and Pott-Buter [1989]. The conditional expectation which is used to formulate the outcome of the dynamic consumption

[9]Blundell, et.al. [1993] have shown that in micro data both nonlinear terms in the expenditure variable and interaction terms involving the real expenditure are empirically important. Their functional form, however, did not allow for the coefficient of the second order term in total expenditure, β_{2k} to be free to vary across the consumption categories.

[10]Because, we estimate the demand equations in budget share form where the purchase is divided by the error-prone component the bias would be somewhat milder and even in the case of a single regressor its sign is undetermined. Nevertheless, it will still remain to be a problem.

decision is taken relative to prices, interest rates, household composition and indicators for wealth variables. One should also include variables correlating with human wealth and labour market conditions. We consider these variables as predetermined and not outcomes of a simultaneous intertemporal optimization decision.

In contrast with the conventional method of instrumental variables that is used by Blundell et. al (1993) we prefer to use a richer set of explanatory variables, i.e. those variables that span the subspace on which the projection is taken. Similarly we allow for nonlinearities and time varying parameters in the six surveys present in our data. Calculating six regressions rather just one it is hoped that a 'better fit' is obtained since the consumption functions obtained by conditioning on the available instruments may drift over time due to changes in labour and credit markets. These in turn affect the dynamic economic environment where consumption decisions are made. Following Bierens and Pott-Buter we replace total expenditure and variables that are functionally related to it by the conditional expectations that are estimated at the initial stage of estimation.

These modifications are particularly important since we are not using instrumental variables method in its conventional form where errors in the endogenous R.H.S. variables are only assumed to be uncorrelated with the instruments but we in effect use a multi-equation structure and estimate a preliminary model for the parameters governing the conditional expectations for those variables.

Theoretical motivation for our EQML method is provided by the following examination where we use a streamlined version of our model to examine the effects of including in the model generated regressors in the sense of Pagan [1984], i.e. preliminary estimates for the parameters $\tilde{\psi}$ rather than actual parameters ψ governing the conditional expectations. This is done by modifying the error term in the model successively. Here we neglect the effects due to modelling heteroskedasticity to keep the presentation managable and return to the latter aspect in Chapter 5.

Consider a system of equations where[11]

$$\begin{aligned} y_h &= \mu + \beta x_h^* + \varepsilon_h^*, & (4.36)\\ x_h &= x_h^* + \eta_h = z_h^T \gamma + \eta_h, & (4.37) \end{aligned}$$

where the variances of the error terms ε_h^*, and η_h are σ^2 and ω^2, respectively. The error terms are assumed independent of the z-variables and uncorrelated both across observations h and across equations.

To simplify exposition we assume that ε_h^* is normally distributed and the parameters of equation (4.37) can be estimated square-root N -consistently by OLS, having asymptotically normal estimator $\tilde{\gamma}$, with the covariance matrix

$$NV_{\tilde{\gamma}} = \omega^2 \left(\frac{1}{N} \sum_i z_i z_i^T \right)^{-1}. \qquad (4.38)$$

[11] One of the first to consider setting up the errors-in-variables problems in this way was Durbin [1954], see also Zellner [1970].

Assume

$$plim \frac{1}{N}\sum_i z_i = \mu_z, \qquad (4.39)$$

$$plim \left(\frac{1}{N}\sum_i z_i z_i^T\right)^{-1} = C^{-1}. \qquad (4.40)$$

Substitute the generated regressors, i.e. the smoothed, fitted values $z_h^T\tilde{\gamma}$ for the true values x_h^* into (4.36) to obtain

$$\begin{aligned} y_h &= \mu + \beta z_h^T\tilde{\gamma} + \varepsilon_h^* + \beta z_h^T(\gamma - \tilde{\gamma}) \\ &= \mu + \beta\tilde{x}_h + u_h, \end{aligned} \qquad (4.41)$$

where $\tilde{x}_h = z_h^T\tilde{\gamma}$ and the new (asymptotically normal) error term u_h has the variance:

$$\begin{aligned} V_h &= \sigma^2 + \beta^2 V_{\tilde{x}_h} \\ &= \sigma^2 + \beta^2 z_h^T V_{\tilde{\gamma}} z_h \\ &= \sigma^2 + \beta^2\omega^2 z_h^T \left(\sum_i z_i z_i^T\right)^{-1} z_h. \end{aligned} \qquad (4.42)$$

Write the estimated quasi loglikelihood for an individual observation h on the dependent variable, in our case budget share, as

$$\begin{aligned} \tilde{\mathcal{L}}_h &= -\frac{1}{2}\left(log(V_h) + \frac{\tilde{u}_h^2}{V_h}\right), \\ \tilde{u}_h &= y_h - \mu - \beta\tilde{x}_h, \end{aligned} \qquad (4.43)$$

with $\tilde{x}_h$ and V_h given previously.

Note that

$$\begin{aligned} \tilde{u}_h &= \varepsilon_h^* - \beta(\tilde{\eta}_h - \eta_h) \\ &= \varepsilon_h^* - \beta z_h^T \left(\sum_i z_i z_i^T\right)^{-1} \sum_j z_j \eta_j. \end{aligned} \qquad (4.44)$$

The first derivatives of the above quasi log likelihood equation are given by:

$$\frac{\partial\tilde{\mathcal{L}}_h}{\partial\mu} = \frac{\tilde{u}_h}{V_h}, \qquad (4.45)$$

$$\frac{\partial\tilde{\mathcal{L}}_h}{\partial\beta} = \frac{\tilde{u}_h\tilde{x}_h}{V_h} + \beta V_{\tilde{x}_h}\left(\frac{\tilde{u}_h^2}{V_h^2} - \frac{1}{V_h}\right), \qquad (4.46)$$

$$\frac{\partial\tilde{\mathcal{L}}_h}{\partial\sigma^2} = \frac{1}{2}\left(\frac{\tilde{u}_h^2}{V_h^2} - \frac{1}{V_h}\right). \qquad (4.47)$$

Summing over the observations and solving for the F.O.C's gives the estimating equations:

$$\frac{1}{N}\sum_h \frac{\tilde{u}_h}{V_h} = 0, \quad (4.48)$$

$$\frac{1}{N}\sum_h \frac{\tilde{u}_h \tilde{x}_h}{V_h} = -\beta \frac{1}{N}\sum_h \frac{V_{\tilde{x}_h}}{V_h}\left(\frac{\tilde{u}_h^2}{V_h} - 1\right), \quad (4.49)$$

$$\frac{1}{N}\sum_h \frac{\tilde{u}_h^2 - V_h}{V_h^2} = 0. \quad (4.50)$$

Consider first the method of instrumental variables. In this case the corresponding equations to be solved for estimators are:

$$\frac{1}{N}\sum_h \tilde{u}_h = 0, \quad (4.51)$$

$$\frac{1}{N}\sum_h \tilde{u}_h \tilde{x}_h = 0, \quad (4.52)$$

$$\frac{1}{N}\sum_h \left(\tilde{u}_h^2 - \sigma^2 - \beta^2 V_{\tilde{x}_h}\right) = 0. \quad (4.53)$$

In matrix notation the estimators can be written as

$$\begin{bmatrix} \hat{\mu} \\ \hat{\beta} \end{bmatrix} = \left(\frac{\tilde{X}^T \tilde{X}}{N}\right)^{-1} \frac{\tilde{X}^T \tilde{u}}{N}, \quad (4.54)$$
$$\tilde{X} = [e \;\; \tilde{x}],$$

where e is a vector of ones.

As the number of observations N $\to \infty$, $\tilde{\gamma} \stackrel{qm}{\to} \gamma$ (convergence in quadratic mean). Simultaneously $\sum_h \frac{1}{N}\tilde{x}_h \stackrel{qm}{\to} \sum_h \frac{1}{N} x_h^*$, and $\sum_h \frac{1}{N} V_{\tilde{x}_h} \stackrel{qm}{\to} 0$, and $\sum_h \frac{1}{N} V_h \stackrel{qm}{\to} \sigma^2$. Furthermore,

$$\sum_h V_{\tilde{x}_h} = \omega^2 \sum_h z_h^T \left(\sum_i z_i z_i^T\right)^{-1} z_h$$
$$= \omega^2 tr\left(\left(\sum_i z_i z_i^T\right)^{-1} \sum_h z_h z_h^T\right) = \omega^2 r, \quad (4.55)$$

$$plim \frac{1}{N} Var(\sum_h \tilde{x}_h) = \omega^2 \mu_z^T C^{-1} \mu_z. \quad (4.56)$$

The sum (4.55) is bounded and independent of N, the number of observations in the data. Above r is the number of explanatory variables in (4.37).

Note that $\mathcal{E}\sum_h \tilde{u}_h \tilde{x}_h = -\beta\omega^2 r$. This produces some small sample bias to the instrumental variables estimator, see (4.52). However, asymptotically under standard assumptions, see (4.39)-(4.40),

$$\sum_h \frac{1}{\sqrt{N}} \tilde{u}_h \stackrel{w}{\to} \mathcal{N}\left(0, \sigma^2 + \beta^2\omega^2\mu_z^T C^{-1}\mu_z\right), \quad (4.57)$$

$$\sum_h \frac{1}{\sqrt{N}} \tilde{u}_h \tilde{x}_h \xrightarrow{w} \mathcal{N}\left(0, (\sigma^2 + \beta^2\omega^2)\gamma^T C\gamma\right), \tag{4.58}$$

$$\sum_h \frac{1}{\sqrt{N}} \tilde{u}_h \sum_i \frac{1}{\sqrt{N}} \tilde{u}_i \tilde{x}_i \xrightarrow{P} (\sigma^2 + \beta^2\omega^2)\gamma^T \mu_z. \tag{4.59}$$

To see this write in vector form $\tilde{u} = \varepsilon + P_z\eta$, and $\tilde{x} = P_z x = Z^T\gamma + P_z\eta$, where P_z is the projection matrix to the column space of Z.[12]

The above equations, and (4.54) can be used to derive the asymptotic covariance matrices of the instrumental variables estimators for μ, β, cf. Pagan [1984],

$$N\mathcal{V}_{\hat{\mu},\hat{\beta}} = M^{-1} \begin{bmatrix} \sigma^2 + \beta^2\omega^2\mu_z^T C^{-1}\mu_z & (\sigma^2 + \beta^2\omega^2)\gamma^T\mu_z \\ (\sigma^2 + \beta^2\omega^2)\gamma^T\mu_z & (\sigma^2 + \beta^2\omega^2)\gamma^T C\gamma \end{bmatrix} M^{-1}, \tag{4.60}$$

$$M = \begin{bmatrix} 1 & \gamma^T\mu_z \\ \gamma^T\mu_z & \gamma^T C\gamma \end{bmatrix}. \tag{4.61}$$

Return to considering the quasi maximum likelihood estimators. Equation (4.55) shows that the term $V_{\tilde{x}_h}$ is of low order compared to the other component, σ^2 in V_h. Therefore, the term on the R.H.S. of (4.49) has a probability limit zero and by modifying the F.O.C. accordingly one easily sees that the scores of the quasi likelihood have probability limits zero. Furthermore, the estimation of the parameters β, and μ by the method of quasi maximum likelihood can be seen as differing from the method of instrumental variables as using weighted least-squares by weights V_h^{-1}, or having the individual variables divided by $\sqrt{V_h}$. This produces potentially a more efficient estimator than the method of instrumental variables. In fact inspiration for the quasi likelihood estimator was offered to us by similar two step estimation methods which have been proposed for simultaneous equations Tobit model, see eg. Amemiya [1983]. In matrix notation our estimator can be written as

$$\begin{bmatrix} \tilde{\mu} \\ \tilde{\beta} \end{bmatrix} = \left(\frac{\tilde{X}^T\tilde{D}^{-1}\tilde{X}}{N}\right)^{-1} \frac{\tilde{X}^T\tilde{D}^{-1}\tilde{u}}{N}, \tag{4.62}$$
$$\tilde{X} = [e \ \tilde{x}],$$

where e is a vector of ones, and $\tilde{D}$ is a diagonal matrix with terms V_h on the diagonal.

The covariance matrix of the estimators is given by

$$N\mathcal{V}_{\tilde{\mu},\tilde{\beta}} = \left(\frac{\tilde{X}^T\tilde{D}^{-1}\tilde{X}}{N}\right)^{-1} Cov(\frac{\tilde{X}^T\tilde{D}^{-1}\tilde{u}}{N}) \left(\frac{\tilde{X}^T\tilde{D}^{-1}\tilde{X}}{N}\right)^{-1}, \tag{4.63}$$

where the covariance matrix in the middle can be calculated as in (4.57)-(4.59).

On the other hand, recall that the term $V_{\tilde{x}_h}$ is of low order compared to the other component, σ^2 in V_h. Therefore, asymptotically, $plim\tilde{D} = \sigma^2 I$, or to be more exact all

[12]The notation $Y \xrightarrow{w} \mathcal{N}$, refers to the weak convergence in the space of probability distributions defined in the Euclidean space. The notation $x_n \xrightarrow{P} a \iff plim\ x_n = a$, in turn refers to convergence of random variables in probability.

sums that involve dividing by V_h can be replaced with division by σ^2. This shows that the asymptotic covariance matrix is equal to the matrix which is produced by the method of instrumental variables and asymptotically the method of quasi likelihood is square-root N -equivalent with the method of instrumental variables. This is no surprise since it can be shown as in Pagan [1984] that if the extra variables in the equation (4.36), in our simple example the constant term, are either orthogonal to the z-variables or are in the linear subspace spanned by the z-variables then the method of instrumental variables (and EQML-method) is also asymptotically equivalent with the full maximum likelihood estimator. Therefore, any efficiency gain of EQML vis-a-vis the method of instrumental variables is produced only in small samples. Furthermore, in our estimation exercise the EQML-method utilizes the common restrictions that accrue from using on the R.H.S. interaction terms involving predetermined variables and a common error-prone variable, see (4.72) below.

We can alternatively calculate the covariances of the EQML-estimators for the parameters by forming the information matrix to get the the asymptotic covariance matrix of the μ, β parameters. Note here that the scores of the quasi likelihood are not independent as in the case of proper likelihood. Therefore, one cannot use the equation

$$\mathcal{I}_{\theta,\theta^T} = lim\frac{1}{N}\mathcal{E}\left(\sum_h \frac{\partial\tilde{\mathcal{L}}_h}{\partial\theta}\frac{\partial\tilde{\mathcal{L}}_h}{\partial\theta^T}\right) = lim\frac{1}{N}\left(\sum_h \mathcal{E}\frac{\partial\tilde{\mathcal{L}}_h}{\partial\theta}\frac{\partial\tilde{\mathcal{L}}_h}{\partial\theta^T}\right), \tag{4.64}$$

since the last equality does not hold but instead one has to calculate the components:

$$\begin{aligned}
\mathcal{I}_{\mu,\mu} &= \frac{1}{N}\mathcal{E}\left(\frac{\partial\tilde{\mathcal{L}}}{\partial\mu}\right)^2 = Var\left(\sum_h \frac{1}{\sqrt{N}}\frac{\tilde{u}_h}{V_h}\right) \\
&= \frac{(\sigma^2 + \beta^2\omega^2\mu_z^T C^{-1}\mu_z)}{\sigma^4}, & (4.65) \\
\mathcal{I}_{\mu,\beta} &= lim\frac{1}{N}\mathcal{E}\left(\frac{\partial\tilde{\mathcal{L}}}{\partial\mu}\frac{\partial\tilde{\mathcal{L}}}{\partial\beta^T}\right) = \mathcal{E}\left(\sum_h \frac{1}{\sqrt{N}}\frac{\tilde{u}_h}{V_h}\sum_i \frac{1}{\sqrt{N}}\frac{\tilde{u}_i\tilde{x}_i}{V_h}\right) \\
&= \frac{(\sigma^2 + \beta^2\omega^2)\mu_z^T\gamma}{\sigma^4}, & (4.66) \\
\mathcal{I}_{\mu,\sigma^2} &= lim\frac{1}{N}\mathcal{E}\left(\frac{\partial\tilde{\mathcal{L}}}{\partial\mu}\frac{\partial\tilde{\mathcal{L}}}{\partial\sigma^2}\right) = \mathcal{E}\left(\sum_h \frac{1}{\sqrt{N}}\frac{\tilde{u}_h}{V_h}\sum_i \frac{1}{2\sqrt{N}}\frac{\tilde{u}_i^2 - V_i}{V_i^2}\right) = 0, & (4.67) \\
\mathcal{I}_{\beta,\beta} &= lim\frac{1}{N}\mathcal{E}\left(\frac{\partial\tilde{\mathcal{L}}}{\partial\beta}\frac{\partial\tilde{\mathcal{L}}}{\partial\beta}\right) = Var\left(\sum_h \frac{1}{\sqrt{N}}\frac{\tilde{u}_h\tilde{x}_h}{V_h}\right) \\
&= \frac{(\sigma^2 + \beta^2\omega^2)\gamma^T C\gamma}{\sigma^4}, & (4.68) \\
\mathcal{I}_{\beta,\sigma^2} &= lim\frac{1}{N}\mathcal{E}\left(\frac{\partial\tilde{\mathcal{L}}}{\partial\beta}\frac{\partial\tilde{\mathcal{L}}}{\partial\sigma^2}\right) = \mathcal{E}\left(\sum_h \frac{1}{\sqrt{N}}\frac{\tilde{u}_h\tilde{x}_h}{V_h}\sum_i \frac{1}{2\sqrt{N}}\frac{\tilde{u}_i^2 - V_i}{V_i^2}\right) \\
&= -\frac{\beta\sigma^2\omega^2 r}{\sigma^6}, & (4.69)
\end{aligned}$$

$$\mathcal{I}_{\sigma^2,\sigma^2} = lim \frac{1}{N}\mathcal{E}\left(\frac{\partial\tilde{\mathcal{L}}}{\partial\sigma^2}\frac{\partial\tilde{\mathcal{L}}}{\partial\sigma^2}\right) = Var\left(\sum_h \frac{1}{2\sqrt{N}}\frac{\tilde{u}_i^2 - V_i}{V_i^2}\right)$$
$$= \frac{1}{2\sigma^4}. \quad (4.70)$$

The square-root N -consistent covariance matrix of parameters μ, and β is in this case calculated by finally invoking the inversion formula for a partioned matrix.

$$NV_{\tilde{\mu},\tilde{\beta}} = \left(\mathcal{I}_{\theta,\theta} - \mathcal{I}^{-1}_{\sigma^2,\sigma^2}\,\mathcal{I}_{\theta,\sigma^2}\,\mathcal{I}_{\sigma^2,\theta}\right)^{-1}, \quad (4.71)$$

where

$$\mathcal{I}_{\theta,\theta} = \begin{bmatrix} \mathcal{I}_{\mu,\mu} & \mathcal{I}_{\mu,\beta} \\ \mathcal{I}_{\beta,\mu} & \mathcal{I}_{\beta,\beta} \end{bmatrix},$$
$$\mathcal{I}_{\theta,\sigma^2} = \begin{bmatrix} \mathcal{I}_{\mu,\sigma^2} \\ \mathcal{I}_{\beta,\sigma^2} \end{bmatrix}.$$

This is naturally equal to the covariance matrix which was produced earlier.

Consider a more general case where μ is a linear combination of predetermined explanatory variables and estimable parameters. It can be shown as in Pagan [1984] that if these extra variables are either orthogonal to the z-variables or are in the linear subspace spanned by the z-variables the above EQML-method is also asymptotically equivalent to full maximum likelihood estimator. This can be shown by invoking the inversion formula for a partioned matrix which corresponds to (4.71) above.

In our estimation exercise the necessary modifications involve several aspects of the model into which we now delve into. Recall that real expenditure terms are in this study defined by using Stone price indices and not the theoretically correct $A(q)$ indices (4.11). Our earlier observations and those by Pashardes [1993], and the necessary modifications to the calculation of the elasticities, (4.15)-(4.28), suggest that using the Stone price index in micro data as a substitute for $A(q)$ means that the uncompensated price coefficients get estimated more inaccurately. In our opinion there remains, however, another potentially more severe problem towards biased estimation if the observed budget shares are used in the calculation of the Stone index. The nature of the bias is dependent on how the disturbances of the statistical model are generated. They may reflect the individual effects of consumption or simply sampling errors, probably both. In both cases the explanatory variables related to the real expenditure and the disturbances are no longer uncorrelated. Therefore we choose to instrument the budget shares in the Stone price index used in forming the real expenditure measure.[13]

At the second stage of our two-stage estimation procedure we substitute for the actual values in our model the fitted values of real expenditure.[14] Specifically, let $\beta_{1k} = \sum_i \beta_{1ki}x_i$

[13]Instrumented values are truncated below at zero and the fitted values for the other budget shares are proportionally adjusted so as to sum to one in cases with negative values of individual fits.

[14]Below we will be implicitly utilizing the assumption that the parameters for the conditional expectation of the real expenditure variable are square-root N -consistently estimated with a set of instruments, where N refers to the number of observations.

define the dependence of parameters β_1 on some predetermined variables. Assume that measured logarithmic nominal expenditure $\log M \sim (m^*, \sigma_m^2)$ where the "true", theoretical concept is governed by a linear model $m^* = \sum_j z_j \psi_{mj}$ which are estimated in the initial stage. Similarly, $w_l = \sum_j z_j \psi_{lj}$, giving $\log P_S^* = \sum_l \sum_j z_j \psi_{lj} \log q_l$. To simplify subsequent notation let total real expenditure be defined in short-hand by $\tilde{m}^* = \sum_j z_j \psi_j$.[15]

The error-prone components $\beta_{1k}\tilde{m}$ are replaced by their conditional expectations in relation to a set of exogenous variables,

$$\mathcal{E}(\beta_{1k}\tilde{m}|x,z) = \sum_i \beta_{1ki} x_i \mathcal{E}(\tilde{m}|x,z) = \sum_i \beta_{1ki} x_i \sum_j z_j \psi_j. \qquad (4.72)$$

The last equality in the sequence (4.72) is based on the observation that it seems always beneficial to include the predetermined variables x_i among the set of instruments, $\{x_i\} \subset \{z_j\}$. In contrast, Blundell, et.al. [1993] estimate each of the variables $x_i\tilde{m}$ separately by instrumental variables. Since x_i are assumed predetermined, (4.72) indicates that our method should be a more efficient one.[16]

Next one must take account at the second stage that we are using generated regressors, i.e. preliminary estimates $\tilde{\psi}$ rather than actual parameters ψ. This done by modifying the error terms in the model successively, see (4.38). First,

$$\begin{aligned} \tilde{\varepsilon}_{1k} &= \varepsilon_k - \sum_i \beta_{1ki} x_i u_{1k} \\ &= \varepsilon_k - \sum_i \beta_{1ki} x_i \sum_j z_j (\tilde{\psi}_j - \psi_j), \end{aligned} \qquad (4.73)$$

with the expectation and the variance

$$\mathcal{E}(\tilde{\varepsilon}_{1k}) = 0 \qquad (4.74)$$

$$\mathcal{E}\left(\tilde{\varepsilon}_{1k}^2\right) = \sigma_k^2 + (\sum_i \beta_{1ki} x_i)^2 \sum_{jl} cov(\tilde{\psi}_j, \tilde{\psi}_l) z_j z_l, \qquad (4.75)$$

under standard instrumental variable assumptions.

The estimated covariances of those parameters estimated at the initial stage are utilized at the final stage to guarantee correct inferences in the final model. Recall that Pagan [1984] has shown applying an earlier result by Durbin [1954] that in a linear model with standard instrumental variable assumptions, including the predetermined variables of the model x_i among the set of instrumental variables, $\{x_i\} \subset \{z_j\}$ ensures an asymptotically efficient two-stage estimation procedure.[17] However, the covariances of parameter

[15] Note that this includes the influence of the preliminary fit for both the nominal expenditure and the budget shares used in the Stone price index. In order of not making an already rough going unnecessary complicated we will not present for full derivations below. Details are available upon request.

[16] This should be obvious, particularly in the case where the predetermined variables x_i are dummies since zero observations that are the result of multiplication of real expenditure with the dummies are 'structural' and should not be modelled.

[17] The second term on the R.H.S. of (4.75) tends to zero asymptotically under standard assumptions. Asymptotic efficiency is therefore not affected whether it is included or not.

estimates are estimated biasedly. Our modification (4.75) is made to prevent this from happening, see (4.65)-(4.70).[18]

Furthermore, since there is a quadratic real expenditure term in the model one must allow for the calculable bias in the estimation of the squared term $\tilde{m}^2$ and correct for it.[19] By the well known formula, $\mathcal{E}y^2 - Var(y) = (\mathcal{E}y)^2$. Therefore, one substitutes for $\tilde{m}^2$ in the R.H.S. of (4.11) a variable that is based on the corresponding fit of the conditional expectation using preliminary estimates $\tilde{\psi}$,

$$\beta_{2k}(\tilde{m}^2 - Var(\tilde{m})) = \beta_{2k}\left((\sum_j z_j\tilde{\psi}_j)^2 - \sum_{jl} cov(\tilde{\psi}_j, \tilde{\psi}_l)z_j z_l\right). \tag{4.76}$$

In contrast to the above equation Blundell, et.al. [1993] and Riihelä and Sullström [1993] apply instrumental variables to $\tilde{m}^2$. In effect this assumes some degree of heteroskedasticity in observed values of logarithmic total expenditure. We chose to ignore heteroskedasticity in instrumenting $\tilde{m}$ at the expense of a possible loss of efficiency in $\tilde{\psi}_j$. Instead we use the existing functional relationship between $\tilde{m}$ and $\tilde{m}^2$ to get compensating efficiency gains at the second stage of estimation.[20]

Similarly as above the disturbance term of the model so far (4.73) gets modified further to

$$\begin{aligned}\tilde{\varepsilon}_{2k} &= \tilde{\varepsilon}_{1k} - \beta_{2k}u_{2k} \\ &= \tilde{\varepsilon}_{1k} - \beta_{2k}\left((\sum_j z_j\tilde{\psi}_j)^2 - (\sum_j z_j\psi_j)^2 - \sum_{jl} cov(\tilde{\psi}_j, \tilde{\psi}_l)z_j z_l\right). \end{aligned}\tag{4.77}$$

with the expectation $\mathcal{E}(u_{2k}) = 0$.

The necessary modifications in the variance of the augmented disturbance term are postponed until we consider a supplementary variable which is introduced to test our model for an early and interesting 'relative income hypothesis' in consumption behaviour which was originally put forth by Duesenberry [1949], see Section 6.1. To examine these ideas we introduce a positional variable into the model. The variable is the signed distance of the household from the median consumer. The median is estimated using

[18] Because the final form of our model is a more complicated one, full efficiency is not guaranteed by this modification.

[19] In writing the final version of the report we were delighted to find an article by Hausman et.al [1995] where *distributional properties of the endogenous R.H.S. variables*, or their higher order moments, are used to estimate the parameters in an errors-in-variables problem, having analogy with our methdod. This problem is conventionally solved by the use of instrumental variables estimation, and Hausman et.al [1995] comment that the former method "has only rarely been used by econometricians." In the present case, we have several generated regressors sharing common preliminary estimators $\tilde{\psi}$ rather than actual parameters ψ, and we use *the distributional properties of the estimators* (normality and the four first moments) to develop the analysis. Note that if estimators are used the conditions for asymptotic normality are considerably less sensitive to the distributional properties of the variables measured with error relative to the case where distributions of the variables are to be used.

[20] In addition, it seems that Blundell, et.al. [1993] obtain slightly biased t-values since covariances between the instrumented fits are ignored in the process.

the population mean of logarithmic total expenditure which is adjusted for the size of household. The variables are based on instrumented values and the mean is calculated separately for each sample year available.[21] Härdle and Jerison [1988] have found that Engel curves are more stable across cross-sections if they have been normalized with mean income. This should give some additional credence to our choice of the auxiliary variable. Specifically, introduce to the R.H.S. of (4.11)

$$\beta_{rk}(\tilde{m} - \sum_h \omega(h,t)\tilde{m}(h)), \tag{4.78}$$

where $\omega(h,t)$ are the sampling weights for the survey year $t, t = t(h)$ in which the corresponding observation, h is collected, $\sum_h \omega(h,t) = 1$, with t fixed, $\forall\ t = 66, \cdots, 90$. Similarly the disturbance term of the model (4.77) is modified further to

$$\begin{aligned}\tilde{\varepsilon}_{3k} &= \tilde{\varepsilon}_{2k} - \beta_{rk}(u_{1k} - u_{3k}) \\ &= \tilde{\varepsilon}_{2k} - \beta_{rk}\left(\sum_j z_j(\tilde{\psi}_{tj} - \psi_{tj}) - \sum_h \omega(h,t)\sum_j z_j(h)(\tilde{\psi}_{tj} - \psi_{tj})\right). \end{aligned}\tag{4.79}$$

with u_{1k} defined earlier (4.73), and the expectation $\mathcal{E}(u_{3k}) = 0$.[22]

The variance must also be modified. Note that we must account for the covariances between the terms u_{ik}, $i = 1,2,3$. Collecting all the covariances that are not zero one gets,

$$\begin{aligned}\mathcal{E}\left(\tilde{\varepsilon}_{3k}^2\right) &= \mathcal{E}(\tilde{\varepsilon}_{1k}^2) + \beta_{2k}^2\mathcal{E}(u_{2k}^2) + \beta_{rk}^2\left(\mathcal{E}(u_{1k}^2) + \mathcal{E}(u_{3k}^2) - 2Cov(u_{1k}, u_{3k})\right) \\ &+ 2\beta_{2k}\sum_i \beta_{1ki}x_i Cov(u_{1k}, u_{2k}) + 2\beta_{rk}\sum_i \beta_{1ki}x_i\left(\mathcal{E}(u_{1k}^2) - Cov(u_{1k}, u_{3k})\right) \\ &+ 2\beta_{2k}\beta_{rk}\left(Cov(u_{2k}, u_{1k}) - Cov(u_{2k}, u_{3k})\right). \end{aligned}\tag{4.80}$$

The $\mathcal{E}(\tilde{\varepsilon}_{1k}^2)$ is given by (4.75). In calculating some terms above, higher order moments of $\tilde{\psi}_j$ are needed. We resort to asymptotic normality of parameter estimators to calculate the third and fourth moments,[23]

$$\mathcal{E}(u_{2k}^2) = 4\sigma_{\tilde{m}}^2\left(\sum_j z_j\psi_j\right)^2 + 2\left(\sigma_{\tilde{m}}^2\right)^2, \tag{4.81}$$

$$\mathcal{E}(u_{3k}^2) = \sum_{jl} cov(\tilde{\psi}_j, \tilde{\psi}_l)\bar{z}_j\bar{z}_l, \tag{4.82}$$

[21] Note that since we calculate total expenditure using a rough equivalence scale (Section 3.2.3), we should arrive at a more reasonable outcome than by utilizing unequalized values of expenditure. Furthermore, the mean of logarithms is in our case quite near the median because the distribution of logarithms deviates only slightly from normality.

[22] In the above formula we have explicitely written the parameters ψ_{tj} as depending on the survey years, $t = 66, \cdots, 90$.

[23] Asymptotic normality holds under relatively weak additional conditions to those that guarantee convergence in quadratic mean.

$$Cov(u_{1k}, u_{3k}) = \sum_{jl} cov(\tilde{\psi}_j, \tilde{\psi}_l) z_j \bar{z}_l, \quad (4.83)$$

$$Cov(u_{1k}, u_{2k}) = 2\sigma^2_{\bar{m}} \sum_j z_j \psi_j, \quad (4.84)$$

where $\sigma^2_{\bar{m}} = \sum_{jl} cov(\tilde{\psi}_j, \tilde{\psi}_l) z_j z_l$, and $\bar{z}_j = \sum_h \omega(h) z_j(h)$.

Finally, we allow for heteroskedasticity in the disturbances ε_k. This is done in a simple and economical but simultaneously in a relatively powerful way by connecting the fit of the budget share equation and the corresponding variance of the error by a functional relationship that is governed by a single estimable parameter δ_k per equation,

$$\sigma^2_k = \exp\{\delta_{0k} + \delta_{k\alpha}\alpha_k\}. \quad (4.85)$$

Furthermore, we account for the sampling structure and data collection methods which vary between the surveys, see Section 3.1. This is done by estimating a time-varying variance component, and letting the parameter δ_{0k} to depend on the survey year t, $t = 66, \cdots, 90$. The procedure has a natural counterpart in the ordinary random effect approach to modelling real panel data. We modify our subsequent notation to reflect this.

Note that by ignoring the use of generated regressors in the case of the logarithmic total expenditure variable and its square term one necessarily introduces heteroskedasticity to the model in finite samples. The above modifications in the equation error term (4.73, 4.77, and 4.79) account for these effects. Therefore assumption (4.85) is done to account and test for any remaining heteroskedasticity.[24] One may motivate the functional form in (4.85) arising from an approximation at mean of a stochastic parameter model, where $\alpha_k = \sum_j \alpha_{kj} x_j$, with stochastic parameters α_{kj} and a set of exogenous omitted variables x_j that are unknown to the modeller. Furthermore, demand models that are estimated using cross-section data generally assume that the households face the same prices everywhere. Ignoring spatial variation in prices is not necessarily a good assumption, see Deaton [1987]. If there is random variation in prices the budget shares which are obtained by differentiating the now stochastic logarithmic expenditure function w.r.t. logarithmic prices have inherent error terms which have variances that are functionally related to the derivatives of the expenditure function.

Because the induced disturbances at the second stage of estimation have a relatively complicated structure we choose to use the quasi maximum likelihood method to estimate the parameters separately for each equation. The quasi loglikelihood for an individual observation h on budget share w_{hk}, conditional on the exogenous variables, is given under the (quasi-)normality assumption as

$$\tilde{\mathcal{L}}_{hk} = -\frac{1}{2} log(\sigma^2_{thk})$$

[24]The heterogeneity is connected to the term α rather than to the whole R.H.S. of (4.11) for reasons of convenience. The main reason is that now heterogeneity is connected to the exogenous part of the model.

$$
\begin{aligned}
&- \frac{1}{2\sigma^2_{thk}} \Bigg[w_{hk} - \alpha_{hk} - \sum_l \gamma_{kl} \log q_{\tau l} - \sum_i \beta_{1ki} x_{hi} \sum_j z_{hj} \tilde{\psi}_{tj} \\
&- \beta_{rk} \left(\sum_j z_{hj} \tilde{\psi}_{tj} - \sum_h \omega(h,t) \sum_j z_{hj} \tilde{\psi}_{tj} \right) \\
&- \beta_{2k} \left((\sum_j z_{hj} \tilde{\psi}_{tj})^2 - \sum_{jl} cov(\tilde{\psi}_{tj}, \tilde{\psi}_{tl}) z_{hj} z_{hl} \right) \Bigg]^2 . \qquad (4.86)
\end{aligned}
$$

Summing (4.86) over observations gives the criterium which is maximized w.r.t. the estimable parameters α, β, γ, and δ to get estimates at the second stage.[25] Above the parameters α_{hk} are allowed to vary in relation with a set of exogenous variables $\alpha_{hk} = \sum_j \alpha_{kj} z_{hj}$. The index t above refers to the survey which the observation h belongs to, $t = t(h)$, and $t = 66, \cdots, 90$. This is used to define the median household which is used as the reference level on the third row of (4.86).[26] Similarly, the price variables $\log q_{\tau l}$ are dependent on the time period τ when the observation is collected, $\tau = \tau(h)$.

The variance term of the model (4.86) is given by

$$
\begin{aligned}
\sigma^2_{thk} &= \exp\{\delta_{0kt} + \delta_{k\alpha} \alpha_{hk}\} + (\sum_i \beta_{1ki} x_{hi})^2 \sum_{jl} cov(\tilde{\psi}_{tj}, \tilde{\psi}_{tl}) z_{hj} z_{hl} \\
&+ \beta^2_{2k} \mathcal{E}(u^2_{2k}) + \beta^2_{rk} \left(\mathcal{E}(u^2_{1k}) + \mathcal{E}(u^2_{3k}) - 2Cov(u_{1k}, u_{3k}) \right) \\
&+ 2\beta_{2k} \sum_i \beta_{1ki} x_i Cov(u_{1k}, u_{2k}) + 2\beta_{rk} \sum_i \beta_{1ki} x_i \left(\mathcal{E}(u^2_{1k}) - Cov(u_{1k}, u_{3k}) \right) \\
&+ 2\beta_{2k} \beta_{rk} \left(Cov(u_{2k}, u_{1k}) - Cov(u_{2k}, u_{3k}) \right), \qquad (4.87)
\end{aligned}
$$

where the terms referring to the auxiliary variables u_{jk}, $j = 1,2,3$, are given in (4.75)-(4.84).

4.3 Imposing adding-up and symmetry restrictions on estimators

The estimation method that we use is relatively complicated. For example, one cannot directly impose parameter restrictions across equations as would be needed in testing for symmetry in the γ parameters by either maximum likelihood or score tests. Furthermore, the adding-up constraints of the model parameters are not necessarily valid at the estimates that we obtain since in the estimation method the individual observations are weighted on the basis of their (the inverse of) estimated variance terms. Similarly, if heteroskedastic models are estimated in an equation by equation manner the method of imposing adding-up by simply dropping one equation is not invariant to the particular

[25] All calculations in this study have been made using GAUSS, Aptech Systems, Inc.

[26] Note that the parameters of the instruments for real expenditure are also dependent on the survey year t, $t = 66, \cdots, 90$.

equation selected for omission. To preserve invariance *we estimate all equations separately* and calculate instead a Waldian test for these restrictions using the unrestricted form of model as the base line.

Let the set of linear parameter restrictions be written as a matrix equation $R\alpha = r$, rank(R) $= \rho$, where α is a vector that is obtained by collecting together parameters in all individual equations. The Wald test statistic which has under the null hypothesis an asymptotic χ^2-distribution with ρ degrees of freedom is given by

$$\mathcal{W}_{H_0} = (R\hat{\alpha} - r)^T \left(R\mathcal{V}R^T\right)^{-1} (R\hat{\alpha} - r), \tag{4.88}$$

where $\hat{\alpha}$ is the unrestricted quasi maximum likelihood estimator of the parameters, and $\mathcal{V}$ is the corresponding covariance matrix.[27]

Note that in calculating $\mathcal{V}$ we assume that estimators are uncorrelated across equations. This is in effect assuming that the covariance matrix for error terms is diagonal which is naturally untrue if the error terms have a singular covariance matrix, for nonsingular specifications see Summers [1959], Chavas and Segerson [1987], and Bierens and Pott-Buter [1989]. We are using actual budget shares to ease interpretation of the estimation results. The shares add to one by construction.[28] Furthermore, the EQML is using the same generated regressors which proxy for the theoretical unobserved R.H.S. variables in all equations. This should also cause some correlation across equations. These points are overlooked here. In full system estimation of the budget share equations they could have been made use of to obtain more efficient estimators.

Similarly, one can form a linear function of the unrestricted estimators $\hat{\alpha}$ which satisfies the constraints $R\alpha = r$ setting

$$\tilde{\alpha} = \hat{\alpha} + \mathcal{V}R^T \left(R\mathcal{V}R^T\right)^{-1} (r - R\hat{\alpha}). \tag{4.89}$$

The above estimator has the asymptotic covariance matrix

$$Cov(\tilde{\alpha}) = \mathcal{V} - \mathcal{V}R^T \left(R\mathcal{V}R^T\right)^{-1} R\mathcal{V}. \tag{4.90}$$

This covariance matrix is smaller than the one corresponding to the unrestricted estimator $\hat{\alpha}$, $Cov(\tilde{\alpha}) \leq Cov(\hat{\alpha}) = \mathcal{V}$.[29]

One can easily prove that the estimator $\tilde{\alpha}$ is the *best unbiased linear transformation* of the unrestricted estimators in the sense that under the null hypothesis it has the smallest asymptotic covariance matrix in the set of estimators that are linear functions of the unrestricted estimators $\hat{\alpha}$ and satisfy the linear constraint $R\alpha = r$. Since the

[27] If R has less than full row rank one substitutes a corresponding generalized inverse for the inverse matrix in the middle of (4.88).

[28] In retrospect it may have been fruitful to follow the path of the previously cited authors to the end by replacing in our model the denumerator by the fitted value of total expenditure, rather than retaining the error-ridden variable which is merely producing extra noise in the dependent variable, or modelling directly for the expenditure in the category.

[29] This is an ordering in the space of positive definite matrices, and $A \leq B$, is equivalent with $B - A$ is positive semidefinite.

restricted estimators are formed on the basis of unrestricted estimators in all individual equations the method has a nice invariance property that other nonlinear models have to impose by more complicated means. Furthermore, they are asymptotically equivalent to full maximum likelihood estimators of the system with restrictions imposed at the outset. The above remarks are made on the previous caveat of assuming that estimators are uncorrelated across equations.

If the constraint $R\alpha = r$ does not hold but instead $R\alpha = r_1$ the estimator $\tilde{\alpha}$ produces a bias which is equal to $\mathcal{V}R^T\left(R\mathcal{V}R^T\right)^{-1}(r - r_1)$. Furthermore, one can calculate the generalized mean square error of the estimator $\tilde{\alpha}$ and it is equal to

$$\begin{aligned} \mathcal{E}(\tilde{\alpha} - \alpha)(\tilde{\alpha} - \alpha)^T &= Cov(\tilde{\alpha}) + (\mathcal{E}\tilde{\alpha} - \alpha)(\mathcal{E}\tilde{\alpha} - \alpha)^T \\ &= \mathcal{V} - \mathcal{V}R^T\left(R\mathcal{V}R^T\right)^{-1}\left(I - (r - r_1)(r - r_1)^T\left(R\mathcal{V}R^T\right)^{-1}\right)R\mathcal{V}. \end{aligned} \tag{4.91}$$

Chapter 5

Preliminary Results

5.1 Preliminary fit of real expenditure

Some of the structural variables of the model are projected on a subspace spanned by a set of instruments to form conditional expectations of the variables. This smoothing is made in the study to account for data imperfections encountered in collecting the consumption data. In equation (4.11) total consumption expenditure should correspond to the theoretical concept which is exogenous to the decision how expenditure is to be currently distributed among its component categories rather than to the error prone actual expenditure measure which reflects the relatively short bookkeeping periods used in collecting the actual data, for example with plenty of zero purchases occurring for some items and other data imperfections. Consider for example a case where a good is purchased at rather irregular intervals that are long relative to the bookkeeping period. Now whenever consumer's stock is augmented the purchase of the commodity exceeds considerably the amount consumed in the bookkeeping period. Similar observations hold in the negative direction for those who have not augmented their stocks. In the mean however the consumption is properly estimated if the number of observations is large enough. At the individual level we, however, observe that there is a positive correlation between total consumption expenditure in a bookkeeping period and recording of purchases of individual items which has unpleasant implications for econometric estimation. In effect a random effect is operating on both sides of the Engel curve. We would expect to find too strong positive response of demand for an individual consumption category to total expenditure, eg. Summers [1959].[1]

Furthermore, total expenditure should correspond to the conditional expectation which in turn is the solution for an intertemporal optimization problem where the household efficiently uses available information, predetermined variables, in forecasting the

[1] If several regressors are involved the sign of the bias in the coefficient of total expenditure is no longer a priori known. Nevertheless, it will still remain to be a problem which affects the other estimated parameters of the model as well. Note that we estimate the demand equations in budget share form where the purchase is divided by the error-prone component. This may cause the bias to be somewhat milder and its sign is unpredictable even in the case of a single regressor.

future values of all relevant variables, see Bierens and Pott-Buter [1989] The conditional expectation is taken relative to prices, interest rates, household composition and indicators for wealth variables. One should also include variables correlating with human wealth and labour market conditions.

First we deal with nominal total expenditure. In contrast with the conventional method of instrumental variables that is used by Blundell et. al (1993) we use a richer set of explanatory variables, i.e. those variables that span the space on which the projection is taken. Furthermore, we allow for a different form (time varying parameters) in the surveys (six) present in our data. Calculating six regressions rather just one it is hoped that 'a better fit' is obtained since the 'consumption function' defined by conditioning on the available instruments may drift over time due to changes in labour and credit markets. These in turn affect the dynamic economic environment where consumption decisions are made. These modifications are particularly important since we do not use the conventional method of instrumental variables where errors in the endogenous R.H.S. variables are only assumed to be uncorrelated with the instruments but we in effect use a multi-equation structure (4.36) and (4.37) and estimate the parameters of a preliminary model (4.37) for the conditional expectation of total expenditure variable.

Note that it is not obvious how the conditional expectation of total consumption is identified independently of the equations defining consumption in the component categories without imposing restrictive separability conditions. If an instrument entered the former it was observed to enter at least one of the latter equations in our data. Here we solve this problem by using time-varying parameters and nonlinear and product terms in the former equation and in turn consider the share equations as parsimonous simplifications of the more complicated models. In all we have used a constant term and seventy variables (Table A2.2), where the set of variables naturally includes the exogenous factors of the model for budget shares.[2] It should be noted that we consider these variables as predetermined and not outcomes of a simultaneous intertemporal optimization decision. Logarithmic area of the dwelling and a quadratic term in it are used as additonal instruments to capture effects of permanent income or wealth on consumption. We rely heavily on this 'proxy' for wealth. The area variable is allowed to have an interaction term with 13 other regressor, 11 of them indicator variables. Several indicators that measure holding of major assets (car, weekend house), tenure choice (owning or renting), dwelling type (small house, flat), and amenities (Bathroom, Warm water, WC) available in the dwelling are also included.

Educational status is used here as a proxy for human capital. Total disposable income of the household in logarithmic form and a quadratic term in it are also included among the regressors and some additional indicator variables to take account of the labour supply decision of the household. The labour supply variables that we have access to (self-employed household head, household head out of workforce, spouse working, number of retired persons) are not very detailed and decisions concerning them are made on a long term basis. Therefore we feel that they are predetermined enough for our purposes

[2]The price variables, however, were not included since they correspond to quite short time periods in our model, and have presumably little informational value to the intertemporal decision.

and need no separate treatment with instruments. Regional variables are used to capture effects of local labour market conditions and otherwise unobserved, permanent differences in relative prices. In addition, both the logarithm of the age of household head and the logarithmic household size are present with interaction terms with four indicator variables each. Twelve additional interaction variables are formed among the indicator variables. The logarithmic variables measured in interval scale, area of dwelling, age and household size have all possible pairwise product terms (three) in the model, for a complete list of the variables, see Table A2.2.

To account for any remaining interactions among variables two additional variables are formed by taking the fit of a preliminary equation (with the 68 variables), and calculating the Ramsey's RESET-terms, the fit to the second and to the third power.[3] The final fit is a combined fit of all the 70 variables. The problem of a possible over-fitting does not worry us since there are so many observations available (33 420).

The next step is to make a similar operation with the budget shares as the object variables. In doing this two generated variables are added to the list of explanatory variables to account for the cross section Engel curves in consumption. These are the fitted values of the logarithmic total expenditure and a quadratic term in it. Finally, the fitted values of the logarithm of total expenditure are deflated with the Stone price index with the weights calculated from the fitted values and prices calculated continuously for each sample period using the specific information on which period the expenditure data was collected (Section 3.2.2).[4]

A notable feature of the data is that in 1981, the fourth sampling year in the data, the bookkeeping period used in collecting the data was shortened from a month to a two-week period, in hope of enhancing the quality of collected data. There had been some indication of fatigue when the longer bookkeeping period was used (Table 3.1). On the other hand, shortening of the bookkeeping period leads inevitably to more zero observations and increase in variance of expenditures if the length is arithmetically accounted for (Table 3.3).

[3]Ramsey [1969] argued for reset terms as useful additional instrumental variables and devised a celebrated test for the functional form of model which can be seen as test which is based on instrumental variables estimation of the model.

[4]The data has twelve different (monthly) bookkeeping periods for each surveys in 1966-1976 and about twenty-six bookkeeping periods for each survey from 1981 onwards (Chapter 3.). The weights are truncated below at zero and the fitted values for the other budget shares are proportionally adjusted so as to sum to one in cases with negative values of some budget share fits.

Figure 5.1. Fitted and observed values, LNX in 1966

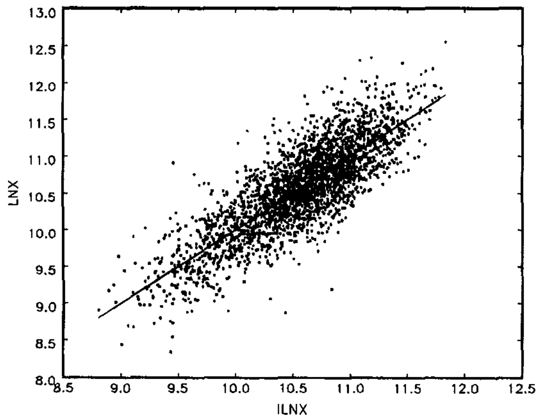


Figure 5.1. Fitted and observed values, LNX in 1971

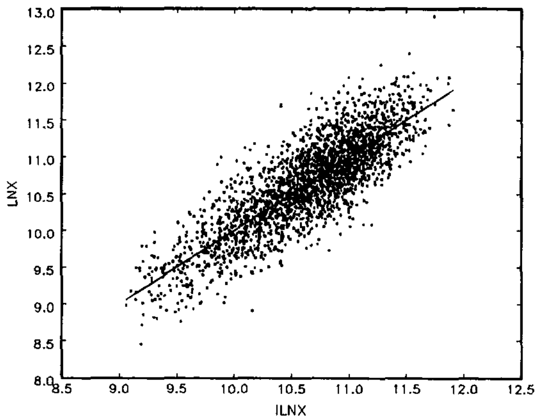


Figure 5.1. Fitted and observed values, LNX in 1976

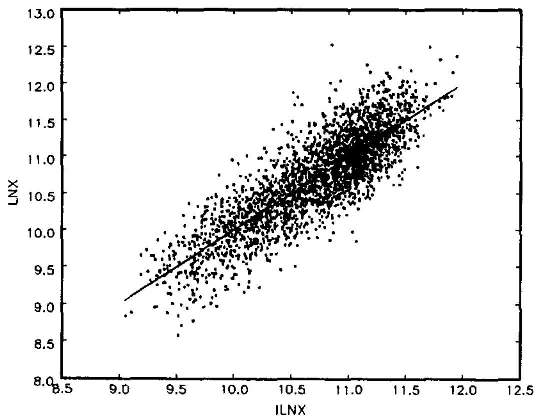


Figure 5.1. Fitted and observed values, LNX in 1981

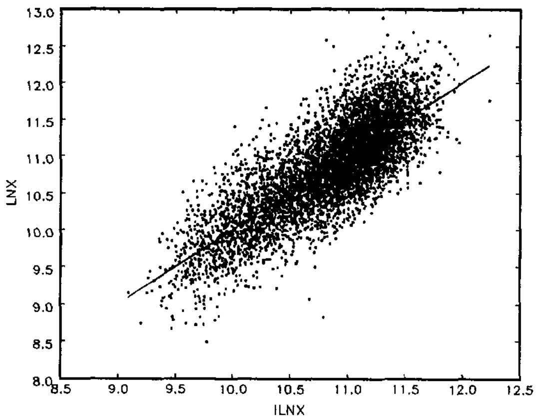


Figure 5.1. Fitted and observed values, LNX in 1985

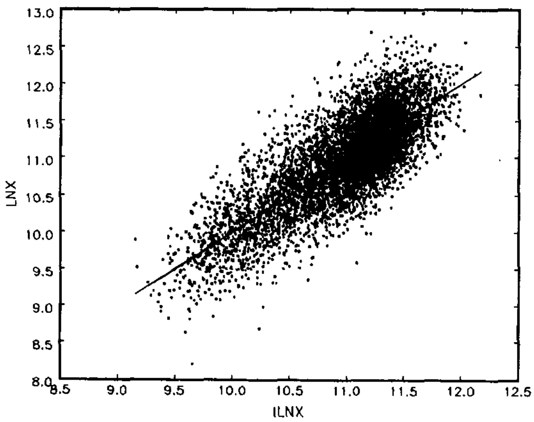


Figure 5.1. Fitted and observed values, LNX in 1990

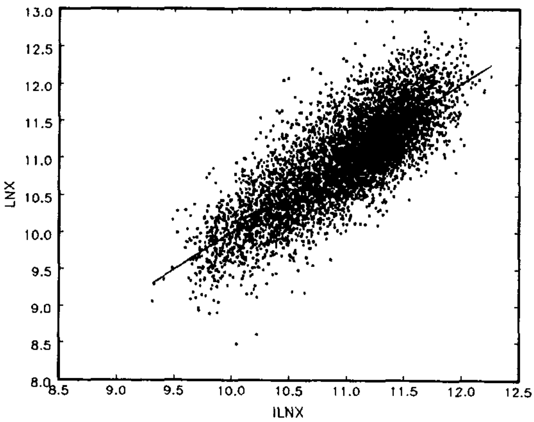


Table 5.1. The fitted values of log expenditure.

Year	Nominal	R^2	Real	R^2
1966	9.2036	0.681	10.5805	0.676
1971	9.5387	0.705	10.6530	0.702
1976	10.2582	0.724	10.7422	0.719
1981	10.8689	0.636	10.8663	0.635
1985	11.2987	0.621	11.0022	0.621
1990	11.5691	0.654	11.0235	0.655
All	10.8049	0.876	10.8791	0.676

These aspects can be clearly seen as a deterioration of the fit since 1981, see Table 5.1 where values of nominal and real expenditures are shown together with the coefficient of determination of the instrument equations for each survey year.

The same tendency is observable in Figure 5.1 where the actual values of real expenditure are plotted against the fit obtained from the instruments.[5] On the other hand, visual examination of Figure 5.1 gives no clear indication of heteroskedasticity in the model errors. This gives credence to our preference for OLS estimation in this phase and more complicated methods of estimation seem unnecessary.

Finally, we calculated the variance of the preliminary fit of the logarithmic real expenditure to collect some finite sample efficiency gains in the second stage of our quasi likelihood estimation exercise using the formula (4.80).[6]

5.2 Testing for heteroskedasticity

The budget share equations are tested for heteroskedasticity by first estimating equations by OLS using the chosen set of exogenous regressors and including the fitted values of the real expenditure variables. A variant of the Lagrange multiplier test similar to

[5]At this point one cannot help commenting that the weighted variables which correspond to the estimates at the population level show a closely similar tendency to increase over the sample period independently whether one considers fitted or actual values. However, if one looks at the standard deviations of logarithmic variables, a kind of measure for inequality, one notes that only half of the increase in inequality (three versus six thousand parts in the value of the standard deviation) remains after the data are smoothed by projection in contrast to the raw values, in the change from 1976 to 1981. In other periods the two measures show closely similar development. One may suggest that a major part of the apparent increase in inequality was in fact accounted for by the shortening of the major bookkeeping period and should not be taken to indicate an increase in actual inequality. We plan to develop these ideas in later analyses of the data while inequality in consumption is considered.

[6]Actually to be on the safe side in estimating these covariance terms we resorted to the heteroskedastic consistent estimators for the covariances by White [1980], although no clear indication of heteroskedasticity is actually detected.

that proposed by Breusch and Pagan [1980] is used.[7] Specifically, the logarithm of the squared residual is regressed on a number of variables. The test was originally proposed by Park [1966], and the test is presumably more powerful than the Breusch-Pagan test against the specific alternative considered here.[8] We included as test variables dummies for the sample surveys to detect differences in sampling framework and methods of data collection, see Section 3.1 on sampling methods, and that part of the least squares fit of the preliminary OLS estimation which is composed of the exogenous variables in the fit, see (4.85). Six extra variables in all.

Table 5.2. Results of heteroskedasticity tests.

Variable	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
Mean	0.2827	0.0356	0.0685	0.2369	0.0631	0.0302	0.1545	0.0800	0.0486
Fit0	2.22	36.6	11.59	3.29	25.41	53.11	15.14	20.59	35.43
T	4.51	50.17	15.35	22.82	17.94	56.26	82.67	39.93	46.27
$\frac{1}{6}\chi^2(6)$	21.18	448.96	196.30	93.07	159.91	803.71	1220.04	377.67	1480.92

Table 5.2 provides the results.[9] The component categories of consumption are formed as follows: Category 1 (W_1) is Food, (W_2) is Beverages and Tobacco, (W_3) is Clothing and Footwear, (W_4) is Housing and Energy, (W_5) is Household Appliances, (W_6) is Health Care, (W_7) is Transport and Communication, (W_8) is Education and Entertainment, and the final, residual category (W_9) consists of Other Goods (and Services).

The means of the expenditure shares in the data are given in the first row of Table 5.2. The last row provides the test statistic for heteroskedasticity. The second rows shows the coefficient of the fit term in the auxiliary regression of logarithmic squared residual indicating the strength of the mutual relationship between the fit and heteroskedasticity. The third rows gives an asymptotically normal test statistic for a non-zero coefficient of the fit term.

There is a considerable amount of heteroskedasticity present and variance of the error term seems to be positively correlated with the OLS fit, i.e. the expected budget share conditional on the exogenous variables. The problem of heteroskedasticity is particularly severe in those categories that have relatively low budget shares and a fair amount of zero observations (Table 3.3). This suggests that the truncated distribution of the budget

[7] The Breusch-Pagan test is not dependent on the exact functional form for heteroskedasticity, and can be interpreted as testing for non-zero correlation between the squared residuals and the fit of the model, see eq. (5.4) below. Our version of the test is constructed to produce as a side product starting values for quasi maximum likelihood estimation.

[8] The squared residuals are truncated from below to guard against taking logarithms of 'near zero' residuals and prevent instability in results.

[9] The numerical results are actually based on Model P in Section 6.2. All variants of the basic specification in the study produced closely similar test results.

shares is partly responsible for the above phenomenon and our method of analysis is at least partially successful in controlling for the heteroskedasticity. In the present study the nonlinearity of mean that for example models in the Tobit family imply is not utilized in the estimation. Bivariate models for joint determination of purchase and consumption decisions that could handle zero observations and in principle also differing lengths in bookkeeping periods have been developed by Deaton and Irish [1984] and Kay et.al. [1984], see also Suoniemi [1990].[10] We find no easily interpretable patterns in the variance components estimated for the separate surveys, although there is a case for forming a common variance component for the three first surveys when the data collecting period was one month. However, for some reason, good or detrimental to the analysis, both the first and the last surveys in 1966 and 1990 seem to have in most cases the lowest values of the variance component (Appendix 3).

5.3 Efficiency gain of using a functional model for heteroskedasticity

Below we use a streamlined version of our model to examine the efficiency gains due to modelling heteroskedasticity by directly proposing a skedastic function. This is done in a simple and economical but simultaneously in a relatively powerful way by connecting the conditional mean and the variance of the error term in the model ε by a skedastic function that is governed by a single extra parameter δ per equation.[11] The conditional loglikelihood of an individual observation h on the dependent variable y_h, in our case budget share, is given under the normality assumption as,

$$\mathcal{L}_h \doteq -\frac{1}{2}\left(log(\sigma_h^2) + \frac{u_h^2}{\sigma_h^2}\right), \tag{5.1}$$

$$u_h = y_h - \mu_h = y_h - \beta^T z_h,$$

$$\sigma_h^2 = \exp\{\omega + \delta\mu_h\}. \tag{5.2}$$

The first derivatives of the above likelihood equation are given by:

$$\frac{\partial \mathcal{L}_h}{\partial \mu_h} = \frac{u_h}{\sigma_h^2} + \frac{\delta\sigma_h^2}{2}\left(\frac{u_h^2}{\sigma_h^4} - \frac{1}{\sigma_h^2}\right), \tag{5.3}$$

$$\frac{\partial \mu_h}{\partial \beta_h} = z_h,$$

$$\frac{\partial \mathcal{L}_h}{\partial \delta} = \frac{\mu_h\sigma_h^2}{2}\left(\frac{u_h^2}{\sigma_h^4} - \frac{1}{\sigma_h^2}\right), \tag{5.4}$$

---

[10]Note, however, that the specific type of nonlinearity which is present in the Tobit models is entirely due to the assuming Gaussian distribution and does not cover other more general instances.

[11]In this section the effect of using the fitted values from a preliminary regression among the explanatory variables is subsumed to keep the presentation manageable, see Section 4.2.

$$\frac{\partial \mathcal{L}_h}{\partial \omega} = \frac{\sigma_h^2}{2}\left(\frac{u_h^2}{\sigma_h^4} - \frac{1}{\sigma_h^2}\right). \tag{5.5}$$

Summing over the observations and solving for the F.O.C gives:

$$\sum \frac{u_h z_h}{\sigma_h^2} = \delta \sum \frac{z_h}{2}\left(\frac{u_h^2}{\sigma_h^2} - 1\right), \tag{5.6}$$

$$\sum \left(\frac{u_h^2 \mu_h}{\sigma_h^2} - \mu_h\right) = 0, \tag{5.7}$$

$$\sum \left(\frac{u_h^2}{\sigma_h^2} - 1\right) = 0. \tag{5.8}$$

If the parameters β are estimated by the method of weighted least squares where the parameters governing the calculation of weights δ and ω by (5.2) are estimated using any consistent procedure the equation (5.6) is replaced by

$$\sum \frac{u_h z_h}{\sigma_h^2} = 0. \tag{5.9}$$

The equation (5.7) shows that the estimation of the parameters β by the method of maximum likelihood and weighted least squares are equivalent if the linear form μ_h contains a constant term and only one additional regressor. In the more general case of several regressors the R.H.S. of equation (5.6) has a probability limit of zero and the two methods are asymptotically equivalent. The extra efficiency that the method of ML is contributing concerns the estimation of the skedastic function (5.2).[12] By these arguments, to get a lower bound on the efficiency gain of ML it is sufficient to compare the estimation of the model by OLS and weighted least squares with weights calculated according to our skedastic function for the conditional variance.

In the case of functional heteroskedasticity the square-root N -consistent covariance matrix of the OLS estimator, b_{ols} is estimated biasedly by the OLS method as,

$$NV_{ols} = s^2\left(\sum \frac{z_h z_h^T}{N}\right)^{-1}, \tag{5.10}$$

$$s^2 = \sum \frac{(y_h - b_{ols}^T z_h)^2}{N}.$$

In contrast, the non-biased estimator should be

$$NV_{ub} = \left(\frac{\sum z_h z_h^T}{N}\right)^{-1}\left(\sum \frac{\exp\{\omega + \delta\mu_h\} z_h z_h^T}{N}\right)\left(\frac{\sum z_h z_h^T}{N}\right)^{-1}. \tag{5.11}$$

[12]For those not preferring simple arguments like those above the result can be proved, alternatively by calculating the second-order derivatives of the loglikelihood, taking the probability limits, and forming the asymptotic covariance matrix of the β parameters by invoking the inversion formula for a partioned information matrix as in Section 4.2, details available upon request.

Finally, the correctly weighted LS method gives the covariance matrix of the efficient estimator as

$$NV_{wls} = \left(\sum \frac{\exp\{-\omega - \delta\mu_h\} z_h z_h^T}{N} \right)^{-1}. \tag{5.12}$$

The exponential function for the variance (5.2) is useful as allowing for a simple approximation of the efficiency gain due to the weighted LS method if the regressors have multinormal distribution. Under this assumption the moment generating function of the regressors is given by

$$\psi(\tau) = \mathcal{E} e^{-\tau^T z} = exp\{-\tau^T \nu + \frac{1}{2}\tau^T \Omega \tau\}, \tag{5.13}$$

where ν is the mean and Ω the full rank covariance matrix of the regressors. Taking second derivatives of (5.13) gives

$$\begin{aligned} \mathcal{E}\left(e^{-\tau^T z} z z^T\right) &= \frac{\partial^2 \mathcal{E} e^{-\tau^T z}}{\partial \tau \partial \tau^T} \\ &= \frac{\partial^2 \psi}{\partial \tau \partial \tau^T} = exp\{-\tau^T \nu + \frac{1}{2}\tau^T \Omega \tau\} \left(\Omega + (\Omega\tau - \nu)(\Omega\tau - \nu)^T\right) \end{aligned} \tag{5.14}$$

The OLS estimate b_{ols}, for the vector β is consistent, $plim\ b_{ols} = \beta$. Therefore, taking the value of (5.14) at the points $\pm\delta\beta$ and invoking the law of large numbers enables us to write the stochastic limits of (5.10) -(5.12), as N $\uparrow \infty$. Note that subsequently, we drop the element e^{ω} which is common to all formulas.

$$plim\ NV_{ols} \propto \exp\{\delta\beta^T\nu + \frac{1}{2}\delta^2\beta^T\Omega\beta\}(\Omega + \nu\nu^T)^{-1}, \tag{5.15}$$

$$\begin{aligned} plim\ NV_{ub} \propto\ & \exp\{\delta\beta^T\nu + \frac{1}{2}\delta^2\beta^T\Omega\beta\} \times \\ & \left(\Omega + \nu\nu^T\right)^{-1} \left(\Omega + (\delta\Omega\beta + \nu)(\delta\Omega\beta + \nu)^T\right) \left(\Omega + \nu\nu^T\right)^{-1}, \end{aligned} \tag{5.16}$$

$$plim\ NV_{wls} \propto \exp\{\delta\beta^T\nu - \frac{1}{2}\delta^2\beta^T\Omega\beta\} \left(\Omega + (\delta\Omega\beta - \nu)(\delta\Omega\beta - \nu)^T\right)^{-1}. \tag{5.17}$$

Note in (5.15) that the OLS estimate for s^2 has the probability limit,

$$plim\ s^2 = \mathcal{E}(y_h - z_h^T b_{ols})^2 = \mathcal{E} e^{\omega + \delta\beta^T z} = \exp\{\omega + \delta\beta^T\nu + \frac{1}{2}\delta^2\beta^T\Omega\beta\}. \tag{5.18}$$

The term $e^{\delta\beta^T\nu}$ is common to all equations and does not count in comparisons. Introduce the square root matrix Λ, $\Lambda^2 = \Omega$, and apply the formula

$$(A + xx^T)^{-1} = A^{-1} - \frac{A^{-1}xx^TA^{-1}}{1 + x^TA^{-1}x}.$$

The limits (5.15),-(5.17) can now be simplified in the form:

$$
\begin{aligned}
plim\ NV_{ols} &\propto e^{\frac{1}{2}\|\delta\Lambda\beta\|^2}\Lambda^{-1}\left(I - \frac{\Lambda^{-1}\nu(\Lambda^{-1}\nu)^T}{1+\|\Lambda^{-1}\nu\|^2}\right)\Lambda^{-1}, && (5.19)\\
plim\ NV_{ub} &\propto e^{\frac{1}{2}\|\delta\Lambda\beta\|^2}\Lambda^{-1}\left(I - \frac{\Lambda^{-1}\nu(\Lambda^{-1}\nu)^T}{1+\|\Lambda^{-1}\nu\|^2}\right)\times && (5.20)\\
&\quad \left(I + (\Lambda^{-1}\nu + \delta\Lambda\beta)(\Lambda^{-1}\nu + \delta\Lambda\beta)^T\right)\left(I - \frac{\Lambda^{-1}\nu\nu^T\Lambda^{-1}}{1+\|\Lambda^{-1}\nu\|^2}\right)\Lambda^{-1} && (5.21)\\
plim\ NV_{wls} &\propto e^{-\frac{1}{2}\|\delta\Lambda\beta\|^2}\Lambda^{-1}\left(I - \frac{(\Lambda^{-1}\nu - \delta\Lambda\beta)(\Lambda^{-1}\nu - \delta\Lambda\beta)^T}{1+\|\Lambda^{-1}\nu - \delta\Lambda\beta\|^2}\right)\Lambda^{-1}. && (5.22)
\end{aligned}
$$

To compare the variance of the fit of the model taken at the mean of regressors, $NVar(b^T\nu) = N\nu^T Cov(b)\nu$, one multiplies (5.19)- (5.22) on the left by ν^T and on the right by ν, assuming $\Lambda^{-1}\nu \neq 0$ to obtain:

$$
\begin{aligned}
plim\ N\nu^T V_{ols}\nu &\propto e^{\frac{1}{2}\|\delta\Lambda\beta\|^2}\frac{\|\Lambda^{-1}\nu\|^2}{1+\|\Lambda^{-1}\nu\|^2}, && (5.23)\\
plim\ N\nu^T V_{ub}\nu &\propto e^{\frac{1}{2}\|\delta\Lambda\beta\|^2}\left(\frac{\|\Lambda^{-1}\nu\|^2 + \|\|(\Lambda^{-1}\nu\|^2 + \delta\beta^T\nu|^2}{(1+\|\Lambda^{-1}\nu\|^2)^2}\right), && (5.24)\\
plim\ N\nu^T V_{wls}\nu &\propto e^{-\frac{1}{2}\|\delta\Lambda\beta\|^2}\left(\|\Lambda^{-1}\nu\|^2 - \frac{\|\|(\Lambda^{-1}\nu\|^2 - \delta\beta^T\nu|^2}{1+\|\Lambda^{-1}\nu - \delta\Lambda\beta\|^2}\right). && (5.25)
\end{aligned}
$$

In the case of $\Lambda\beta = 0$, and $\beta^T\nu = 0$ all three equations give identical results. To clarify things, note that now there are no second-order gains obtainable at the mean although they are available at other values of the fit. Furthermore, there may exist gains in higher-order comparisons of estimators than those that are related to the order square-root N.

Return to considering the individual coefficients. To simplify the formulae (5.19),-(5.22) we assume that the data has been centred so as to make $\nu = 0$.[13]

$$
\begin{aligned}
plim\ NV_{ols} &\propto e^{\frac{1}{2}\|\delta\Lambda\beta\|^2}\Omega^{-1}, && (5.26)\\
plim\ NV_{ub} &\propto e^{\frac{1}{2}\|\delta\Lambda\beta\|^2}\left(\Omega^{-1} + \delta^2\beta\beta^T\right), && (5.27)\\
plim\ NV_{wls} &\propto e^{-\frac{1}{2}\|\delta\Lambda\beta\|^2}\left(\Omega^{-1} - \frac{\delta^2\beta\beta^T}{1+\|\delta\Lambda\beta\|^2}\right). && (5.28)
\end{aligned}
$$

It is easy to see that the above matrices are ordered $plim\ NV_{wls} \prec plim\ NV_{ols} \prec plim\ NV_{ub}$, with equality, if and only if $\delta = 0$. The efficiency gain of using the weighted LS method can be examined by (5.27) and (5.28). The gain consists of two elements that contribute to it. First, the scalar coefficient in front of the matrices is smaller in the

[13]Centring the data has no effect on the estimation results. The efficiency gain concerning the constant term of the model can be examined through the equation that connects in the usual way the parameters obtained from centred weighted regression and means of correctly weighted variables. Note that here one has to apply sums that are properly weighted.

formula referring to the weighted LS formula (5.28) than in (5.27), if $\delta\Lambda\beta \neq 0$. Second, the difference of the matrix part given in the parenthesis in equations (5.27) and (5.28) is positive definite and equal to

$$\delta^2\beta\beta^T + \frac{\delta^2\beta\beta^T}{1+\|\delta\Lambda\beta\|^2} = \frac{\delta^2(2+\|\delta\Lambda\beta\|^2)\beta\beta^T}{1+\|\delta\Lambda\beta\|^2}. \tag{5.29}$$

If we compare the above matrices (5.19),-(5.22) by their trace, i.e. the sum of the variances of the individual coefficients we obtain:

$$plim\ Ntr(V_{ols}) \propto e^{\frac{1}{2}\|\delta\Lambda\beta\|^2}\left(tr(\Omega^{-1}) - \frac{\|\Omega^{-1}\nu\|^2}{1+\|\Lambda^{-1}\nu\|^2}\right), \tag{5.30}$$

$$\begin{aligned} plim\ Ntr(V_{ub}) \propto\ & e^{\frac{1}{2}\|\delta\Lambda\beta\|^2}\Big(tr(\Omega^{-1}) + \|\Omega^{-1}\nu + \delta\beta\|^2 \\ & -2\ \frac{(\Omega^{-1}\nu+\delta\beta)^T\Omega^{-1}\nu\nu^T(\Omega^{-1}\nu+\delta\beta) + \|\Omega^{-1}\nu\|^2}{1+\|\Lambda^{-1}\nu\|^2} \\ & +\ \frac{\|\Omega^{-1}\nu\nu^T(\Omega^{-1}\nu+\delta\beta)\|^2 + \|\Lambda^{-1}\nu\|^2\|\Omega^{-1}\nu\|^2}{(1+\|\Lambda^{-1}\nu\|^2)^2}\Big), \end{aligned} \tag{5.31}$$

$$plim\ Ntr(V_{wls}) \propto e^{-\frac{1}{2}\|\delta\Lambda\beta\|^2}\left(tr(\Omega^{-1}) - \frac{\|\Omega^{-1}\nu - \delta\beta\|^2}{1+\|\Lambda^{-1}\nu - \delta\Lambda\beta\|^2}\right). \tag{5.32}$$

To conclude we give an indication of the efficiency gains obtainable in the data. We present calculations that are based on our empirical estimation results. Take the trace of (5.27) and (5.28) and divide to calculate a measure of relative efficiency as

$$e.f.f. = e^{\|\delta\Lambda\beta\|^2}(1+\|\delta\Lambda\beta\|^2)\left(\frac{tr(\Omega^{-1}) + \|\delta\beta\|^2}{(1+\|\delta\Lambda\beta\|^2)tr(\Omega^{-1}) - \|\delta\beta\|^2}\right). \tag{5.33}$$

In the special case of one regressor the above formula (5.33) is

$$e.f.f. = e^{\|\delta\sigma_x\beta\|^2}(1+\|\delta\sigma_x\beta\|^2)^2. \tag{5.34}$$

This means that relative efficiency in estimating the parameter β is positively dependent on the standardized coefficient of the explanatory variable $\sigma_x\beta = \rho_{xy}\sigma_y$, (in OLS $\beta = \sigma_{yx}/\sigma_{xx}$). It is naturally dependent on the parameter δ.

Consider a more general case of several but independent regressors. In the homoskedastic case the corresponding parameter estimators are also independent and the trace is an appropriate measure of efficiency. There is no loss of generality in considering standardized variables $\Omega = I$, and standardized coefficients of the explanatory variables $\beta_x = \sigma_x\beta_x$.[14] Note that the parameter δ is unchanged by these modifications. This gives

[14]In a more general case consider the canonical uncorrelated variables and their coefficients. To be more specific form a spectral representation $\Omega = \sum \lambda_j P_j$ where the orthogonal projections P_j are onto the eigenspaces correponding to the eigenvalues λ_j, and the orthogonal eigenspaces span the whole parameter space $\bigoplus P_j = \mathcal{R}^m$.

$$
\begin{aligned}
e.f.f. &= e^{\|\delta\beta\|^2}(1+\|\delta\beta\|^2)\left(\frac{m+\|\delta\beta\|^2}{(1+\|\delta\beta\|^2)m-\|\delta\beta\|^2}\right) \\
&= e^{\|\delta\beta\|^2}(1+\|\delta\beta\|^2)\left(\frac{1+\frac{1}{m}\|\delta\beta\|^2}{(1+\frac{m-1}{m}\|\delta\beta\|^2)}\right).
\end{aligned} \tag{5.35}
$$

Therefore the relative efficiency is inversely dependent on the number of parameters to be estimated tending to $e^{\|\delta\beta\|^2}$ as the number of parameters m goes to ∞.

Table 5.3 provides our estimate for the scalar factor $\lambda = \|\delta\Lambda\beta\|^2$ on the left hand of the brackets. The estimates which give a lower bound on the average increase in efficiency produced by weighted LS method are actually based on our model P in Section 6.2.[15]

Table 5.3. Efficiency gain of weighted LS.

Variable	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
λ	0.391	0.289	0.140	0.050	0.116	0.508	0.580	0.179	3.920
e^{λ}	1.478	1.335	1.150	1.051	1.123	1.662	1.786	1.196	50.40
$e^{\lambda}(1+\lambda)$	2.057	1.720	1.312	1.104	1.252	2.506	2.824	1.410	248.01

The second row of Table 5.3 can be interpreted as showing that on the average one would need, say in the case of Food expenditure, W_1 at least 1.5 times (lower bound) as many observations (the upper bound is about two) as we have available to obtain the same level of accuracy in estimating the parameters of the model by OLS than by the method that accounts for heteroskedasticity.[16]

We have over forty parameters to estimate so the lower bound in Table 5.3 is more appropriate here. It will be interesting to see whether system methods where one could directly introduce cross-equation restrictions to improve the efficiency in estimation of the cross-price coefficients in (4.10) would produce similar gains. We return to these aspects in later parts of the study.

[15] Other specifications produced closely similar results.

[16] We actually employ the method of estimated quasi maximum likelihood and use the information on common parameters in the regression and skedastic function to reap additional rewards in the more efficient estimation of the skedastic parameters. Recall that conditional on the skedastic parameters ML and weighted LS are asymptotically equivalent to the order square-root N.

5.4 Estimation strategy for heteroskedastic models

The parameters of the budget share equations are estimated by the following method. First we test for heteroskedasticity and as a side product obtain estimates for the variance components of the survey years and the parameter connecting the fit to heteroskedasticity, eg. as given by the third row in Table 5.2. In the next step the starting values for structural, i.e. equation parameters are obtained by estimating the budget share equation by a weighted regression of the model. The weights are calculated as the inverse of the estimated variance for each observation using the estimated skedastic function.

Finally, the quasi maximum likelihood method is utilized to get final more efficient estimators of the parameters using the above consistent preliminary estimates as starting values. Here we model for heteroskedasticity using a skedastic function and simultaneously take account the sample variability that is introduced by using the estimated conditional expectations for expenditure terms and not the true theoretical variables, as explained in (4.80). For comparison and testing purposes we use the quasi maximum likelihood estimators to calculate new variance weights and estimate the model parameters anew by weighted least squares.

Chapter 6

Evolution of the Age Profiles and Engel curves in Consumption

6.1 Models allowing structural change

The evolution of the age profiles and Engel curves in consumption over the sample period 1966-1990 are examined by estimating a series of models with varying degrees of parsimony. This approach is selected in order to find out which effects conveniently summarize the data without setting unreasonable restrictions on the fit. Below we shall see that diagnostic methods have to be used in a liberal and relaxed manner to avoid from producing by far too complicated models.

The main problem with the data set which we have available is that the number of observations in individual surveys is very large but on the other hand the number of surveys is small. In these circumstances parameters that are identified by variation across the cross-sectional units will tend to be estimated very accurately while parameters that are identified by variation across time, i.e. across surveys are estimated quite poorly. If one is not very concerned with the time-varying effects, for example price effects one preferably uses a 'fixed-effects' model. These models have the additional good property that the possible bias in estimators that is caused by not including in the model effects that vary with time and simultaneously produce correlation between the explanatory variables and the error term of model, such as business-cycle or trend effects is not so severe in fixed-effects models. The bias is substantially reduced as we are effectively conditioning on the mean value of the error component in the individual surveys and the errors may in fact correlate with the regressors but still do not produce any bias.[1]

[1]Any possible correlation between the regressors and the error term after subtracting the survey means is naturally still present and produces some bias. The severity of this depends on the case we consider. For example, suppose that some of the households are liquidity-constrained but no variable directly relating to this is available. In this case the fixed-effects model allows for a gradual or cyclical relaxing of liquidity-constraints in the aggregate level but if liquidity-constraints are correlated with say individual wealth and income variables they are confounded with the latter effects and the "true" coefficients cannot be estimated unbiasedly.

The first model, Model A, includes among the regressors dummy variables for each survey. As noted before, using these variables together with the price variables has the negative side effect that only movements within the sample years in relative prices are effectively included as explanatory factors. The reason for this is that the differences in the yearly means of prices, and any other variable for that matter, are smoothed out and their effect is confounded with the coefficients of the survey dummies.[2] Therefore it does not seem sensible to include a full set price variables in these models and we prefer to forming a price variable which is separate for each consumption category. The variable is the 'logarithm of relative price' which is formed by dividing the corresponding component price index with the Stone price index which we use to define real expenditure (Section 3.2.3). Because any variation between the survey years in this variable is in estimations effectively smoothed out we do not have high hopes for getting sensible interpretation of the price parameter in terms of own price elasticity of demand.[3] Table 6.1 gives a good picture of the amount of price variability between the surveys and within the surveys in the data. For example only about eight per cent of the total variation in the price variable LRP_1 is due to variation within the surveys.

Table 6.1. Variation in relative prices.

Variable	LRP_1	LRP_2	LRP_3	LRP_4	LRP_5	LRP_6	LRP_7	LRP_8	LRP_9
SD between surveys	0.0468	0.0403	0.0802	0.0537	0.1243	0.0720	0.0293	0.0474	0.0556
SD in 1966	0.0174	0.0158	0.0143	0.0137	0.0203	0.0158	0.0158	0.0158	0.0158
SD in 1971	0.0127	0.0197	0.0205	0.0223	0.0172	0.0127	0.0168	0.0121	0.0181
SD in 1976	0.0284	0.0161	0.0198	0.0217	0.0159	0.0146	0.0106	0.0135	0.0136
SD in 1981	0.0123	0.0241	0.0163	0.0133	0.0148	0.0079	0.0130	0.0094	0.0122
SD in 1985	0.0072	0.0112	0.0135	0.0096	0.0077	0.0117	0.0149	0.0087	0.0086
SD in 1990	0.0085	0.0171	0.0174	0.0072	0.0066	0.0195	0.0083	0.0064	0.0124
SD total	0.0488	0.0440	0.0819	0.0554	0.1249	0.0733	0.0320	0.0485	0.0570
within var. ÷ total var.	0.0790	0.1627	0.0409	0.0600	0.0106	0.0375	0.1654	0.0441	0.0495

SD refers to standard deviation.

On the other hand, adopting the above form of the model should not lead to any major concern since in this section we are primary interested in the age and the real expenditure variables of the model and return to the estimation of price elasticities in a later part of the study where models more constructive for the purpose of estimating the price elasticities of demand are employed.

[2]Note similarities with using fixed effects in modelling proper panel data.

[3]The endogeneity of this variable and covariance with the real expenditure variables are properly accounted for in the EQML estimation by augmenting the pseudo error variance accordingly, see Section 4.2.

Keeping the focus on our current mission we use two auxiliary variables that are not commonly employed in empirical studies of consumption. The basic explanatory variables include the logarithmic age of household head (LAGE) and a square term of this variable (LAGESQ). Since the natural range of the age variable is bounded then taken together with the corresponding coefficients these variables allow for the effect of age to be either monotonously decreasing or increasing, or to have either the shape of a well or a hump. The first two cases occur when the local extreme value of the binome (in logaritmic age) occurs outside the natural range of age.

The first supplementary variable is the logarithmic age of the household head in a given year (LCOHAGE), in our case we select arbitrarily the year 1981.[4] This variable allows for a slowing creeping effect w.r.t. the survey years which may be a useful device to capture some cohort effects in slowly changing consumer environment where new commodities are introduced and habits and preferences evolve. On the other hand, using only the calender age at the time of the survey neglects the gradual overturn of population, and having in the sample people that are observed to be same age but have in fact been grown-up and moulded in widely differing economic and social environments.

The second variable is constructed using the instrumented fitted values of total real expenditure adjusted for the number equivalent adults in the household. It is the signed distance of the household from the median consumer. The median is estimated using the population mean of logarithmic total expenditure which is adjusted for the size of household.[5] The variables are based on instrumented values and the mean is calculated separately for each survey year available.[6] The variable called 'relative consumption' builds both on early remarks by Veblen [1899] which have become popular in psychological and sociological literature under the heading 'relative deprivation' theory and an early and interesting 'relative income hypothesis' in consumption behaviour put forth by Duesenberry [1949]. Loosely speaking the hypothesis suggests that a consumer's consumption habits should reflect his (or her) social reference group. When that individual's income fall below the comparison level, he feels relatively deprived.[7] Alternative interpretations to the above phenomenon might involve the concept of positional goods, i.e. goods whose consumption is dependent on the consumer's position in the income distribution rather than on his actual income level, for example domestic help and other labour services, and locational amenities that are scarce. To examine and test these ideas we introduce the positional variable (LNRELX) into the model.

The full estimation results are shown in Appendix 3 (Table A3.1). In particular we

[4]In selecting this year one has to guard against the unexpected effects which may result if logarithms are taken from variables having some low values with respect to the bulk of data.

[5]Härdle and Jerison [1988] have found that Engel curves are more stable across cross sections if they have been normalized with mean income. This should give some additional credence to our choice of the auxiliary variable.

[6]Note that since we calculate total expenditure using a rough equivalence scale (Section 3.2.3), we should arrive at a more reasonable outcome than by utilizing unequalized values of expenditure.

[7]Relative deprivation theory which is a common theme in psychological and sociological literature has not made much impact into the economic literature. Recent writers that have followed Duesenberry's footsteps include Boskin and Sheshinski [1978], Akerlof and Yellen [1990], and Clark and Oswald [1994].

find that our two supplementary variables enter the fit with significant coefficients. Table 6.2.a introduces some interesting summary diagnostics from the preliminary OLS regressions. The ordinary Durbin-Watson statistics is produced here as offering an excellent non-parametric diagnostic test for the Engel curve specification since in calculating it we have ordered the data w.r.t. both the survey year and the value of the fitted real expenditure variable of the model.[8]

Table 6.2.a. Summary diagnostics by preliminary OLS, Model A.

Variable	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
Mean	0.2827	0.0356	0.0685	0.2369	0.0631	0.0302	0.1545	0.0800	0.0486
S.E.E	0.0904	0.0412	0.0570	0.0906	0.0642	0.0388	0.1209	0.0584	0.0599
R^2	0.3670	0.0844	0.0768	0.3142	0.0175	0.0822	0.2202	0.1109	0.1013
DW	1.8725	1.9727	1.9957	1.6979	1.9781	1.9771	1.7314	1.9826	1.9548

We consistently find that our Model A seems to be performing better in terms of fit in cases where the consumption category is responsible for a substantial part of consumer outlay. In addition in those categories where purchases of durables have a larger role, eg. category W_5, Household appliances the fit is deteriorated. On the other hand, an initially better fitting model increases the power of specification tests, as is clearly indicated by the row 'DW' and row 'RESET(3)', Ramsey [1969] in Table 6.2.b. The Durbin-Watson test is statistically significant indicating misspecification in consumption categories W_1, W_2, W_4, W_7, and W_9. Note the low power of the test in category W_5 which is due to the poor fit of the model.

Table 6.2.b. Summary diagnostics by weighted LS, Model A.

Variable	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
Mean	0.2827	0.0356	0.0685	0.2369	0.0631	0.0302	0.1545	0.0800	0.0486
S.E.E	0.0876	0.0380	0.0555	0.0882	0.0568	0.0275	0.1007	0.0558	0.0420
R^2	0.3530	0.0772	0.0791	0.3023	0.0232	0.0708	0.2537	0.1160	0.1338
RESET(3)	47.872	154.939	24.894	271.521	3.822	65.300	123.128	100.084	105.752

Table 6.2.b provides the summary statistics for a weighted least squares estimation with skedasticity weights calculated using the EQML estimates. The RESET test, Ram-

[8] It is common for data released by Statistical Offices to be ordered according to geographical sampling areas even when information on the specific sampling strata is not released. Therefore the Durbin-Watson test using the original ordering of the data is quite effective in testing for within strata correlation. This aspect is not examined in the study. The number of observations is so large (33 420) in this study that we would expect the test statistic to lie quite near two under the null. In fact in our case values under 1.98 indicate some deficiencies in functional form which show up as positive autocorrelation in the ordered data.

sey [1969] is calculated by including the second, third and fourth powers of the fit as additional explanatory variables in a weighted regression and testing for whether they enter the model with statistically significant coefficients. Under the null hypothesis the test statistic is distributed by the χ^2-distribution with three degrees of freedom. It offers a complementary test for functional misspecification with quite good power properties. This is reflected in the results with only the category W_5, Household Appliances passing the test for misspecification. Table A3.1 provides the estimation results for both the quasi likelihood method and the weighted LS described above. Recall that these two methods produce parameter estimators that are asymptotically equivalent. Therefore, differences in the results indicate the importance of accounting in the quasi likelihood for influences that are relevant in finite samples, see eg. the R.H.S. of (4.49).[9]

On the other hand, weighted least squares give generally higher t-values for the parameters. This is a consequence of not allowing for the randomness in those variables replaced with estimators for their conditional expectations but treating them as fixed in repeated samples. In contrast, the method of quasi likelihood properly accounts for this and in addition it deals with the uncertainty concerning the skedastic parameters to be estimated in the process.

A slightly more general version of the previous model is obtained by allowing the real expenditure term (ILNXR) to have different slope coefficients for each survey year. Similarly, the logarithmic age for the household head (LAGE) is having a freely varying coefficient. The variable which earlier captured the cohort effect is naturally dropped here to prevent perfect multicollinearity. Note that if we want to retain the relative consumption term for comparison with the restricted Model A, presented above we can actually add only four additional variables affecting the slope, product terms of the survey dummies with the total expenditure variable in the model. Otherwise there is a linear dependence between the relative consumption variable, the survey dummies and the expenditure variables formed separately for the surveys.

For this model, Model B, with eight extra variables we estimate the parameters by the method of quasi maximum likelihood and weighted regression with weights obtained from the quasi maximum likelihood estimates similarly as before. The results are shown in Appendix 3 (Table A3.2). Table 6.3 represents the summary statistics from the weighted least squares estimation.

[9]One could construct a test of the model by comparing the EQML estimators with alternative estimators obtained by a method which is consistent under less demanding conditions, the conventional method of instrumental variables with the heteroskedasticy allowed for by using weighted least squares would serve as one, see Davidson and MacKinnon [1993].

Table 6.3. Summary diagnostics by weighted LS, Model B.

Variable	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
Mean	0.2827	0.0356	0.0685	0.2369	0.0631	0.0302	0.1545	0.0800	0.0486
S.E.E	0.0876	0.0380	0.0554	0.0882	0.0567	0.0275	0.1005	0.0557	0.0418
R^2	0.3535	0.0785	0.0800	0.3033	0.0245	0.0722	0.2550	0.1167	0.1360
RESET(3)	52.466	164.140	22.676	256.395	2.536	49.301	118.994	60.102	78.204

These two models seem to be equally successful in explaining the data although one may find some parameter variation among the common explanatory variables (Appendix 3). However, the added variables have coefficients that are significantly different from zero using the asymptotic t-test with conventional levels of significance (Table A3.2). The quasi maximum likelihood tests for comparison with the full and restricted model are shown in Table 6.4.

Table 6.4. Quasi maximum likelihood test of the restricted Model A and Model B.

Model	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
A	33190.6	59336.3	48109.7	32960.9	46972.2	66738.6	24458.5	47205.2	51333.8
B	33198.2	59370.9	48132.8	32974.7	47008.3	66767.4	24486.2	47271.4	51415.9
$\chi^2(8)$	15.16	69.22	46.24	27.77	72.16	57.75	55.33	132.38	164.25

In all consumption categories except the first, W_1 the null hypothesis is rejected. However, the test statistic is of seemingly low order in comparison with the likelihood of the model. But note that likelihood is not invariant to the scale of the data. The low practical value of the significance test is better revealed in Tables 6.2a and 6.3 which show that the coefficients of determination are practically of the same size. Observe also the values in the row LOGS0 in Appendix 3 which give an estimate of the error term variance in 1985.

The most general model, Model C is formed by a collection of estimation results that are obtained by allowing *different parameters for all variables* in each survey. This gives 160 more parameters to be estimated as compared to Model B. For Model C we do not estimate the parameters by the method of quasi maximum likelihood, but use instead weighted regression applying six separate regressions with weights obtained from the 'restricted' Model A, presented above. Note that under the implicit null hypothesis defined by Model A the variance structure is estimated consistently. In addition using a common weighting structure for all models provides a consistent testing framework for various null hypothesis of added coefficients that are canonically nested. The full set of estimation results are shown in Appendix 3 (Tables A3.3 (i),-(vi)).

The above collection of models offers a natural framework of testing parameter restrictions. Calculating the pseudo loglikelihood based on a weighted LS estimation using a common consistently estimated skedastic function (Model A) for the variance components provides a χ^2-test statistics for the nested sequence of alternative hypotheses (Table 6.5). The test is a consistent and unbiased one.[10]

Table 6.5. Pseudolikelihoods and χ^2-tests based on weighted LS estimators.

Model	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
A	33414.0	59631.3	48352.3	33087.3	47055.9	66946.2	24540.2	47317.2	51533.0
B	33426.1	59663.6	48382.4	33103.6	47098.8	66983.4	24568.9	47377.2	51620.2
1966	3116.1	6013.4	4223.6	3285.2	5196.0	6679.3	3023.8	5535.0	7315.0
1971	2944.8	5053.6	4122.8	3006.5	4363.7	5424.7	2548.1	4960.3	6453.4
1976	3591.5	6221.6	4516.5	3566.4	4797.2	7837.0	3018.2	4689.7	6241.3
1981	6898.1	13022.0	11068.5	7457.4	10784.3	17990.1	5235.4	10595.8	12293.9
1985	7886.0	15147.0	11662.5	8501.9	9435.0	14134.4	5281.2	10235.0	10592.2
1990	9227.5	14377.7	13039.0	8018.3	12621.6	15065.2	5610.1	11485.7	8888.3
$H_1(8)$	24.37	64.63	60.17	32.56	85.72	74.47	57.49	120.04	174.36
$H_2(168)$	500.02	407.79	561.34	1496.92	283.47	366.36	353.30	368.44	501.89

The alternative hypothesis H_1 allows for varying slope coefficients in the logarithmic age and real expenditure variables. The test statistic is distributed by the χ^2 with eight degrees of freedom. The most general hypothesis H_2 allows for all coefficients to be free to vary from survey to survey. In particular we note that additional parameters seem in average to have at most a comparable effect on the statistics bearing on H_2 as on H_1, in relation to the number of extra parameters. The only exception to the above rule is category W_4 which mainly consists of housing costs.[11] The tests lead to a formal rejection of the hypothesis H_0 defined by Model A. The summaries of the fits for each survey year are shown in Appendix 3 (Tables A3.4 and 5). Note that the fits of the individual surveys seem to suffer from same magnitude of misspecification in functional form as the models fitted to our whole data set. In addition the coefficients seem to be rather unstable across the cross sections. These observations seem to indicate that trying to estimate demand equations using a single cross section is a near futile exercise. The instability of the price coefficients is a good indication of the hazards involved (Tables A3.3 (i),-(vi)), but note also instability relating to parameters that are identified by variation within the surveys. The last effect is somewhat unexpected.

We suspect that formal rejection of the restricted Model A is the expected outcome

[10]The pseudo likelihood differs from the above, quasi likelihood since the former does not allow for the sample variation introduced by the use of fitted values of a preliminary model and treats them as fixed in repeated sampling experiments.

[11]On the behalf of the rental equivalent of owner occupied housing which forms a large subcomponent in this variable, costs are based on imputed values and the rules that are used in calculations may have varied considerably over the sample period. However, we are quite certain that people in Statistics Finland have made their best in constructing the variables in the study. The underlying calculations are based on the area and number of rooms, quality and condition of dwelling, site of residence, and the availability of amenities.

of any consistent test if applied to our data. The main reason for this is by ordinary econometric standards an enormous number of observations (33420). Any sensible analysis of data should be concerned with the parsimony of the model and not allow the number of coefficients to creep upwards in order to capture any twigs or tails of data by adding extra powers and interaction terms of variables, cf. Section 5.1. In contrast, the asymptotic square-root N -consistent estimate of the variance of the fit should be tightly controlled. A less academic reader might present the matter in the form of asking a simple question, what is the real insight gained by using these more complex functional forms in explaining the data. The answer is not easy because of the many both functionally related and correlated regressors involved. What may at first sight seem as a dramatic change in individual parameter values may in closer examination turn out to have a small combined net effect on the fit. Graphical methods seem to be the best way to compare complex models as the ones in the present study and subsequently we use them and hopefully reveal the salient features of the models. In Section 6.2 we introduce an additional model with a full set of price variables and compare its performance with the models of the present section.

6.2 Model with a full set of price variables

Here we present the estimation results of a model, Model P, with a full set of price variables. In the analysis we drop the survey dummies but retain our two supplementary variables, relative consumption variable and the age variable that captures some cohort effects. Homogeneity of demand (4.8) with respect to the price variables is imposed on the data by forming eight price variables with the logarithmic component price index relating to the last, ninth category subtracted from the other price variables. The means of the variables, $LP_i - LP_9$, i = 1,..,8, are provided in Table A2.1. The implied coefficients for price variables referring to the last category are shown in the last row of Table A3.6 which shows the estimation results obtained by the method of quasi maximum likelihood.

Comparing with Model A presented in Section 6.1 the Model P, has now two parameters more (eight price parameters versus one price variable and five survey dummies in Model A). The fit and diagnostics of the model are comparable to those of Models A and B (Tables 6.6.a, and 6.6.b).

Table 6.6.a. Summary diagnostics by preliminary OLS, Model P.

Variable	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
Mean	0.2827	0.0356	0.0685	0.2369	0.0631	0.0302	0.1545	0.0800	0.0486
S.E.E	0.0901	0.0412	0.0571	0.0907	0.0639	0.0390	0.1207	0.0580	0.0597
R**2	0.3660	0.0831	0.0770	0.3105	0.0182	0.0827	0.2211	0.1094	0.1010
DW	1.8719	1.9698	1.9947	1.6998	1.9772	1.9776	1.7314	1.9809	1.9544

Table 6.6.b. Summary diagnostics by weighted LS, Model P.

Variable	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
Mean	0.2827	0.0356	0.0685	0.2369	0.0631	0.0302	0.1545	0.0800	0.0486
S.E.E	0.0880	0.0380	0.0555	0.0885	0.0567	0.0275	0.1006	0.0558	0.0420
R^2	0.3514	0.0762	0.0789	0.2999	0.0233	0.0695	0.2542	0.1153	0.1336
RESET(3)	43.831	165.332	27.026	263.208	6.480	74.022	114.876	95.860	110.135

If the estimation results provided by the quasi likelihood method and weighted LS are compared (Table A3.6) one notes that differences are somewhat smaller than in the case of Models A and B. The two methods should produce parameter estimators that are asymptotically equivalent. Therefore, huge differences in the results could indicate misspecification of the model over and above those effects that are due to accounting in the quasi likelihood for influences that are relevant in finite samples. Recall that the method of weighted LS gives generally t-values that are too high. This is a consequence of not allowing for the stochasticity in those variables substituted for the conditional expectation but treating them as fixed in repeated samples.

Note that the matrix of estimated price coefficients is far from symmetric and a rough examination of the standard errors of estimates would indicate that symmetry restrictions are rejected by the data. We return to a more detailed examination of the estimation results of Model P after comparing the models that we now have in hand.

6.3 Engel curves and age profiles in consumption

To compare the Engel curves and the age profiles in consumption obtained by Models A, B, C and P we resort to graphical methods. In Appendix 3 (Figure A3.1) we show the Engel curves and the age profiles in consumption for the categories W_2,- W_9.[12] The corresponding figure for the category W_1, Food is produced here.

[12]The Engel curves are customarily defined as showing how the demand for a commodity evolves as the expenditure (or income) is varied. In this study, we depart from the usual terminology and choose to define the Engel curve as representing how the budget share evolves as the total expenditure is varied. The reason for this is that the corresponding figure is more informative and easier to visualize in the latter case. Note that on the x-axis we show the logarithmic real expenditure. This means that a unit increase in the x-axis (in logarithms) correspond to about 2.7 fold increase in the value of the real expenditure variable. The range of values shown in the x-axis includes almost the entire range of values observed in the data (Table A2.1).

Figure 6.1. Model P, Engel curves in 1966–90 variable W1

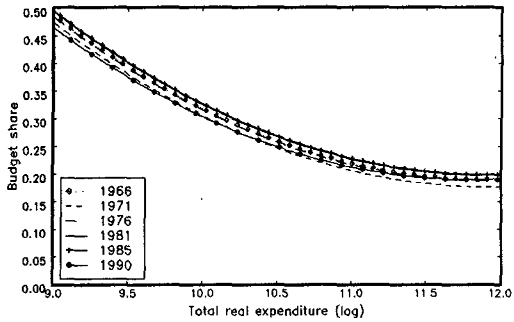


Figure 6.1. Model P, Age profiles in 1966–90 variable W1

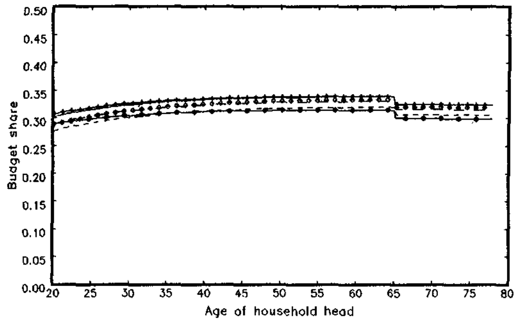


Figure 6.1. Model A, Engel curves in 1966–90 variable W1

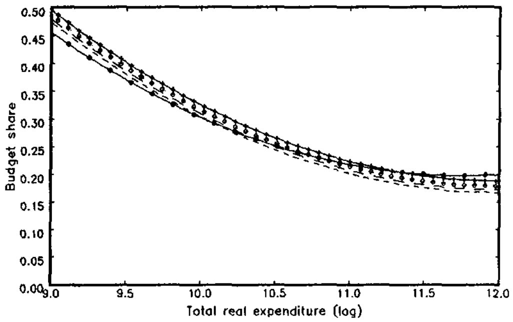


Figure 6.1. Model A, Age profiles in 1966–90 variable W1

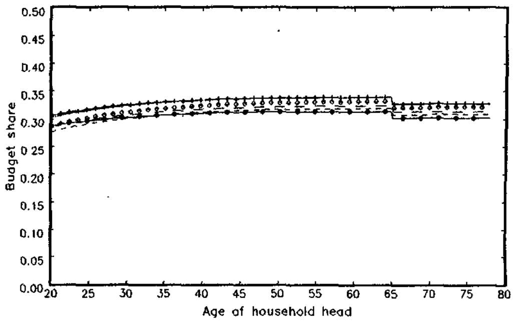


Figure 6.1. Model B, Engel curves in 1966–90 variable W1

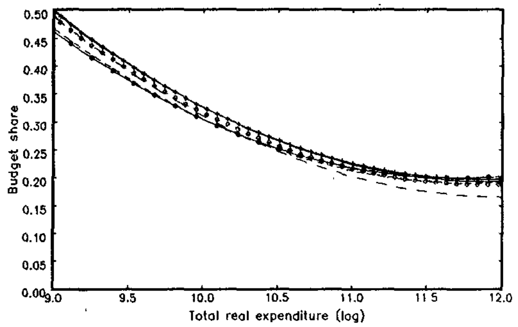


Figure 6.1. Model B, Age profiles in 1966–90 variable W1

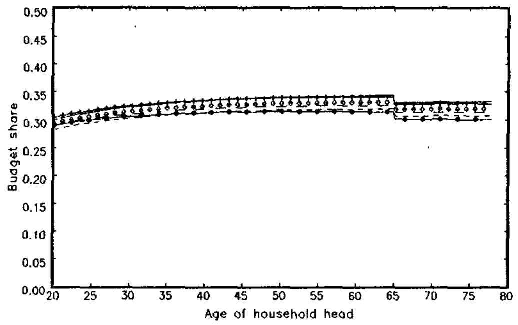


Figure 6.1. Model C, Engel curves in 1966–90 variable W1

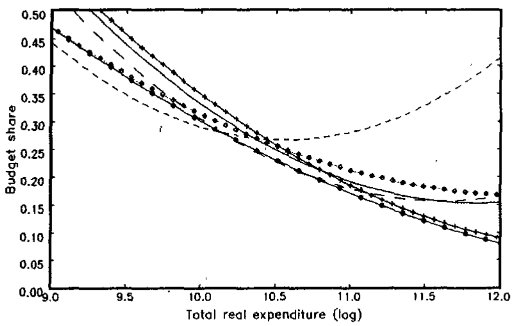
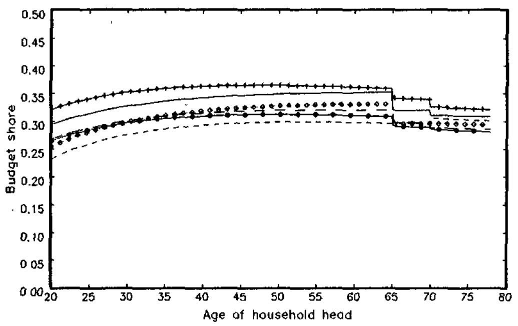


Figure 6.1. Model C, Age profiles in 1966–90 variable W1



The models in Figure 6.1 are ordered with decreasing levels of parsimony.[13] The panels in the top row give the curves that are calculated by using the estimated parameters of Model P which includes all the price variables. We calculate and show the curves separately for each individual survey year from 1966 to 1990, six curves in each panel. The panels in the second row give those curves that are calculated using Model A with a single (relative) price variable but including survey dummies. Similarly, in the third row are shown the results of Model B which in turn allows different slopes for the logarithmic real expenditure and age variable for each survey. In the panels of the bottom row are shown the curves that are based on Model C allowing all coefficients of the model to vary between the surveys.

The curves represent ceteris paribus effects, i.e. in calculating them we hold the other variables affecting the fit constant. The values for other variables are set to some typical reasonable values. Note that the real expenditure variable is adjusted for the number of equivalent adults in the household. However, if ceteris paribus effects are considered, then in comparing low values in this variable on the left of the x-axis with the high values on right of the x-axis we are not comparing total expenditures that are elevated due to a large household size.[14] In contrast to the above rule the prices are, however, allowed to vary. Here we use the mean values for each individual survey, especially to see if the price variables in Model P and dummies in Model A produce similar net effects on the fitted curves. Naturally in calculating the Engel curves that are shown in the left hand side panels of Figure 6.1 we vary all expenditure variables, the second order term and slopes that are connected to the household composition in a consistent manner. Similarly, the age variables, LAGE, LAGESQ, and LCOHAGE, are varied consistently on the right hand side panels of Figure 6.2 together with some additional variables that are linked to age for natural reasons. In the special case shown here, an adult pair with no children, we assume that the household head which is a male retires from work at the age 65 and his spouse is retiring five years later. The variables reflecting the socio-economical status of the household head (RETIRED) and the number of old age persons in the household (OLDAGE) are also modified according to this rule. This produces two jumps in the age profile in consumption occurring at ages 65 and 70. In reality the retirement age varies and the estimated jumps reflect the average effects of these variables and should not be taken too literally.

If we study for example the curves for share of Food expenditure, W_1 we find that the curves for the individual surveys (holding real total expenditure or the age of the household head, respectively, constant across the surveys) move very closely together (Figure 6.1). The only exception is the bottom left panel where the curves related to the individual surveys show divergent behaviour at higher levels of real expenditure. This has a quite natural explanation. In the early survey years one does not have many observations with real expenditure at those higher levels that are customarily found in

[13]Actually the first, Model P has two extra parameters if compared to the second, Model A.

[14]Here the household size is kept fixed so this makes really no difference, but note that in Chapter 7 we make comparisons which involve family size and composition by examining the unadjusted total real expenditure.

the last surveys. This is due to the gradually improving living standards over the 24 year time period that is covered by our data. Therefore, the quadratic term in the logarithmic real expenditure relating to the early survey years which have freely estimated coefficients in Model C, give unreasonable fits outside the range observed in those surveys. Their fits overshoot in the case of Food, W_1 but give a very mixed picture in the other expenditure categories. On this point the Figures 6.1, A3.1 give a very useful warning of the hazards involved in trying to estimate Engel curves on the basis of individual cross sections of the data. The hazards are particularly severe if ones tries to extrapolate the Engel curve outside its sample range to represent economic conditions prevailing in later surveys.

The age variable has a natural range of values which are little affected by which survey we consider. Therefore, the age profiles in consumption that are shown in the bottom row panels (Model C) show much less variability across the surveys than the Engel curves. The variability that is still present in the age curves is due to getting some instability in the coefficients for the individual surveys. The most appreciable differences in relation to Model C, seem to be in the categories W_2, Beverages and Tobacco, and W_6, Health Care, and W_8, Education and Entertainment. On the whole differences are minor.

To summarize the figures in Appendix 3, we find that Models P, A and B show quite similar behaviour across the surveys although the extra slope parameters of Model B were earlier found to be significant. However, they do not seem to affect the fit very much and their inclusion may introduce multiple effects in the other coefficients of the model (for example the second order terms) which seem to cancel each other out to give a minor net effect.[15] The most notable exceptions to the rule are categories W_5, Household Appliances, and W_7, Transport and Communication, where Model C allows for a continuing increase in the budget share whereas the models with less flexibility force the budget share to eventually decrease as a function of total expenditure. The residual category, W_9, Other goods and services has become over the years more important and increased its share. This is probably due to a gradual inclusion of new commodities and service charges to the survey diaries which are such that they do not seem to belong naturally to the other, more established consumption categories. Similarly, we have previously found out that reporting has been on higher level in this category in the more recent surveys if compared with the National Accounts values (Table 3.2). Therefore, it seems quite natural that Model C gives a somewhat better picture of the evolution in its budget share over time.

In most consumption categories the quadratic term in logarithmic real expenditure has a moderating and counter-balancing effect to the slope if one compares with the coefficient of the log-linear term (Tables A3.1, 3.2, and 6). Note that in calculating the second order term we have subtracted a constant from it which corresponds to a typical value of logarithmic total real expenditure observed in the data (Section 3.2.3). This

[15] Naturally, there may exist combinations in the values of the explanatory variables where the departing effects are more marked. Note, however, that age and real expenditure seem on a priori grounds to be among the more important explanatory variables, and as a consequence they were allowed to have time varying coefficients.

has as a consequence that the coefficient for logarithmic real expenditure directly gives the slope of the Engel curve. Similarly, the coefficient of the quadratic term gives the derivative of the slope at this point, a measure of curvature.[16] In effect this produces a reparametrisation of the model which has no effect on the estimation results but helps in interpreting the results, for details see Section 3.2.3. The estimate for the coefficient relating to the quadratic variable is statistically different from zero in most consumption categories. These effects are reflected in the left hand side panels of the three first rows in Figure 6.1. The category, Food W_1, is a necessity with the Engel curve having a negative slope.[17] The slope gradually increases and the Engel curves become almost horizontal at very high levels of the real expenditure which correspond to a high position in the income distribution. Similarly, category W_6, Health Care, is a clear necessity. If the age profiles in consumption are examined the category, Food seems to increase its share in the total budget as people age and the same observation holds true for the latter category.

Category W_4, Housing and Energy and the residual category, W_9 seem to be clear luxuries which also increase their share in consumption as people age. On the other hand the budget shares of W_2, Beverages and Tobacco, and category W_7, Transport and Communication have expenditure elasticities quite close to one and have relatively constant budget shares. Younger people seem to have more use for transport services. Similarly, the age profile in the category of Beverages and Tobacco seems to eventually decrease as the head of household gets past the early thirties.

Variables, W_3, Clothing and Footwear, W_5, Household Appliances, and W_8, Education and Entertainment are consumption categories whose Engel curves display as being a luxury good at low levels of real expenditure but turn to a necessity at very high levels of expenditure.[18] The age profiles in consumption are decreasing in W_8, quite flat in W_5, and slowly increasing in W_3, with respect to the age of the household head.

All the above general features in the consumption patterns are in good accordance with what one would a priori expect. The commodities that are connected to consumption activities that take mainly place at home get more important as the household ages and moves through the lifecycle.

Furthermore, on the basis of the observations in Figures 6.1, and A3.1 we conclude that Model P which includes no survey dummies but uses instead a full set of price variables does not set undue restrictions on the data, and simultaneously conveniently summarizes their most important features. It provides a parsimonious model, although, we found earlier that the data rejects Model P by formal tests. In the following we examine Model P in more detail and give the other Models, A, B, and C no further consideration in this study.

[16]To see this derivate the equation for the budget share (4.11) w.r.t. the logarithmic total expenditure.

[17]A commodity is said to be a necessity if its expenditure (or income) elasticity of demand is less than one but greater than zero. Considering the budget shares that we use to characterize the consumption decision this is equivalent with that the budget share of a normal good is a decreasing function of total expenditure. On the other hand a commodity is a luxury good if the elasticity of demand is more than one. This in turn means that the budget share is everywhere an increasing function of total expenditure.

[18]In the panel relating to Model C we, however, noted earlier that W_5, is a luxury throughout the range of the total expenditure variable.

6.4 Cohort and life-cycle profiles in consumption

In the previous section we have examined the age profiles in consumption. These represent ceteris paribus effects, i.e. in calculating them we hold the other variables affecting the fit constant. In practice if we observe a typical household all through its lifecycle we see changes in other variables too. Children are born into the family, they age and finally leave to start their own independent life as consumers. The income available to a household typically increases at first and may finally have a down-turn at old age. Simultaneously, over time there is economic growth present which is reflected in higher living standards and higher levels of total consumption. Therefore, one may with good reason argue that showing ceteris paribus effects w.r.t. age in individual surveys is a good description over only a limited range of values.

To accompany the examination in Section 6.3 we present here alternative and supplementary figures that show the total, marginal effect of the age of the household head. We label the figures as life-cycle profiles in consumption since in calculating them we make predictions for all other variables on the basis of the age variables that we allow to vary over the same range of values as in Figure 6.1.

To be more specific, we calculate estimates for the population means and covariances of the explanatory variables of our Model P, separately for each individual survey.[19] The predictions for other than the age variables are then calculated using the regression formula

$$\mathcal{E}(x_h(i)|z_{age\ h}(i)) = \mu_x(i) + C_{xz}(i)C_{zz}(i)^{-1}(z_{age\ h}(i) - \mu_z(i)). \qquad (6.1)$$

Above the index i, i = 66,- 90, refers to the survey in question, and h gives the individual observation. The vector z_{age} includes the age variables that we vary, LAGE, LAGESQ, and LCOHAGE, and x stands for all other explanatory variables. The population means are given by the vector μ, and the population covariances are denoted by C with the subindices referring to the corresponding submatrix within the large matrix. In contrast to the above rule for the price variables we use the mean values taken separately for each individual survey.

By the above method we can produce life-cycle profiles in consumption that simultaneously take account of the predictable changes in the other variables as well. Of these effects the most notable one concerns the income effects that operate through the total real expenditure variables. Over the sampling period the real income and real expenditure of households have increased simultaneously as the households have aged (Table 5.1). As we saw in Section 6.2 in some cases these effects on the consumption share operate in the opposite directions and the above method is a convenient tool to examine the net effect.[20] Furthermore, we find it instructive and interesting to visualize the cohort

[19]In estimating the population variates we naturally use the sampling weights (Section 3.1). These are formed as the inverse of the probability of being included in the survey with non-response properly allowed for in the calculation of the weight, see Section 3.1, and Laaksonen [1988].

[20]In principle one could obtain similar patterns by calculating the mean shares from the raw data over a suitably defined partition over the values of the age variable. Here we would probably run into difficulties that are due to sample variability if the partition is fine enough, and we feel that our method

effects, between surveys, and life-cycle effects, within surveys, in one figure.

In Figure 6.2 we show the life-cycle profiles in consumption for each survey. In addition we have shown typical cohort paths of households by connecting the profiles relating to individual surveys with dotted lines reflecting the way how a typical household moves through the life-cycle profiles relating to the different surveys as time passes. For example in the top left hand side panel are shown the life-cycle profiles in consumption for the share of Food consumption. We take households at ages 20, 30, 40, 50, in year 1966 and follow their movement through the picture over the 24 year time period that is available to us. This movement is shown by the dotted lines, eg. point in the curve for year 1966 that corresponds to the age 20 is connected to the point in the curve for year 1971 that corresponds to the age 25, e.t.c.

One finds that changes in the values of income (and other) variables across surveys have caused the expenditure share of Food to fall dramatically over the sample period, although the effect that depends on age alone is having a slowly upwards creeping influence on the curve. Interestingly enough we find that between the years 1976 and 1981 there is hardly any movement. This may reflect the fact that the economic growth was slacking in the time period in question.[21] Note that we have not connected curves with cohort lines in categories W_2 and W_5 since here the life-cycle profiles in consumption move closely together and the inclusion of lines would only make the corresponding panels messy.[22] In category W_8, Education and Entertainment we find totally opposite effects to those in category, Food. Here the life-cycle profiles in consumption are decreasing w.r.t. the age variable but income effects across the surveys cause the cohort effect to be a clearly increasing one.

It is interesting to note that in the category W_7, Transport and Communication, the curves are decreasing w.r.t. the age but a simultaneous increase over time in living standards causes the expenditure share of an individual cohort to be nearly constant, especially so in the younger cohorts of the data. In contrast in category W_3, Clothing and Footwear, the income effects strengthen the downward movement as the household ages when cohort effect is considered.

that includes a large number of explanatory factors instead is preferable.

[21]Change in data collection methods that took place in 1981 could also play a role here, see the previous discussion in Section 5.1, but 'reporting' of Food has actually been on a higher level after 1976 (Table 3.2).

[22]Note that the vertical distances between the curves in category W_5 are of comparable absolute level than say those of W_3. The selection of a scale to the panel plays naturally a role here. We feel, however, that relative differences between the curves more properly measure the changes in consumption structure over time which are our main interest.

Figure 6.2. Model P, Cohort profiles in 1966–90 variable W1

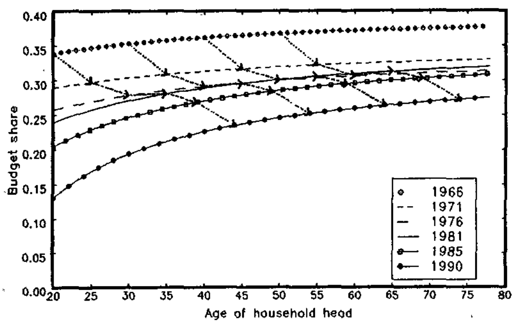


Figure 6.2. Model P, Cohort profiles in 1966–90 variable W2

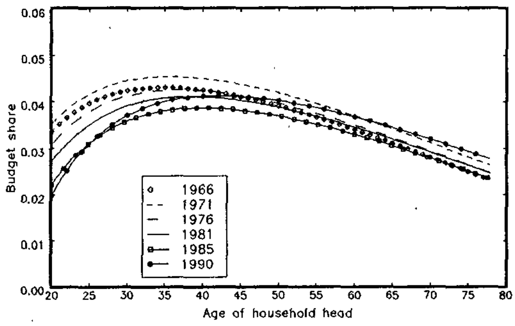


Figure 6.2. Model P, Cohort profiles in 1966–90 variable W3

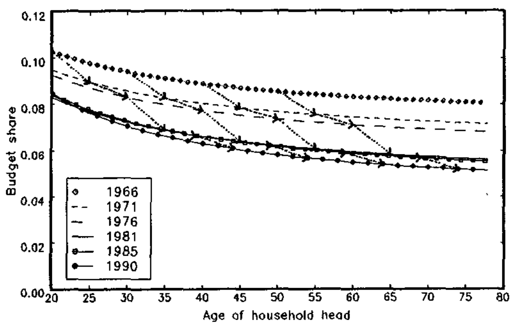


Figure 6.2. Model P, Cohort profiles in 1966–90 variable W4

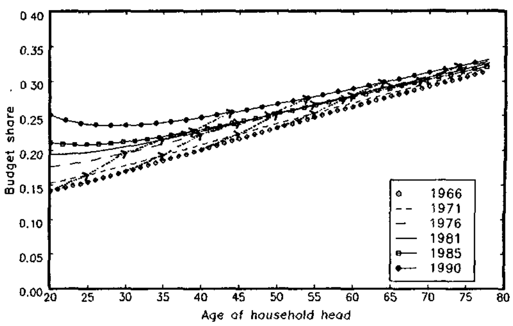


Figure 6.2. Model P, Cohort profiles in 1966–90 variable W5

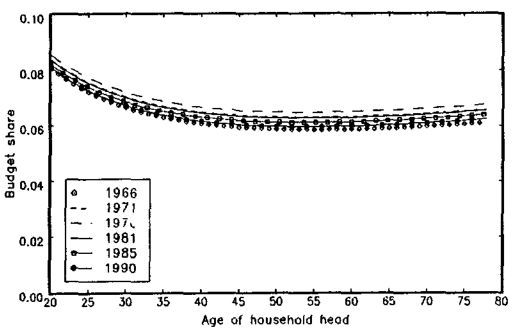


Figure 6.2. Model P, Cohort profiles in 1966–90 variable W6

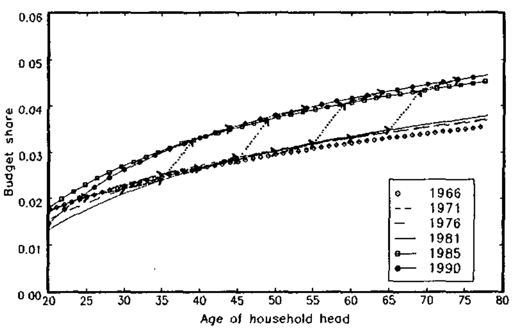


Figure 6.2. Model P, Cohort profiles in 1966–90 variable W7

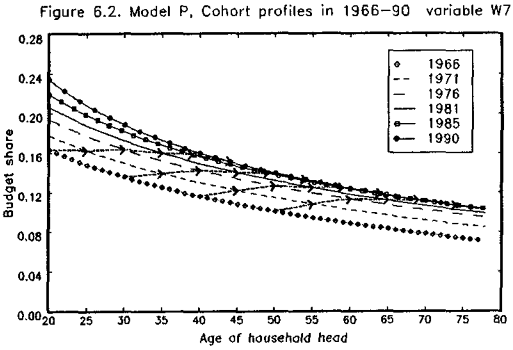
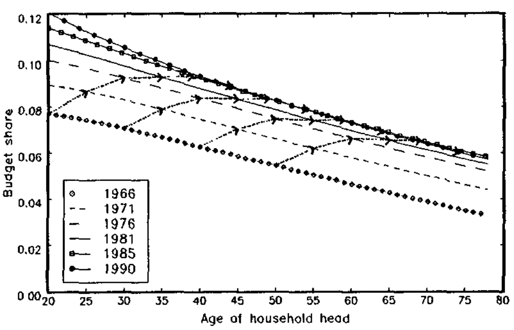


Figure 6.2. Model P, Cohort profiles in 1966–90 variable W8



In all the categories considered above, one can observe an ordering in the curves which is more or less the same as the survey years give. In the category W_6, Health Care, however, the curves form two separate groups with the last two surveys, in 1985 and 1990 being on a higher level than the others. This is exactly the same period when reporting has been on a higher level than earlier (Table 3.2). As a sideline we also note that the life-cycle curve for the category W_2, Beverages and Tobacco is at the highest level in 1971 if one considers those of under 30 years old. In the two latest surveys the curves are on a lower level at these values of the age variable. Note that we have not included in the model variables that would capture the liberalization of alcohol policy that took place in the late 1960's and resulted in a marked increase in alcohol consumption in Finland. The reason for the behaviour shown in our curve is probably due to the fact that the changes in the values of explanatory variables across the surveys capture the structural changes that took place in late 1960' and early 1970's in Finnish society. These included an increased inflow of people into cities as labour moved from rural to urban areas, and more rewarding earnings possibilities especially for the young people entering the workforce. The above observations by no means exhaust the possibilities of interpreting the effects that are shown in Figure 6.2. We leave these to an interested reader.

Chapter 7

Consumption Structure, Household Composition, and Other Effects

7.1 Consumption structure and household composition

Household composition is expected to be a major factor that affects how total expenditure is allocated among the component categories. One of the earliest authors to examine the influence of family composition on consumption was Ernst Engel [1895]. He initiated the estimation of equivalence scales. Since then especially the determination of the cost of children has been a major industry within the broader area of consumption research. These studies have an immediate application in welfare policy since they give a useful tool that can used to control for changes in the size and composition of households in order to arrive at meaningful comparisons of living-standard, on these points see Deaton [1986] and Pollak and Wales [1981].[1] In this study our ambition level is more moderate. We do not try to estimate meaningful and theoretically consistent equivalence scales but return to these question in a follow-up study.

In this section we use Model P (Table A3.6.) to present a rough picture how changes in the composition of household, i.e. the number of children, adults and old-aged persons and the gender of the household head, affect the expenditure shares in the nine component categories of consumption which are examined in the study.

First, recall that the total expenditure variable that is used in our study is calculated per the number of equivalent adult members in the household. Therefore, the model already includes a rough measure of equivalence scale that is based on the convention introduced by OECD. We readily admit that this scale is at best a rough first approximation to a more relevant measure. We have, however, included in the model several

[1] In fact the question how households allocate purchases among family members is more subtle than indicated above since there may be bargaining type elements involved in the process. These latter aspects invalidate the standard neoclassical theory and in particular the symmetry of cross-price responses but have testable implications on allocation within the household, see Manser and Brown [1980].

other variables and interaction terms with the real expenditure variable that capture the effects of household size and household composition. Therefore even if the OECD-scale is a poor proxy these other variables correct for its influence and the estimated net effect is hopefully quite near the proper one.[2]

On the other hand, consider the case where the equivalence scale is independent of relative prices, as such a highly implausible assumption, and additionally that we have used the 'correct' scale to adjust for real total consumption. In this case one would expect that all variables that are related to the size and composition of households have statistically insignificant coefficients if entered in the budget share equations. An immediate examination of the estimation results reported in Table A3.6 reveals that the null hypothesis that consists of using real expenditures adjusted for the number of equivalent adults calculated with the OECD-scale is rejected by the data and the preliminary adjustment for household size is not sufficient. Furthermore, in several instances the estimated coefficients are both highly significant statistically and have a marked influence on the fit indicating that family composition and size have an important effect on consumption in Finland. The coefficients that can be interpreted as capturing the left-over influences to individual categories have a varying pattern of signs.

The gender of the household head enters the budget share equations with coefficients that are both highly significant statistically and have marked influence on the fit (Table A3.6.). If the household head is a female then the budget shares of the categories W_1, Food, and W_2, Beverages and Tobacco are on a lower level. In contrast, the shares of W_3, Clothing and Footwear, and W_4, Housing are increased. The parameter estimate corresponding to the category W_5, is statistically insignificant, and the budget shares for W_7, Transport and Communication, and W_8, Education and Entertainment are on a higher level if the head of the household is a male. In the residual category we find a small increase in the budget share in female households. If slope coefficients are considered where we allow for corresponding changes in the gender variable the slope is changed to the same direction as before in the last five categories but in the categories W_1, and W_2, the slope is having a change to the opposite direction. If the above influences are compared with the Engel curves in consumption one cannot find any immediately recognisable pattern. However, in most categories the gender variable, if head is female, is producing effects that operate similarly as aging of household heads (Section 6.3).

Examination of the other coefficients in model P that are related to household composition is not easy because one has to bear in mind that the household size and composition operate simultaneously through several variables. First, introducing an additional child to the household directly affects the variables CHILDREN, the number of children, HHSIZE, the household size and HHSIZESQ, the quadratic term in the previous variable. The most difficult ones to fathom are those influences that change the slope of the Engel

[2]A clear deficiency in the OECD-scale is that the age of persons in the household is not properly accounted for although it has a major influence on consumption, as we already found out in Chapter 6. Second, it has been argued the economies of scale w.r.t an extra member in the household is not accounted for to the full extent. These effects are particularly strong in the case of durable goods, but should be less striking eg. in the category W_1, where Food expenditure is considered.

curve and that accrue through the variables interacting with real total expenditure. The last variable note, is itself influenced by these factors through the OECD-scale (Section 3.2.3). However, recall that in forming the real expenditure variable we have subtracted a constant from it which corresponds to a typical value. Therefore, at value $\tilde{m} = 0$ the effects of household composition can be assessed directly by not taking into a account the real expenditure variables. This helps interpretation if we are satisfied with looking at the influence near the typical value of the real expenditure variable. However, households with several members have naturally higher total expenditure. If the OECD-scale is a reasonable scale to adjust total real expenditure for the number of equivalent adults one can rely on the above remark in these cases as well if we do not depart too far from the typical value, calculated in this case per the number of equivalent adults.

If the whole range in the total expenditure variable is under consideration one has to collect all the relevant variables. It is useful to get an approximation to the OECD-scale to express it in the same variables that are used in our model. An approximation of the OECD-scale[3] which is useful in relating to the other variables the combined effect of the parameters of the real expenditure variables and of the scale variable, is given by

$$\begin{aligned}\log(scale) &= \log(1 + 0.7(n_a - 1) + 0.5n_c) = \log(0.7) + \log(n) + \log\left(1 + \frac{a_1}{n} - \frac{a_2 n_c}{n}\right) \\ &\approx \log(0.7) + \log(n) + \frac{a_1 - a_2 n_c}{n}, \qquad (7.1)\end{aligned}$$

where n_c is the number of children and n_a is the number of children, and the coefficients are $a_1 = 3/7$, $a_2 = 2/7$. The approximation is excellent if the size of household, $n \geq 2$, and the number of children in household is not too large relative to the total number of members, say $n_c \leq 2n_a$.

Figure A4.1 provides a graphical presentation of the separate influences on consumption which are due to both total expenditure and household composition by presenting the fit of the budget shares in categories W_2,-W_9. The curves are given for six different household types. Here we give the corresponding fit for the consumption of Food, W_1. The household types are, starting from the top left panel, a single young female, a single young male, a pair with two children, a pair with four children, an old, retired pair, and an old female.[4] The Engel curves are provided separately for each survey, and the range in the values of total real expenditure shown is based on the scale of values typically encountered in the survey, i.e. the mean of logarithms ±2SD's, calculated for each specific household type.[5]

[3]The OECD-scale is calculated as follows the first adult in the household gets weight 1, and each additional adult gets a weight 0.7. Furthermore, the children (under 18 years of old) get weight 0.5.

[4]It is widely acknowledged that children of differing ages may have different impact on consumption. It is customary to make a distinction between children under school-age, in lower grades in school, and teenagers. In this study we have to refrain from a more detailed analysis that aspects like this imply due to lack of data.

[5]Note that presently we are using total real expenditure which is not calculated per equivalent adult member in contrast to the procedure used in the figures of Chapter 6.

Figure 7.1. Female, Engel curves in 1966–90 variable W1

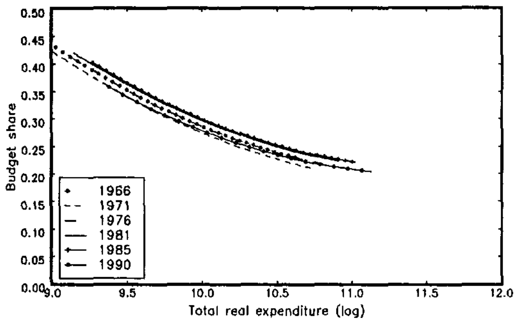


Figure 7.1. Male, Engel curves in 1966–90 variable W1

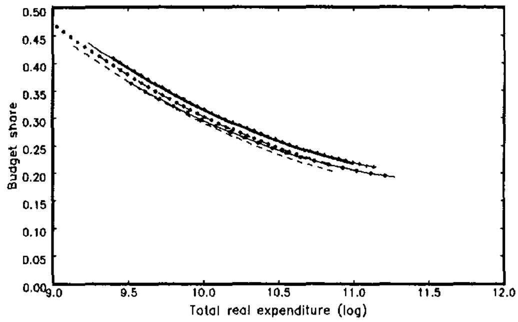


Figure 7.1. Pair + 2 ch, Engel curves in 1966–90 variable W1

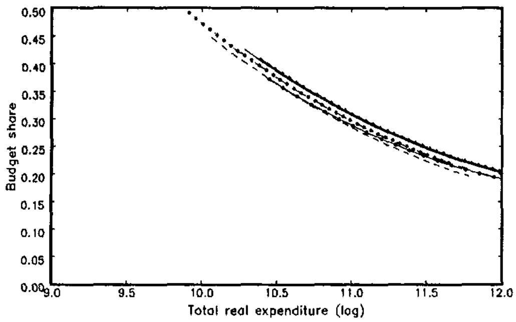


Figure 7.1. Pair + 4 ch, Engel curves in 1966–90 variable W1

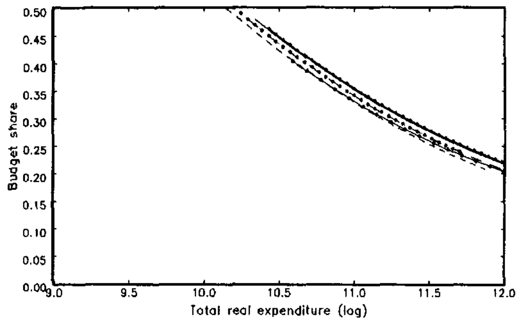


Figure 7.1. Old pair, Engel curves in 1966–90 variable W1

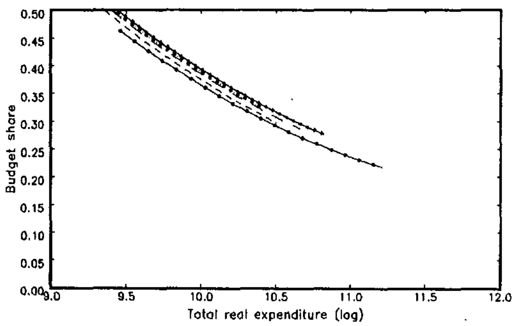


Figure 7.1. Old Female, Engel curves in 1966–90 variable W1

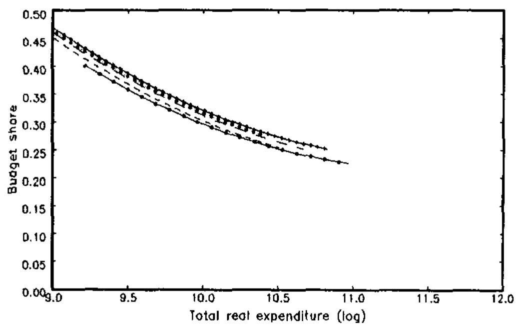


Figure 7.1. Engel curves in 1966 variable W1

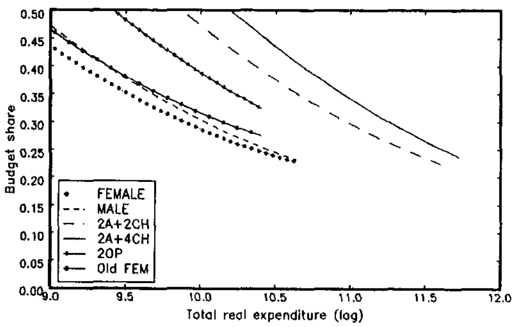
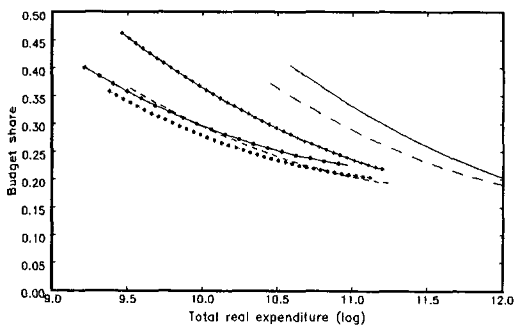


Figure 7.1. Engel curves in 1990 variable W1



To facilitate easy comparison across household types the two bottom panels gives the Engel curves for 1966 and 1990, respectively. A comparison between the last two panels shows the effect of improved living standards and increased consumption possibilities that have occurred in the 24 year time period.

One finds that the budget share of Food consumption W_1, is markedly influenced by household size with the single female households having the lowest share of Food if other effects are held constant. This is what we expected by common reason and previous studies since economies of scale w.r.t. the household size and number of children should not play a major role in this consumption category. Food consumption seems to be a necessity if considered w.r.t. the size of household.[6] Note that larger households also tend to have higher levels of total real consumption and the combined effect calculated at the mean values of logarithmic real consumption shows that the actual shares of Food consumption differ considerably less. This is a feature that we will find in the other categories of consumption as well and it shows that the preliminary adjustment of the real expenditure variables by the OECD-scale is not too far off the mark. In fact, as we noted above the individual coefficients of the demographic variables related to the size and composition of households do provide with a reasonably undistorted picture, even not accounting for the effects accruing through the real expenditure variables.

In the case of Housing and Energy, W_4 we find that old females have particularly high expenditure shares whereas the households with children have the lowest share. Here one may find economies of scale operating. One may hypothesize that liquidity constraints have prevented full adjustment in the size of dwelling to account for household size in the case of young households with children, or alternatively that housing services are a luxury w.r.t. the household size, similarly as they were found to be a luxury w.r.t. the total expenditure variable in Chapter 6. Need for space and other housing amenities seems to depend more on economic resources than on family size. The other types presented, retired pair and the two single member households have Engel curves that lie quite near each other.

Households with a single male seem to find most use of Tobacco and Beverages, W_2 with the old pair, and female households consuming least. If there are children present the share is not much affected. Since the category consists mainly of 'adult goods' the results indicate that this category has less substitution possibilities for the goods consumed by children. Similar observations hold w.r.t. the category W_7, Transport and Communication, with a qualification that young females also seem to have a relatively high expenditure share. The category Education and Entertainment, W_8 can be broadly seen as giving a similar picture. The opposite holds for expenditures on W_6, Health Care with old age persons consuming most. Allowing for the higher level of total consumption by the household types with children they seem to have quite similar expenditure shares at mean values in all the previous categories W_2, W_6, W_7, and W_8 as the households with a single young member.

[6]Necessity, or luxury w.r.t. the household size is naturally measured with an inverted scale w.r.t. the size variable, cf. with the expenditure function formulated per the number of members in the household, see Section 4.1.

In the category Household Appliances and Furniture, W_5 the economies of scale shine clearly through with the three types of households with a single member having the highest share with the Engel curves lying almost on top of each other. An alternative interpretation is that W_5 is a relative luxury w.r.t. the household size. Note that old pairs have somewhat low budget shares. A quite similar picture is offered in the category W_3, Clothing and Footwear. A qualification that we make is that males seem to account for their higher consumption in category W_2 by spending a little less on clothing than the other household types with a single member. Note that in this study we could not differentiate children w.r.t. their age due to lack of data. Therefore it is possible that the age variables that we use may pick up some effects that are due to family composition and therefore are taken into account elsewhere. Especially older children with more expensive clothing and possibly more response to fashion should have a larger effect on the budget share than is seen here.

The residual category W_9 seems to include goods and services that are either in greater demand by the single member households or as having among them commodities that have economies of scale involved, for example service fees. In the latter respect the panel referring to the year 1990 gives a clearer picture than the one referring to the starting survey 1966. Recall that the residual category has increased its share probably by repeated introduction of new goods and services that were not previously accessible to consumers, or like banking costs not previously charged for, and not included in consumption. Similarly, 'underreporting' has been on a lower level in the more recent surveys (Table 3.2).

To give a short summary, those activities that take place outside home seem to be more preferred by households having a single young member. In contrast, in those consumption activities that take place mostly at home one finds both economies of scale and more preference by old-aged persons. Food consumption and consumption of Health Care, W_6 have effects that one would consider reasonable from physical reasons alone.

Finally, just to give a rough idea of equivalence scale calculations, measure the horizontal distance of the budget share curves referring to a single young male and a couple with two children. Choose a starting point where the distance is measured as the mean of logarithmic expenditure in the group corresponding to the former curve. A coarse estimate for this number is a little above one in categories W_1, W_2, W_3, W_5, and W_7, and less in the category Housing and Energy, W_4. The former values correspond to a roughly three-fold increase in total expenditures which is not too far away from the corresponding value 2.7, given by the OECD-scale.

7.2 Other effects

In this study we pick up only a few effects to closer examination, and leave a more detailed analysis to an interested reader (Table A3.6). Start with considering the regional effects. The variable MIDDLE refers to a less populated part of the country in the middle of Finland. Similarly, the variable NORTH corresponds to the North of Finland and

Lapland where there are extremely few people. The coefficients seem to have similar signs if compared to the reference case which is the South of Finland with the NORTH having the more extreme influences. In particular, holding other effects constant expenditures on Transportation, W_7, Clothing, W_3, and Housing and Energy, W_4 seem to be on a higher level in the North with the counter-balancing reductions made in the categories Beverages and Tobacco, W_2, Health Care, W_6, Education and Entertainment, W_8, and the residual category, W_9. This is sensible in view of the colder winter there.

If households that live in rural areas, variable RURAL, are considered we find a similar pattern of effects with additional decreases and increases made in the above categories with the exception that the budget share of Clothing W_3, is not so markedly affected. The estimated parameters of the regional variables may have been affected by omitted variables. In particular permanent, regional differences in relative prices may have been important. Note also that greater distances in the more thinly populated areas mean more costs of shopping in the form of extra money and time involved by the need to communicate over wider distances.

If the socio-economical status of the household head is examined we find that farmers, variable FARMER, spend quite little on Tobacco and Beverages, W_2 and more on Housing and Energy, W_4 than the reference group that consists of blue-collar workers. Similarly, as the former households tend to have older members there seems to be some effects that are left over even after accounting for the influence of the age variables. These make them spend more on Health Care, W_6 and less on Education and Entertainment, W_8. On the whole in the Farmer group most of the influences can be interpreted similarly as the regional effects but they are sometimes even more marked than the ones encountered previously.

If self-employed and private entrepreneurs, variable SELFEMPL, are considered we find that they spend more in Clothing, W_3 and in the residual category, W_9 making the corresponding reductions across the other categories. If white-collar workers are considered the effects are quite similar to those in the previous group. On the other hand, in households with the head not belonging to the labour force, variable RETIRED, consisting typically of older persons but also students belong to this group we find that they spend more on Housing, W_4 and Health Care, W_6 and less on Food, W_1 and Transportation, W_7. These effects operate in the same direction as those that we found when age profiles in consumption were considered.

On education variables we have little a priori reasons to expect marked influences, especially so since other variables (total real expenditure) have already been taken into account in the model. However, note that these variables serve also for proxies for human capital. Households attaining the higher educational levels seem to spend less on the category W_2, Beverages and Tobacco, and more in the category W_8, Education and Entertainment than the reference group. The same tendency is seen in a dampened manner in those who have attained the middle levels in education.

In estimating the allocation of consumer demand among the component categories we have conditioned on a number of variables that correspond to decisions that are made on a long term basis but can be considered as predetermined when the current allocation decision is made. One could argue that the analysis would need at least to endogenize these decision and preferably estimate models for these as well, see Blundell et.al. [1993]. However, the latter procedure is in our opinion out of the reach of the current econometric estimation technology and the data that is available to us. We have previously given arguments for using a modelling strategy that is based on forming the conditional expectation of the total expenditure variable in lieu of using an intertemporal model at the outset.

On the other hand, if the the intertemporal indirect utility function is separable and separability holds w.r.t. leisure and consumption one should not observe these variables entering the budget share equations independently. However, our indicator variables have statistically significant coefficients in most of the component equations. The variable SPOUSENW, is an indicator of the spouse's labour supply decision having value *zero if there is some labour supplied* and one, otherwise. The decision clearly affects the amount of leisure, or time available for work in home. Increase in leisure is accompanied by a corresponding increase in the share of Housing, W_4, Health Care, W_6, and Beverages and Tobacco W_2 with the most savings made in the category, Education and Entertainment, W_8. Similarly, the budget share for W_3, Clothing and Footwear has a lower level in this case. Somewhat surprisingly we see a slight decrease in the share of the category W_7, Transport and Communication if there is labour supplied. Browning and Meghir [1991] have earlier observed the importance of labour supply variables in budget share equations, and our results seem to give additional evidence on that leisure is not separable from the consumption of commodities at the level of categorization that we consider.

The availability of a car in the household, variable CAR, has marked influences on the consumption pattern with owning naturally increasing the share of Transport and Communication, W_7. The corresponding savings are made across all other categories. Similarly if the household has a weekend house, variable WEHOUSE, it indicates increased needs of transport and communication services with reductions made elsewhere. However, note that share of Housing and Energy, W_4 is not affected, a quite natural result. The type of heating system that households have installed, variable CENTHEAT, is having a large effect on the costs in Housing and Energy, W_4. The dwelling type, small house, variable SMHOUSE, have similar effects with again increased costs in Housing and Energy, W_4, and Household Appliances and Furniture, W_5. Families that live in semi-detached houses, variable SDHOUSE, have rather similar influences as the previous group but spend more on Education and Entertainment, W_8 and Transportation, W_7. This in turn is a feature that may be a consequence of that most of these households live in sub-urban areas near population centres, and the variable serves also as an indicator of real wealth. If people are renters, variable TENURENT, they seem spend less on Housing and Energy. On the other hand, the choice of renting should in principle reflect more need for housing services relative to the portfolio demand of housing as an asset. However, in Finland the rental markets of housing have been heavily regulated in the time period of our study, and in some cases owning may a corner solution due to the implicit rationing in the rental markets. In a substantial part the rentable apartments have been publicly provided to those passing a means-test, and only preset (restricted) dwelling sizes have been available. Similarly, the other effects that we have picked up above may have been affected by the fact that these variables serve as proxy for real wealth.

Finally, we find some seasonal effects in consumption. These are relatively straightforward to interpret but we shall not discuss them.

Chapter 8

Price and Expenditure Elasticities of Household Demand

8.1 Imposing adding-up and symmetry restrictions on estimators

In the last part of the study we report the elasticity measures of the effects on demand by the price and total expenditure variables. First, note that since we are using an allocation model which is based on a flexible form to represent these effects the elasticities are not constant if different household are compared but vary depending on the values of the above variables but also on the values of our other explanatory factors. The latter effects have already been discussed in Chapters 6 and 7.

Second, the estimation results that have been presented so far on our preferred Model P are based on the method of estimated quasi maximum likelihood (EQML), where heteroskedasticity of the disturbances and preliminary fits by instruments has been accounted for. The estimation method that we use is relatively complicated. Therefore estimation is done in an equation by equation manner and its extension to handle systems of equations is not straightforward. For example, one cannot directly impose parameter restrictions across equations as would be needed in testing of the symmetry in the γ parameters by either maximum likelihood or score tests.

Furthermore, the adding-up constraints of the model parameters are not necessarily valid at the estimates that we obtain since in effect the individual observations are weighted on the estimated skedastic function in the estimation method. On the other hand, homogeneity of demand w.r.t. the prices is easily handled by using a simple transformation of the price variables. However, since our estimators are unbiased only asymptotically there may be some small sample bias in the estimators. Particularly so, since the method that we use is essentially a two-stage one with preliminary fits of the conditional expectations of the endogenous factors substituted for the theoretical variables in the second stage.

Instead we calculate a Waldian test of these restrictions using the unrestricted form of Model P, as the base line. To recall from Section 4.3, let the set of linear parameter restrictions be written as a matrix equation $R\alpha = r$, rank(R) $= \rho$, where α is a vector that is obtained by collecting together the parameters in all individual equations. The Wald test statistic which has under the null hypothesis the asymptotic χ^2-distribution with ρ degrees of freedom is given by

$$\mathcal{W}_{H_0} = (R\hat{\alpha} - r)^T \left(R\mathcal{V}R^T\right)^{-1} (R\hat{\alpha} - r), \tag{8.1}$$

where $\mathcal{V}$ is the covariance matrix of the model parameters, and $\hat{\alpha}$ is the unrestricted quasi maximum likelihood estimator of the parameters.[1] The results are given in Table 8.1.

Table 8.1. Tests of the adding-up and symmetry constraints, Model P.

	Adding-up	Symmetry	Symmetry & Adding-up
χ^2-statistic	1461.8	621.5	2032.2
Degrees of freedom	45	36	81
P-value	$\leq e^{-100}$	$\leq e^{-100}$	$\leq e^{-100}$

The data strongly reject both restrictions on the estimators. In spite of this we go on to form estimators that satisfy these restrictions since in the case of no theoretical constraints operating, it would be hard to give any economic interpretation for the elasticity estimators. Starting from (8.1) one can form a linear function of the unrestricted estimators which satisfies the constraints $R\alpha = r$ setting

$$\tilde{\alpha} = \hat{\alpha} + \mathcal{V}R^T \left(R\mathcal{V}R^T\right)^{-1} (r - R\hat{\alpha}). \tag{8.2}$$

The above estimator has the asymptotic covariance matrix

$$Cov(\tilde{\alpha}) = \mathcal{V} - \mathcal{V}R^T \left(R\mathcal{V}R^T\right)^{-1} R\mathcal{V}. \tag{8.3}$$

The estimator $\tilde{\alpha}$ is the *best unbiased linear transformation* in the sense that it has under the null hypothesis the smallest asymptotic covariance matrix in the set of estimators that are linear functions of the unrestricted estimators $\hat{\alpha}$ and satisfy the linear constraint $R\alpha = r$. Table 8.2 provides the estimates based on (8.2) which have both the adding-up and the symmetry constraints imposed.

[1] If R has less than full row rank one substitutes a corresponding generalized inverse for the inverse matrix in the middle of (8.1).

Table 8.2. Estimation results, Model P, both restrictions imposed.

Variable	Food		Beverages Tobacco		Clothing Footwear		Housing Energy		Household Appliances	
	Param.	T	Param.	T	Param.	T	Param.	T	Param.	T
CONSTANT	-29.5699	-5.19	-38.4857	-19.95	25.8789	7,54	76.4748	12.45	29.8201	10.44
LCOHAGE	-2.9872	-6.91	0.4014	2.16	0.4678	1.54	3.9071	8.20	1.9928	8.04
LAGE	32.7057	10.20	24.3711	21.70	-10.1155	-5.24	-37.7358	-10.91	-13.6025	-8.42
LAGESQ	-3.6635	-8.65	-3.4125	-23.04	1.1986	4.67	5.2178	11.31	1.4799	7.23
HHSIZE	0.8774	8.86	-0.0902	-3.12	0.4923	8.52	-1.0956	-9.84	-0.2881	-6.79
HHSIZESQ	-0.0422	-3.93	0.0164	5.13	-0.0324	-5.37	0.0178	1.43	0.0078	1.82
CHILDREN	-0.6627	-9.85	-0.4166	-19.02	0.0711	1.88	2.3401	31.69	0.1661	5.85
FARMER	-0.9803	-6.84	-0.7962	-16.25	0.0639	0.81	3.5187	22.35	-0.0959	-1.68
SELFEMPL	-0.5942	-3.35	-0.1894	-3.26	0.6442	6.08	-0.5268	-2.73	0.0530	0.72
WHCOLLAR	-0.2328	-2.11	-0.2524	-6.95	0.5816	8.78	-1.7522	-14.79	0.1025	2.24
RETIRED	-1.6337	-10.86	0.0468	0.96	0.0164	0.19	2.0701	12.41	-0.0621	-1.02
EDUCM	-0.2656	-2.79	-0.1711	-5.43	0.2540	4.56	-1.0502	-10.25	0.1841	4.55
EDUCH	0.1027	0.67	-0.6119	-12.43	0.3332	3.69	-3.2280	-19.13	0.3415	5.07
FEMALE	-1.0691	-10.21	-0.7385	-21.03	1.4025	19.54	1.3596	11.72	0.0222	0.50
OLDAGE	-0.1696	-1.92	-0.0105	-0.35	-0.3592	-7.15	2.0884	20.77	0.0908	2.52
SMHOUSE	-0.4285	-4.19	-0.2052	-6.17	-0.4323	-7.28	2.2625	20.27	0.1138	2.55
SDHOUSE	-0.7183	-2.72	0.1184	1.33	0.6836	4.13	-0.5448	-2.08	0.2050	1.90
TENURENT	1.0176	9.08	0.9576	21.61	0.5095	7.36	-2.5341	-21.38	-0.1610	-3.42
TENURKIN	0.7246	4.13	0.5430	8.96	1.2037	10.90	-2.6382	-14.52	-0.1010	-1.37
CENTHEAT	-1.6211	-13.88	-0.3112	-8.37	-0.5400	-8.16	2.2678	17.64	-0.0185	-0.41
WEHOUSE	-0.6164	-6.38	-0.1904	-6.04	-0.2130	-3.80	0.3212	3.03	-0.0107	-0.26
BATHROOM	-1.8397	-14.19	-1.0420	-22.11	0.2373	3.30	2.6347	19.04	0.1859	3.65
MIDDLE	-0.1704	-1.98	-0.2186	-7.56	0.0992	1.97	0.8750	9.34	-0.0199	-0.56
NORTH	-0.3044	-2.64	-0.1468	-3.86	0.4094	5.91	0.2465	1.98	0.1350	2.74
RURAL	-0.2477	-2.78	-0.0828	-2.80	-0.1041	-2.03	0.1041	1.10	-0.0360	-0.99
SPOUSENW	-0.4341	-4.71	0.0837	2.80	-0.8678	-15.10	2.3574	23.55	-0.1242	-3.22
CAR	-2.7738	-23.34	-0.6370	-17.52	-1.2467	-18.18	-4.7846	-36.11	-0.2085	-4.67
WINTER	-0.7518	-7.27	-0.4015	-10.93	-0.2288	-3.66	1.3135	11.63	-0.2581	-5.56
SUMMER	2.5005	21.38	-0.0187	-0.49	-0.6185	-9.35	-1.2213	-10.24	-0.3958	-7.64
AUTUMN	0.4532	4.40	-0.1106	-2.86	0.6644	10.14	-0.6718	-6.00	-0.2581	-5.35
LP1	13.3620	14.35	-1.0803	-2.16	2.9621	4.86	-3.7259	-4.71	-1.4945	-2.69
LP2	-1.0803	-2.16	3.7715	3.17	-2.7937	-4.07	2.4069	3.78	-0.0639	-0.10
LP3	2.9621	4.86	-2.7937	-4.07	0.5917	0.59	7.2475	8.73	-4.6460	-7.46
LP4	-3.7259	-4.71	2.4069	3.78	7.2475	8.73	5.8474	4.40	0.7372	1.08
LP5	-1.4945	-2.69	-0.0639	-0.10	-4.6460	-7.46	0.7372	1.08	2.8576	3.43
LP6	-1.3430	-3.90	-2.6820	-4.88	-3.6033	-7.99	-2.5043	-5.96	0.3765	0.77
LP7	-0.9192	-0.89	-1.7990	-1.79	-3.6190	-3.13	-3.5956	-2.58	-2.2046	-1.87
LP8	-2.9932	-3.72	0.3154	0.22	0.0951	0.07	-3.6912	-3.05	7.0479	6.14
ILNXR	-12.8407	-28.16	0.3952	1.84	1.8984	6.57	6.2111	12.28	0.4934	1.82
ILNXCH	-0.4878	-2.96	0.0602	0.95	0.2167	1.98	-1.1223	-6.59	-0.1675	-1.93
ILNXFEM	1.7909	5.80	1.1652	8.36	-0.0818	-0.38	-0.2065	-0.65	-0.5571	-2.86
ILNXSIZE	0.4700	3.38	-0.2236	-3.98	-0.6137	-6.87	2.2830	15.58	-0.0326	-0.44
ILNXSQ	4.5882	13.68	-0.5707	-3.82	-1.4309	-6.20	0.9325	2.68	-0.8542	-3.84
LNRELX	-0.0167	-0.04	0.0028	0.01	0.0119	0.05	1.2088	3.00	0.6235	2.29
LP9	-4.7681	-7.75	1.9251	1.69	3.7655	4.86	-2.7221	-3.56	-2.6104	-2.79

Table 8.2. Estimation results, Model P, both restrictions imposed.

Variable	Health Care		Transport, Communication		Education, Entertainment		Other Goods and Services	
	Param.	T	Param.	T	Param.	T	Param.	T
CONSTANT	-5.4247	-4.64	53.0089	9.79	2.8676	0.80	-14.5701	-6.78
LCOHAGE	0.7439	5.68	-1.0261	-2.05	-2.9883	-7.83	-0.5114	-2.38
LAGE	3.2566	4.87	-19.3775	-6.34	9.1998	4.53	11.2982	9.31
LAGESQ	-0.4507	-5.13	2.2658	5.63	-1.2019	-4.53	-1.4334	-8.87
HHSIZE	-0.1882	-8.96	0.3323	3.64	0.0829	1.46	-0.1229	-3.44
HHSIZESQ	0.0076	3.49	0.0566	5.51	-0.0426	-7.12	0.0112	3.02
CHILDREN	-0.0322	-2.43	-1.6221	-23.27	0.4336	9.94	-0.2775	-10.33
FARMER	0.1899	6.07	-0.7758	-5.47	-0.9044	-10.70	-0.2198	-4.36
SELFEMPL	0.0254	0.66	-0.5996	-3.17	0.1983	1.70	0.9892	12.26
WHCOLLAR	-0.0345	-1.44	0.3097	2.79	0.7297	9.85	0.5485	11.74
RETIRED	0.4354	11.73	-1.0292	-7.35	-0.1714	-1.88	0.3276	5.47
EDUCM	0.0208	1.02	0.2421	2.56	0.5253	8.44	0.2606	6.65
EDUCH	-0.1484	-4.60	0.7753	5.09	1.6662	15.47	0.7694	11.11
FEMALE	0.0336	1.39	-1.2311	-11.82	-0.4460	-6.59	0.6668	12.69
OLDAGE	0.2357	11.25	-1.4236	-16.87	-0.2739	-5.24	-0.1780	-5.21
SMHOUSE	-0.1970	-8.51	-0.0089	-0.09	-0.7076	-10.60	-0.3968	-8.85
SDHOUSE	-0.1363	-2.47	0.2398	0.95	0.2465	1.43	-0.0938	-0.97
TENURENT	0.0660	2.68	-0.3199	-3.07	0.4761	6.51	-0.0118	-0.26
TENURKIN	0.1519	3.95	-0.1136	-0.67	0.1109	0.97	0.1187	1.67
CENTHEAT	-0.0187	-0.73	0.1567	1.41	0.0759	1.10	0.0091	0.20
WEHOUSE	-0.0365	-1.71	0.5820	5.86	0.0191	0.31	0.1447	3.55
BATHROOM	-0.0273	-1.01	-0.2894	-2.40	-0.1685	-2.22	0.3089	6.05
MIDDLE	-0.0219	-1.16	-0.1076	-1.27	-0.0080	-0.15	-0.4279	-12.19
NORTH	-0.0860	-3.40	0.7140	6.11	-0.4416	-6.19	-0.5261	-11.40
RURAL	-0.1525	-7.63	1.3347	15.12	-0.3082	-5.47	-0.5075	-13.08
SPOUSENW	0.1670	8.16	-0.2329	-2.45	-0.9098	-14.73	-0.0394	-1.06
CAR	-0.2594	-10.32	10.9550	87.84	-0.6060	-9.09	-0.4390	-10.77
WINTER	-0.0022	-0.09	-0.1578	-1.52	0.7241	10.81	-0.2373	-5.60
SUMMER	-0.2895	-11.25	-0.6979	-6.40	0.4079	5.83	0.3332	7.45
AUTUMN	-0.1765	-6.83	-0.5889	-5.64	0.4940	7.14	0.1943	4.43
LP1	-1.3430	-3.90	-0.9192	-0.89	-2.9932	-3.72	-4.7681	-7.75
LP2	-2.6820	-4.88	-1.7990	-1.79	0.3154	0.22	1.9251	1.69
LP3	-3.6033	-7.99	-3.6190	-3.13	0.0951	0.07	3.7655	4.86
LP4	-2.5043	-5.96	-3.5956	-2.58	-3.6912	-3.05	-2.7221	-3.56
LP5	0.3765	0.77	-2.2046	-1.87	7.0479	6.14	-2.6104	-2.79
LP6	4.2835	8.74	0.1061	0.16	3.6044	4.13	1.7619	2.40
LP7	0.1061	0.16	6.0286	2.32	2.1040	1.09	3.8986	3.20
LP8	3.6044	4.13	2.1040	1.09	3.1569	0.98	-9.6392	-5.98
ILNXR	-0.0447	-0.25	-0.6236	-1.26	0.7074	2.37	3.8034	12.53
ILNXCH	0.1821	3.87	0.3502	2.22	1.0403	11.06	-0.0720	-1.34
ILNXFEM	-0.0912	-0.75	-1.5405	-5.40	-0.8664	-4.74	0.3874	2.64
ILNXSIZE	-0.0943	-2.21	-0.6435	-4.84	-0.8238	-10.88	-0.3214	-6.65
ILNXSQ	0.1560	1.24	-0.8773	-2.51	-1.7399	-8.14	-0.2036	-1.23
LNRELX	-0.2670	-1.65	1.1065	2.56	-0.6808	-2.39	-1.9891	-6.38
LP9	1.7619	2.40	3.8986	3.20	-9.6392	-5.98	8.3887	4.56

Note that the estimated standard errors for the individual coefficients have a tendency to decrease if compared with the unrestricted estimators in Table A3.6. This is generally true since (8.3) states that any linear combination of the model parameters is estimated now more efficiently. However, the matrix in (8.3) refers to the correct covariance matrix under the null hypothesis. We have given earlier a formula (4.91) to calculate the generalized mean square error of the estimators if the null hypothesis which is imposed on the estimators is not true.

In the present case we have no strong reasons of not believing in adding-up constraints which are related to the budget shares, if the errors enter additively, since the budget shares that we use satisfy these by construction.[2] This can be seen as follows. Let the consumption, labour supply, savings decision in a period be governed by $\mathcal{E}(m|\ z)$, if consumption is considered in isolation. Here m denotes the total expenditure (expressed in logarithmic form), and z is the whole set of variables that affect the consumption decision including currently known price and wealth variables and those variables which are used efficiently by the household to forecast the future values of these variables. Here wealth includes human wealth, i.e. the z-variables should have among them factors affecting labour market conditions and wages in the future. The vector z should naturally include the currently known price variables. With no loss of generality one may consider a simplified version of our model to express in a budget share form the allocation decision how total expenditure is distributed among its component categories:

$$w_k = \frac{q_k x_k}{\sum q_j x_j} = \alpha_k + \sum_j \gamma_{kj} \log q_j + \beta_k (\mathcal{E}(m|\ z) - A(q)) + \varepsilon_k, \tag{8.4}$$

Rationality in forming expectations implies the martingale property of consumption. This ensures that the error terms ε_k have mean zero and are independent of the conditional expectation $\mathcal{E}(m|\ z)$. Since $\sum w_i = 1$ by construction, taking expectations on both sides of (8.4) and summing over the index k shows that the equations that are formed using conditional expectations of m in lieu of the actual values of total expediture satisfy the adding-up constraints, which were given earlier (4.7)-(4.9). Similarly the homogeneity conditions hold providing us with the additional condition (4.3). In contrast, *adding-up of planned expenditure in the various consumption categories to observed total expenditure need not hold*, see Bierens and Pott-Buter [1989] and Chavas and Segerson [1987].[3]

[2]The following remarks are based on an underlying theoretical framework. This set-up is appropriate if we consider the allocation decision among the non-durable items of consumption. So far we have included purchases of durable goods and the acquisitions of these are governed by different, dynamic considerations possibly interacting with the other variables and the *error terms* in the model. These caveats should also be borne in mind if whether to impose the theoretical restrictions is under consideration. The discussion is really more appropriate when the results in Chapter 9 are considered where we leave out the purchases of durable goods.

[3]Note that theoretical considerations would actually recommend not expressing the consumption decision *in budget share form using observed data* as the dependent variable but modelling directly by using conditional expectations and considering the stochastic component as an integral part of the

On the other hand, it may true that symmetry restrictions are out of place here. These doubts arise from recalling that we deal with household data which in effect aggregates the consumption decisions of several persons. So even if one would be a firm believer in the neoclassical theory as giving the true mode of individual behaviour the symmetry conditions do not necessarily survive the aggregation and the implicit bargaining mechanism taking place within the household, see Manser and Brown [1980].

Table 8.3 provides the summary sample statistics which refer to the predictive values that are calculated using the estimates with symmetry and adding-up constraints imposed on the data.

Table 8.3. Descriptive statistics for predictions.

Variable	Mean	Std Dev	Minimum	Maximum
FW_1	0.2830	0.0686	0.118	0.565
FW_2	0.0348	0.0100	0.000	0.072
FW_3	0.0688	0.0166	0.014	0.136
FW_4	0.2367	0.0566	0.000	0.449
FW_5	0.0628	0.0063	0.034	0.101
FW_6	0.0288	0.0079	0.007	0.056
FW_7	0.1565	0.0621	0.012	0.324
FW_8	0.0804	0.0218	0.000	0.142
FW_9	0.0481	0.0187	0.000	0.126

8.2 Price and expenditure elasticities

In the study we use the linearized version of the QAIDS functional form (4.11). Recall the formulae for calculating the elasticities for individual households. First, the uncompensated price elasticities[4]

$$\begin{aligned} \eta_{kl} &= \frac{\partial \log x_k(q,m)}{\partial \log q_l} = -\kappa_{kl} + \frac{\partial \log w_k(q,m)}{\partial \log q_l} \\ &= -\kappa_{kl} + \frac{\gamma_{kl} - (\beta_{1k} + 2\beta_{2k}\bar{m})(\hat{w}_l - \beta_{1l}\bar{m} - \beta_{2l}\bar{m}^2)}{\hat{w}_k}, \end{aligned} \tag{8.5}$$

model. The stochastic component reflects, measurement errors, unobservables, idiosyncratic differences in tastes, and possible optimization errors. If observed shares are used one increases the noise in the data in form of the denominator in (8.4). In fact, this should produce a more complicated (in some cases intractable) heteroskedastic error term and it is questionable whether the error term enters the model additively. Therefore, in general, the use of simple additive homoskedastic errors is not well-founded in the budget share equations, Chavas and Segerson [1987]. We have refrained from this and followed the usual convention for ease in presenting the results in an intuitive manner.

[4]Note that the elasticity formulae (8.5),-(8.7) relate to a consumer with "median taste", i.e. the case where individual error terms ε_i which include individual taste differences have been set to zero.

where $\bar{m} = \log M - \log P_S - \log n$, the logarithmic total real expenditure per the number of equivalent adults in the household, and κ defines the Kroenecker's function, $\kappa_{ij} = 1$ if $i = j$, and zero otherwise. Second, the expenditure elasticities

$$\begin{aligned}
\eta_k &= \frac{\partial \log x_k(q,m)}{\partial \log M} = 1 + \frac{\partial \log w_k(q,m)}{\partial \log M} \\
&= 1 + \frac{\beta_{1k} + 2\beta_{2k}\bar{m}}{\hat{w}_k}. \qquad (8.6)
\end{aligned}$$

Recall that the parameters β_{1k} are allowed to depend on the observation through a collection of predetermined variables, $\beta_{1k} = \sum_i \beta_{1ki} z_i$.

The compensated price elasticities are calculated by the formula[5]

$$\begin{aligned}
\tilde{\eta}_{kl} &= \eta_{kl} + \eta_k \hat{w}_l \\
&= -\kappa_{kl} + \hat{w}_l + \frac{\gamma_{kl} + (\beta_{1k} + 2\beta_{2k}\bar{m})(\beta_{1l}\bar{m} + \beta_{2l}\bar{m}^2)}{\hat{w}_k}. \qquad (8.7)
\end{aligned}$$

We give the elasticities of aggregate market demand in the survey years, 1966-1990. The calculations are based on Model P and the estimates in Table 8.2 with homogeneity and symmetry constraints imposed. Furthermore, we will make some comparisons with the rough descriptive estimates that we have given in Table 2.2 using the alternative sources of time series data.[6]

In calculating the expenditure elasticities at the aggregate level we make the assumption that each household is affected by an equally large relative increase in total expenditure. This means that no changes in income distribution are considered here. To calculate elasticities of the corresponding aggregate consumer demand one has to take account of the sampling framework that was used to draw our samples in the respective years. In actual calculations we do not form individual elasticities to prevent numerical instability, underflow in cases where the denumerator in (8.5) and (8.6) is near zero. Instead we calculate aggregate elasticities with the formula

$$\begin{aligned}
\eta &= \frac{\partial \log \int x_k(q,m^*)\, dF_\omega}{\partial \log z} = \frac{\partial \log \int e^{\log M^* - \log q_k}\, w_k(q,m^*)\, dF_\omega}{\partial \log z} \\
&= \kappa + \frac{\int e^{\log M^*} \partial w_k(q,m^*)/\partial \log z\, dF_\omega}{\int e^{\log M^*} w_k(q,m^*)\, dF_\omega}, \qquad (8.8)
\end{aligned}$$

where $\kappa = 1$ if $z = M^*$, $\kappa = -1$ if $z = q_k$, and zero otherwise. The integration is taken w.r.t. to a discrete point density function which is constructed using the sampling

[5]In this study we have used a linearized version (4.11) of the 'true' functional form (4.6). The linearized form does not fulfil Gorman's condition of integration which is equivalent with having a symmetric Slutsky matrix. The main culprit for this is neglecting the term in the last row of (4.35) which is obtained by derivating the function $B_2(q)$. In calculating the off-diagonal Slutsky elements at the individual level we in fact use the average of the corresponding terms to account for this 'beauty error.' However, the calculations are little affected by this modification.

[6]Note, that the variables have only limited comparability if survey data and data from National Accounts are compared (Section 3.2.1).

weights $dF_\omega(a) = \omega_a$, and for each survey year $\int_a dF_\omega(a) = \sum \omega_a = 1$.[7] In calculating the elasticities by (8.8), we make a small modification which has little practical consequence but has rather to conform to our former treatment of the 'errors-in-variables' problem concerning the nominal total expenditure variable M. Recall that we assumed $\log M \sim (m^*, \sigma_m^2)$ and had a preliminary estimator for the m^* by $\hat{m}^* = \sum_j z_j \hat{\psi}_j$ and an estimator for the variance of $\hat{m}^*$, say ω^2 based on the covariance matrix of the estimators for ψ_j, and the values observed for the z-variables. Here we use this information to substitute for $\exp\{\log M^*\}$ in (8.8) which refers to the true error-free variable the corresponding approximation of the expected value $\exp\{\hat{m}^* - \frac{1}{2}\omega^2\}$ which refers to our estimator. The above approximation is based on a cumulant generating function having zero skewness and zero excess kurtosis. The cumulant generating function is approximated by an expansion

$$\psi_x(t) = \log \mathcal{E} e^{tx} \approx \mu t + \frac{1}{2!}\sigma^2 t^2 + \frac{1}{3!}\kappa_3 t^3 + \frac{1}{4!}(\kappa_4 - 3)t^4,$$

where μ is the mean of the random variable x, and σ^2 is its variance, and κ_3 and κ_4 are the third and fourth cumulant, respectively (κ_3 = skewness, and $\kappa_4 - 3$ = the excess kurtosis).

The estimates of the aggregate elasticities are given in in Appendix 4 (Tables A4.1 (i),-(vi)). To start at bottom with expenditure elasticities one finds immediately that the aggregate market demand for the component categories have expenditure elasticities that are closer to one than individual elasticities taken, say at mean values, or the analysis in Chapter 6 would suggest. The effect is partly a consequence of the fact that in aggregating we weight the individual elasticities in such a manner that households with individually large expenditures in a specific category get a larger weight but simultaneously have elasticities that are closer to one than those with smaller consumption, see (8.5),-(8.8). This is true if total expenditure is held constant. So even as most of those effects that are due to observing households with varying total expenditure would cancel out we will observe a kind of 'regression toward' one phenomenon. This is a general feature of aggregation that we shall meet also as we consider the price elasticities.

The mathematical formula that is used to calculate the elasticities in the case of the QAIDS-form shows that the deviation of its value from the constant κ in (8.8) is inversely dependent on the budget share. This means that holding other variables constant (this is only an approximation) one should observe expenditure elasticities deviating from $\kappa = 1$ over time in those categories with aggregate share decreasing (expenditure elasticity less than one or an unfavourable change in demographics). On the other hand, in those categories with aggregate share increasing (expenditure elasticity more than one or a favourable change in demographics) we should see expenditure elasticities which get closer to one. This is a general feature that is observed in the other elasticities as well. These effects are clearly observable in Tables A4.1 (i),-(vi), and Figure 8.1 where the evolution of aggregate elasticities is shown over the 24 year time period.

[7]The sampling weights are the inverse of the individual probabilities to be included in the sample with each survey year considered separately and nonresponse treated accordingly.

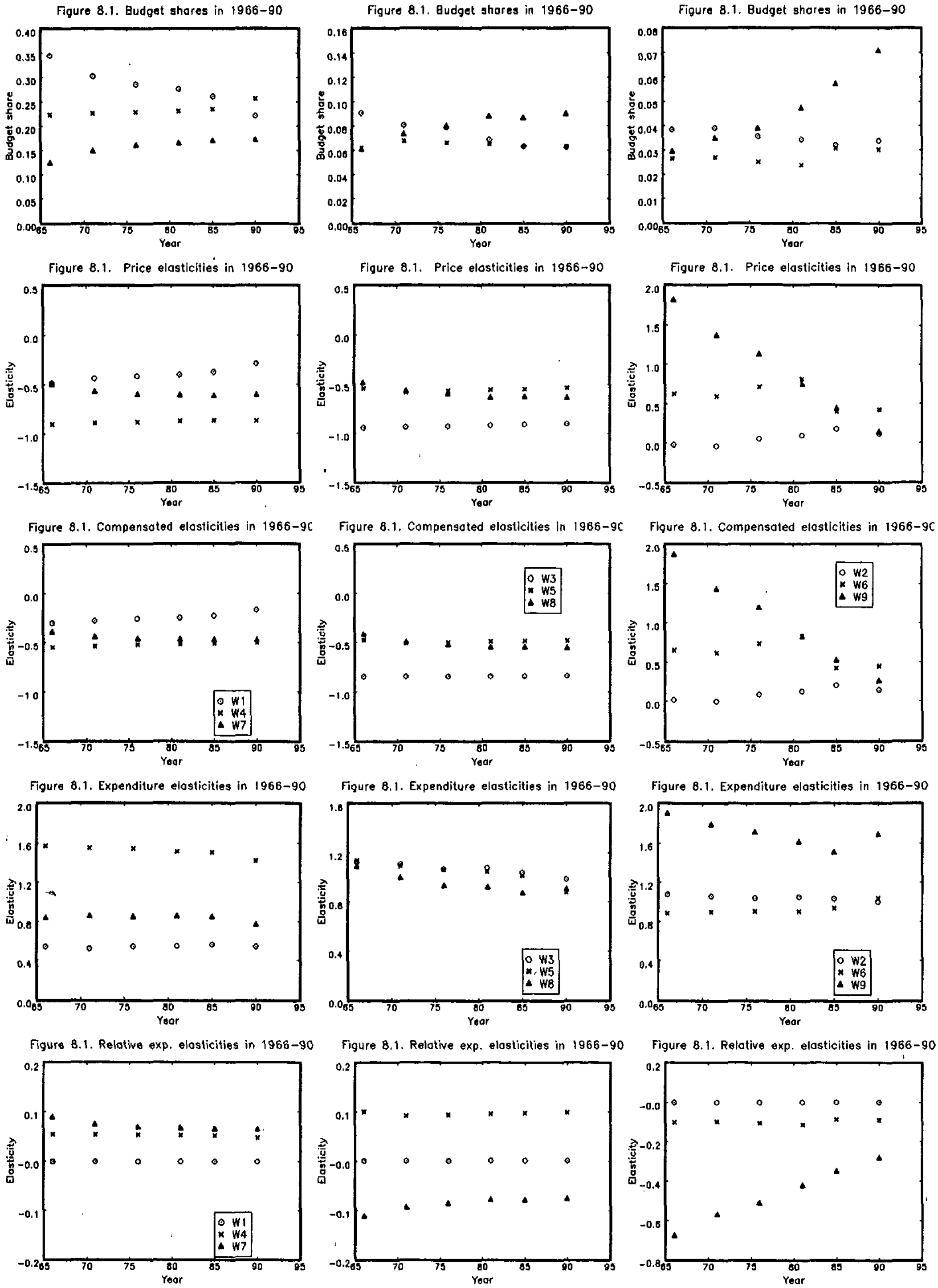


Figure 8.1. Budget shares in 1966–90
Budget share
Year
Figure 8.1. Price elasticities in 1966–90
Elasticity
Figure 8.1. Compensated elasticities in 1966–90
W1
W4
W7
W3
W5
W8
W2
W6
W9
Figure 8.1. Expenditure elasticities in 1966–90
Figure 8.1. Relative exp. elasticities in 1966–90

To supplement the conventional expenditure elasticities we have reported estimates of 'relative expenditure elasticity.' This measure is based on our auxiliary variable which is motivated by the 'relative income hypothesis' in consumption behaviour, originally put forth by Duesenberry [1949]. Specifically, we introduce a positional variable into our model. The variable is the distance of the household from the median consumer, the reference level. The median is estimated using the population mean of logarithmic total expenditure corrected for the size of household and calculated separately for each sample year available (Section 3.2.3). In calculating the elasticity separately for the auxiliary variable we make an assumption that if the position of a household in the income distribution is unchanged the ordinary expenditure elasticity should be calculated by not allowing the coefficient of our auxiliary variable to enter. In a sense the latter is an indexing variable which is treated equally to any other similar variable which is considered as predetermined, such as family size and composition, or age variables. In turn the conventional total expenditure variable takes account of the gradual improvement in living standards over time but does not account for those changes which result from climbing up (or down) the social ladder. Table 8.4 provides the aggregate budget shares and expenditure elasticities in 1990.

Table 8.4. Expenditure elasticities in 1990.

Variable	Aggregate Share	Expenditure elasticities Direct	Relative
W_1	0.221	0.546	-0.000
W_2	0.034	1.001	0.000
W_3	0.063	0.985	0.002
W_4	0.256	1.418	0.047
W_5	0.063	0.878	0.099
W_6	0.030	1.040	-0.088
W_7	0.172	0.769	0.064
W_8	0.090	0.906	-0.076
W_9	0.071	1.691	-0.281

At the aggregate level, the categories, W_4 Housing and Energy, and W_9 the residual category are clear luxuries. This is possibly a consequence of the fact that in this study purchases of durables and (partly imputed) housing costs are included in the corresponding consumption categories. On the other hand, Food is a necessity with all other categories having near unit elasticities (Table 8.4). An explanation for the latter observation is that in analysing broad categories which include a large number of individual commodities some of them necessities and some luxuries one is bound to get a large number of near unit elasticities. Note that somewhat surprisingly the category W_7, Transport and Communication has an expenditure elasticity which is a little under one on the aggregate level. This runs counter to our a priori expectations and to the analysis of the Engel curves in consumption (Section 6.3).[8]

To give more credence to our interpretation of the auxiliary variable we are delighted to see that if all data are considered (Table 4.1 (vi)), the consumption categories, W_1 Food, W_2 Tobacco and Beverages, W_3 Clothing and Footwear, and W_6, Health Care, have practically zero values of the relative expenditure elasticity in the three first categories and with the value of the last category being negative.[9] The corresponding coefficients are not statistically different from zero (Table 8.2). A possible interpretation is that these categories have little use as conspicuous consumption in the sense of Veblen, or include few positional commodities. A priori one would not expect that the consumption of goods in these categories should involve distributional considerations other than the income effects due to general improvement in living standards. Furthermore, the above categories were not found to represent luxury items of consumption in Chapter 6.

On the other hand, one observes that categories, W_4 Housing and Energy, W_5 Household Appliances and Furniture, and W_7 Transport and Communication, have positive relative expenditure elasticities indicating that they may be used for signalling, or show-off purposes, particularly so as we recall that Housing was earlier found represent a luxury item of consumption.[10] The two remaining categories, W_8 Education and Entertainment, and W_9 the residual category, have negative relative expenditure elasticities indicating that they are found more useful in the lower part of the income distribution. In the last five categories the corresponding coefficients are also found to be statistically significant (Table 8.2). On the point concerning the residual category we, however, would like to make a reservation that concerns the gradual increase in its budget share over time. This is partly a consequence of introducing new goods and services, and service fees not previously charged for in the survey, and improved reporting (Table 3.2). However, we are ready to admit that the interpretation of the effects found in connection of our positional variable is not clear cut and may be slightly premature. One has to wait for more studies in this area.

The price elasticities are the key concepts in demand analysis. Note that if the compensated cross-price elasticity, the off-diagonal elements in the matrix given in Table A4.1.(i),-(vi), is negative the commodity category shown in the column is a complement to the category given by the row of the matrix. The substitutes are found similarly, looking up the positive numbers. For instance, Clothing and Footwear, and Housing and Energy were found to be substitutes for Food (Tables A4.1) with statistically significant price coefficients (Table 8.2). All other categories present complement commodities with the exception of Transport and Communication, W_7 where the corresponding parameter estimate does not differ significantly from zero.

[8]When the Engel curves in consumption were calculated we naturally allowed the coefficient of the 'relative expenditure variable' to enter.

[9]'The relative expenditure elasticity' has a rather absurd meaning at the aggregate level if the related thought-experiment is taken literally but it should be considered really as an aggregate measure of all the individual effects concerning the position in the income distribution.

[10]Housing services may have some characteristics of a positional good if dwelling places in the more lucrative neighbourhoods are considered.

Table 8.5 provides the aggregate price elasticities in 1990. Results of the other surveys years are given in Tables A4.1 (i),-(v). Considering the own price elasticities one can observe that we have six estimates that are negative at the aggregate level.

Table 8.5. Price elasticities in 1990.

Variable	Price LP_1	LP_2	LP_3	LP_4	LP_5	LP_6	LP_7	LP_8	LP_9
Uncompensated price elasticities									
W_1	-0.290	-0.033	0.162	-0.056	-0.039	-0.047	0.036	-0.094	-0.186
W_2	-0.318	0.113	-0.825	0.703	-0.019	-0.792	-0.523	0.095	0.567
W_3	0.477	-0.447	-0.904	1.157	-0.742	-0.577	-0.571	0.018	0.603
W_4	-0.243	0.080	0.256	-0.870	0.002	-0.110	-0.216	-0.183	-0.134
W_5	-0.210	-0.006	-0.731	0.144	-0.537	0.063	-0.328	1.134	-0.407
W_6	-0.454	-0.889	-1.196	-0.838	0.122	0.418	0.027	1.189	0.581
W_7	0.000	-0.097	-0.195	-0.154	-0.114	0.013	-0.608	0.144	0.242
W_8	-0.310	0.038	0.017	-0.391	0.789	0.403	0.254	-0.640	-1.064
W_9	-0.835	0.248	0.488	-0.552	-0.413	0.227	0.431	-1.425	0.139
Compensated price elasticities									
W_1	-0.169	-0.015	0.196	0.084	-0.005	-0.030	0.130	-0.045	-0.147
W_2	-0.097	0.147	-0.763	0.960	0.044	-0.762	-0.351	0.185	0.638
W_3	0.695	-0.414	-0.843	1.410	-0.680	-0.547	-0.401	0.107	0.673
W_4	0.071	0.128	0.345	-0.506	0.092	-0.067	0.028	-0.056	-0.033
W_5	-0.015	0.023	-0.676	0.370	-0.482	0.090	-0.177	1.213	-0.345
W_6	-0.224	-0.854	-1.131	-0.571	0.188	0.449	0.206	1.283	0.654
W_7	0.170	-0.071	-0.147	0.043	-0.065	0.036	-0.476	0.213	0.297
W_8	-0.110	0.069	0.073	-0.159	0.846	0.430	0.409	-0.559	-1.000
W_9	-0.461	0.305	0.594	-0.118	-0.306	0.279	0.722	-1.273	0.258

All elasticities are rather low in absolute value reflecting modest substitution possibilities among the categories. But also here aggregation of commodities within categories is partly responsible for this. The demand for the category, W_3 Clothing and Footwear is most responsive to price changes with the uncompensated own-price elasticity of -0.9 in 1990.

The sinful culprits (sigh) that have unexpected signs are the categories, W_2 Tobacco and Beverages, W_6 Health Care, and the residual category, W_9.[11] The same observation holds true if compensated elasticities are examined. To give some excuses it may be that in the category, W_2 Tobacco and Beverages there is some addictive consumption present that is not responding to price as demand normally does. Furthermore, in this

[11] A quick glance at the budget shares (Table 8.4), and the estimates for the coefficients and their standard errors (Table 8.2) would suggest, see (8.8) that the positive sign in elasticity is statistically significant at the individual level only in the category, W_6 Health Care.

category we have found a considerable number of zero observations some of them reflecting genuine decisions not to consume some of the goods included here, or reluctance to give information on their consumption (Table 3.3). The last effect leads to a considerable underreporting of consumption, (Table 3.2). This particular category is by the way sometimes left out if systems of equations of consumer demand are analysed. The category, W_6 Health Care, may in turn have some problems in the variables which are used here since this category includes only out-of-pocket expenses, and expenditures on goods in this category were partly income tax deductible during the sample period and some acquisitions of durables in this category were also partly subsidized after hand. These effects are accounted in the income variables but not in the consumption variables of the data. Furthermore, during the sample period free Public Health Service expanded vastly in Finland and this not accounted for in the budget data. We also experienced considerable difficulties in constructing the corresponding Consumer Price Index variable in the period 1966-1976 (Section 3.2.1).

If the above results are compared with the rough picture given by the corresponding time series in Chapter 2 (Table 2.2) one has to bear in mind that different definitions are involved with the time series obtained from National Accounts (Chapter 2 and 3.1). In addition, recall that change in the demographic variables is accounted by conditioning on those variables in the micro data but in the time series temporal evolution in these variables is confouded with the temporal change in the total expenditure and price variables. Here closer examination of Section 6.4 where cohort effects have been considered is particularly helpful. Furthermore, in estimating the allocation model for consumer demand we have conditioned on a set of variables that correspond to consumer's decisions that are made on a long term basis. If the comparisons were made on equal footing the analysis would need to estimate models for these decisions as well. This runs, however, counter to the methodological framework that we have adopted. Furthermore, it is out of the reach of the data that is currently available to us.

One can observe that if the budget share of Food is considered, both sources of data give a similar picture on the evolution of the demand with the time series share being six to ten percentage points lower than our corresponding micro data variable W_1. The budget share of the category W_4, Housing and Energy, is higher in the cross sections where also a temporal increase is shown which is absent in the corresponding time series. Note that in the latter category of consumption the time series data are constructed on quite different basis than the budget data, and the reporting of expenditure is here on a higher level than the average level in the other categories of consumption (Table 3.2).

On the other hand, the category W_8, Education and Entertainment, has almost the same behaviour in both pictures. The observation holds true also for the category W_3, Clothing and Footwear. In the category W_5, Household Appliances, the time series gives only slightly higher shares. In contrast, the budget share of the category W_2, Tobacco and Beverages, is almost doubled in time series. Recall that the consumption of alcoholic beverages is well known to suffer from considerable under-reporting if the data that are based on surveys made on individual level are compared with the data obtained from the sales of goods (Table 3.2). In the category W_6, Health Care, the values of the budget share are on a similar level but the time series data show a temporal increase which is almost absent in the picture provided by the cross sections. This may again be a consequence of the fact that in the budget data the category includes only out of pocket expenses and expenditures on goods in this category were partly subsidized after hand. Note that Table 3.2 shows that the survey figures have been on an increasing trend if compared with National Accounts, and earlier the 'under-reporting' has been substantial.

In the residual category W_9 one observes a temporal increase in both pictures but the budget share in the time series is about twice as large as the other one and has not been increased as much over the time period as shown in the cross section picture where shares have more than doubled. Earlier we found that the 'under-reporting' has been on a lower level in the three last surveys (Table 3.2). For natural reasons, the time series and budget data concerning the residual category are constructed with the least amount of comparability. In addition one would expect to find some instability in the coefficients. In the category W_7, Transport and Communication the temporal evolution is quite similar but the time series data is showing a higher budget share.

If elasticities of demand are compared in the category, Food, one notes that both the time series and the micro data produce similar estimated elasticities at the aggregate level with the price elasticities closer to zero in the time series. The definitions of commodities to be included in the category correspond presumably quite closely to each other in the two sources of data. Recall that in four categories, W_3, W_5, W_8, and W_9, the time series estimates for own price elasticity are positive, and additionally in the categories W_1, and W_6, the elasticity turns positive at the end of the sample period (Table 2.2 and Figure A1.1).[12] The estimates for elasticities in the category W_4, Housing and Energy, are higher (in absolute value) in the micro data than in the time series. On the other hand, the picture is totally reversed if the category W_7, Transport and Communication, is considered. Here the time series data indicate a luxury item of consumption whereas the micro data indicate a necessity. However, recall that in setting up the model we have been conditioning the demand for commodities in relation to both the type of housing and tenure (owning or renting) and for private car holding. These variables correlate with real wealth. Since we are modelling individual (current) allocation decisions in micro data there are good reasons to proceed in this manner. However, if the time evolution in these conditioning variables, and additionally the change in the demographic variables included in the micro model are properly accounted for, the marked differences that are apparent here may afterall have much less influence, see Section 6.4 on cohort effects. The price elasticities obtained from the time series have been rapidly approaching zero in the sample period (Figure A1.1). In the present case one could also note that the estimates that we obtain from micro data are not very robust w.r.t. the inclusion of purchases of durables in the category W_7, and the model used, see Riihelä and Sullström [1993], and Chapter 9.

[12]Since the method we are using is based on a 'smoothing' operator on the data it has common features with similar operators like the moving average filters used in the estimation of seasonal components and adjustment of time series data. The estimates are generally unstable and uncertain near the end points and some temporal phenomena that we observe may actually be due the smoothing method we use.

In the category W_2, Tobacco and Beverages the estimated expenditure elasticities are at similar levels, over unitary values in the cross section and the time series elasticity on a decreasing trend path. However, in the micro data own price elasticity has been estimated positive in contrast to a small (in absolute value) inelastic time series elasticity. In the category W_5, Household Appliances, the expenditure elasticities are again at similar little over unitary level but with the micro data in turn giving negative own price elasticity and the time series giving positive estimates. In the residual category W_9, both own price elasticities are estimated positive, and the category is deemed to represent luxury consumption with the micro data giving higher expenditure elasticities to reflect the improved reporting in the survey data.

The category W_8, Education and Entertainment, is a clear luxury if time series data are considered whereas the expenditure elasticity is lower in the micro data. In this case the influence of the indicators of human capital referring to the education level attained by the household head, and the temporal increase in the educational levels that are controlled for in the analysis of the micro data are particularly important in explaining the apparent discrepancies (Section 6.4). The own price elasticity is now negative in the micro data but the time series give a very mixed picture over the time period with elasticity value about -0.5 in 1966 but suddenly jumping to 0.5 in 1971.

The category W_3, Clothing and Footwear, has expenditure elasticities that are about one in the micro data but increase in the time series data from 0.6 to 1.4. The own price elasticity is having a near unitary absolut value in the micro data whereas it has the wrong sign in time series. The opposite is true w.r.t. the category W_6, Health Care, where time series data give a decreasing expenditure elasticity (from 1.4 to 0.8) over the sample period whereas elasticity is an increasing one in the micro data creeping slowly upwards to one. In contrast to the previous category the corresponding value of own price elasticity is estimated positive in the micro data and in the time series it starts as having negative values but changes sign in later years. The evolution may be partly due to the reasons given in an earlier discussion about the introduction of public health services and how the expenditure and price variables are constructed in the micro data. To give a summary, some of the differencies in the time series and budget data are resolved by simply looking how the 'underreporting' in surveys has evolved (Table 3.2). In the categories W_6, Health Care, and W_9, Other goods, more marked differencies are easily explained by this. On the other hand, the evolution in the demographic charcteristics which are properly controlled for in the analysis of micro data shows up as a stochastic trend component in the time series data and is easily confouded with the price and income effects. Therefore, comparisons of estimates across the different data sets are not in general on a consistent basis although the results that we obtained were reasonably similar in the category, Food. The continuous updating of elasticity estimates that is employed in our 'smoothing operator' may have been partially succesful in capturing the slowly changing random component in the time series but the net effects on the estimated parameters are quite unpredictable.

Obtaining positive point estimates for compensated demand elasticities in the micro data is a great pity since they do not conform to the theoretical restrictions that are implied by an underlying expenditure function defining rational expenditure minimizing behaviour. In the opposite case, the results would have an immediate application in welfare policy since they give direct access to the expenditure function (4.1) and the associate welfare measures like equivalent variation, see King [1983], and Suoniemi [1994]. These tools could then be used to assess reforms in indirect taxation at the household level. Furthermore, one could simultaneously control for differences in the size and composition of households and demographic characteristics as the age and gender of household head, and geographic location in order to arrive at more relevant comparisons of welfare gains and losses, and living-standard, see Baker et.al. [1990].

Recall that our mission is to give an analytic description of the evolution in the structure of consumption in 1966-1990. Therefore, we have naturally included the purchases of durable goods into the analysis. The decisions concerning acquisitions of durable goods do not necessarily fit nicely into the class of allocation models that we use. These decisions involve dynamic considerations and a better solution not available to us due to data restrictions would be to include into consumption the flow of services that they produce to the households. This is the main reason why studies of consumer budgets that have a welfare theoretic orientation and aim at tax reform analysis normally consider only non-durable consumption. To try our methodology in this area we modify the expenditure variables and price variables accordingly and present in Chapter 9 results on the allocation of non-durables and services among the component categories.

Chapter 9

Analysing Household Demand for Non-durables

9.1 Data

Below the allocation of consumption expenditure among its component categories is examined while purchases of durables are excluded from the consumption categories. Furthermore, the price variable in owner-occupied housing is not based on the relevant user cost variable which accounts for financial considerations, return on capital, tax rates and (de- or) appreciation in house prices. In addition, the consumers are not necessarily at their utility maximizing position with respect to the stream of housing services because of significant transactions costs of relocating. There seems to be a good case for excluding housing costs which are imputed on the part of owner-occupied housing. The possibility of corner solutions in housing markets may produce additional spill-over effects on the demand for transportation services.

We also leave out the category W_2 Beverages and Tobacco since here some addictive consumption may be present, and move the subcategory 'Non-alcoholic beverages' into the category, Food (Section 3.2.1). Furthermore, note that we have found a considerable number of zero observations and under-reporting in the category (Tables 3.2 and 3.3). These modes of behaviour, addiction by drunkards, and absistence by teetotallers, may not respond to changes in prices as demand normally does. Naturally the total expenditure variables and the price indices are also adjusted to exclude spending on the items of consumption that are left out in the analysis.

The descriptive statistics for the modified variables are given in Table 9.1. Comparing our new budget shares with those when durables and housing expenditure were included we find that first there is a drop of twenty percentage points in the category NW_4. This is accounted for by not including the (partly imputed) housing costs. Now the category NW_4 consists of expenditure on housing related Energy, power on heating and light (Section 3.2.1).

Table 9.1. Descriptive statistics for non-durables.

Variable	Mean	Std Dev	Minimum	Maximum
NW_1	0.3746	0.1558	0.000	0.982
NW_3	0.1017	0.0844	0.000	0.758
NW_4	0.0685	0.0608	0.000	0.677
NW_5	0.0491	0.0537	0.000	0.708
NW_6	0.0396	0.0560	0.000	0.833
NW_7	0.1591	0.1148	0.000	0.917
NW_8	0.0957	0.0707	0.000	0.709
NW_9	0.1116	0.1067	0.000	0.951
INW_1	0.3747	0.1008	0.048	0.673
INW_3	0.1017	0.0287	0.000	0.409
INW_4	0.0685	0.0400	0.000	0.406
INW_5	0.0491	0.0131	0.000	0.219
INW_6	0.0395	0.0225	0.000	0.475
INW_7	0.1592	0.0577	0.000	0.470
INW_8	0.0957	0.0281	0.009	0.374
INW_9	0.1116	0.0584	0.000	0.420
LNP_1	-0.0922	0.6565	-1.454	0.515
LNP_3	-0.0968	0.5453	-1.196	0.436
LNP_4	-0.1632	0.4985	-1.266	0.292
LNP_5	-0.1563	0.7596	-1.819	0.556
LNP_6	0.1054	0.6999	-1.192	1.003
LNP_7	-0.1112	0.6532	-1.508	0.530
LNP_8	-0.0300	0.6151	-1.265	0.629
LNP_9	-0.0619	0.6935	-1.482	0.693
ILNC	10.3664	0.8919	7.000	12.645
VARLNC	0.0018	0.0025	0.000	0.194
ILNX	0.0923	0.3182	-1.204	1.483
ILNXFM	0.0229	0.1622	-1.048	1.298
ILNXSZ	0.1968	1.1602	-13.344	5.932
ILNXCH	0.0117	0.5532	-11.120	2.966
ILNXSQ	0.1076	0.1443	-0.073	2.112
LNRELX	-0.0068	0.2340	-1.020	1.263

When purchases of durables are left out the shares of those categories which consist in the main part of non-durables and services, Food, NW_1, Clothing and Footwear, NW_3, Health Care NW_6, and the residual category NW_9, have risen accordingly. The categories, NW_7 Transport and Communication, and NW_8, Education and Entertainment, had earlier a sizeable durable component so their share is not increased so much. In the category NW_5, Household Appliances, dropping expenditure in Furniture causes the budget share to have even a lower level than earlier.

Demand models that are estimated using cross section budget data generally assume that households face the same prices everywhere. Ignoring spatial variation in prices is not necessarily a good assumption, see Deaton [1987]. This may account for some of the deficiencies that we will find in our empirical results. Some effects due to spatial variation in prices may in fact get accounted by the regional variables in the model as discussed in Section 7.2.

9.2 Imposing adding-up and symmetry restrictions on estimators

The quasi maximum likelihood estimates of the model for nondurables are provided in Appendix 5 (Table A5.1.). Model ND is built to conform to Model P (Section 6.2) containing the same (or analogously formed) explanatory variables if appropriate, such as the price variables. Following the procedure explained in Section 8.2 we calculate a Waldian test of the adding-up and symmetry constraints of the estimators using the unrestricted form of Model ND as the base line, see (8.1).

Table 9.2. Tests of the adding-up and symmetry constraints, Model ND.

	Adding-up	Symmetry	Symmetry & Adding-up
χ^2-statistic	792.2	377.8	1145.0
Degrees of freedom	44	28	72
P-value	$\leq e^{-100}$	$6.1\ e^{-63}$	$\leq e^{-100}$

Again we find that the data strongly reject both restrictions. In spite of this we go on boldly ahead to form estimators and an estimator for their asymptotic covariance matrix using (8.2),-(8.3) that satisfy these restrictions on the same grounds as before.[1] Table 9.3. provides the estimates which are based on (8.2) and have both the adding-up and the symmetry restrictions imposed.

We do not give here a detailed examination of the results but note that the variables which are proxies for labour supply, human capital, and real wealth enter Model ND with significant coefficients. This indicates that our earlier finding on consumption and leisure not being separable is robust w.r.t. to the inclusion of durable items in the component categories. Earlier Browning and Meghir [1991] have obtained similar results using data on non-durable consumption.

[1] However, recall the reservations that have been made earlier in Section 8.1 concerning the symmetry restrictions, and the error terms entering the budget share equations additively.

Table 9.3. Estimation results, nondurables, both restrictions imposed.

Variable	Food		Clothing, Footwear		Fuel Power		Household Appliances	
	Param.	T	Param.	T	Param.	T	Param.	T
CONSTANT	-69.5036	-9.57	47.0838	9.06	-1.4069	-0.63	33.9780	15.09
LCOHAGE	0.3533	0.55	1.9802	4.04	-1.5678	-7.14	1.3773	6.75
LAGE	48.8419	11.83	-20.3094	-6.88	4.2006	3.27	-16.6537	-12.93
LAGESQ	-5.4449	-9.99	2.1908	5.63	-0.1731	-1.01	2.0357	12.39
HHSIZE	2.9856	23.32	0.4585	5.08	-0.9368	-21.61	-0.3592	-10.44
HHSIZESQ	-0.3580	-25.32	-0.0074	-0.75	0.0223	4.59	0.0065	1.91
CHILDREN	1.1987	14.94	0.2799	5.23	0.5568	22.13	0.2922	13.00
FARMER	0.6632	3.61	0.5601	4.61	1.7631	25.41	0.0562	1.27
SELFEMPL	-0.8003	-3.38	1.0305	6.37	0.6529	8.33	-0.0448	-0.78
WHCOLLAR	-1.6544	-11.29	0.9257	9.19	-0.1819	-4.39	0.0523	1.49
RETIRED	-1.0993	-5.61	0.0806	0.61	0.5646	8.72	0.1110	2.27
EDUCM	-1.7200	-13.66	-0.0262	-0.31	-0.2184	-5.84	0.2583	7.98
EDUCH	-2.4622	-11.71	-0.4683	-3.29	-0.6900	-11.69	0.4760	8.85
FEMALE	-1.4903	-10.82	1.9651	19.27	-0.2338	-5.44	0.1280	3.62
OLDAGE	1.5899	13.71	-0.4530	-6.01	0.3357	8.24	0.1908	6.58
SMHOUSE	0.4131	2.99	-0.9157	-9.90	4.1162	82.65	0.2014	5.83
SDHOUSE	-1.8231	-5.45	0.2250	0.93	2.1834	18.38	0.3179	3.75
TENURENT	-0.1425	-0.98	0.2208	2.14	-0.9751	-23.20	-0.3242	-8.52
TENURKIN	-0.7557	-3.29	1.1838	7.18	-1.1144	-17.72	-0.2438	-4.18
CENTHEAT	-0.8704	-5.85	-0.1664	-1.67	-0.0599	-1.20	0.1535	4.18
WEHOUSE	-0.2089	-1.63	-0.1039	-1.21	0.3710	9.51	0.1368	4.23
BATHROOM	-1.1188	-6.95	0.9433	8.88	0.1283	2.46	0.4323	10.31
MIDDLE	0.4355	3.85	0.3330	4.32	0.4801	13.59	-0.0390	-1.39
NORTH	-0.0046	-0.03	0.7468	7.08	0.4835	10.00	0.0036	0.10
RURAL	-0.2321	-2.00	-0.1493	-1.92	0.7096	19.23	-0.0701	-2.42
SPOUSENW	0.3337	2.72	-1.0338	-12.14	0.4730	13.28	-0.1261	-4.22
CAR	-3.3757	-23.86	-1.7617	-17.98	-0.2388	-5.83	-0.1665	-4.85
WINTER	-0.8887	-6.51	0.0251	0.27	0.6893	15.90	-0.6465	-14.70
SUMMER	3.0803	20.95	-1.2145	-12.35	-0.1438	-3.25	-0.7451	-15.62
AUTUMN	-0.2028	-1.49	0.8978	9.43	-0.0295	-0.71	-0.5952	-14.26
LNP1	16.6737	9.58	-3.0903	-3.10	2.8552	5.36	-2.2588	-3.90
LNP3	-3.0903	-3.10	4.5036	4.01	3.4408	6.58	-2.5099	-4.86
LNP4	2.8552	5.36	3.4408	6.58	1.5355	3.54	4.2670	10.75
LNP5	-2.2588	-3.90	-2.5099	-4.86	4.2670	10.75	3.2778	4.73
LNP6	-0.2873	-0.66	-0.4792	-1.18	0.0090	0.03	0.9488	2.44
LNP7	-5.3767	-3.87	-4.3894	-4.01	-3.4298	-4.54	-9.5613	-11.04
LNP8	-4.8979	-5.55	-1.7615	-1.92	-3.3354	-5.12	4.9313	6.19
ILNXS	-19.8666	-27.30	4.7371	9.25	-2.2558	-8.22	0.2166	0.65
ILNXCH	-1.0440	-4.12	0.6012	3.12	-0.5729	-5.93	-0.0163	-0.14
ILNXFEM	1.6691	3.88	-1.6800	-5.15	0.0786	0.52	-0.7139	-3.32
ILNXSIZE	0.9769	4.56	-0.2194	-1.39	0.8343	10.33	0.1341	1.44
ILNXSQ	1.9368	3.72	-1.5996	-4.18	0.9905	4.75	-0.4605	-1.80
LNRELX	-0.6030	-1.15	-0.4458	-1.17	-0.0572	-0.32	0.8551	3.21
LNP9	-3.6179	-3.31	4.2858	4.52	-5.3424	-8.24	0.9051	0.98

Table 9.3. Estimation results, nondurables, both restrictions imposed.

Variable	Health Care		Transport, Communication		Education, Entertainment		Other Goods and Services	
	Param.	T	Param.	T	Param.	T	Param.	T
CONSTANT	-3.5673	-2.31	63.4477	10.11	9.3499	2.48	20.6183	4.48
LCOHAGE	1.9943	10.97	-3.8658	-6.42	-1.6596	-4.17	1.3880	2.89
LAGE	1.4494	1.63	-20.6112	-5.81	4.9944	2.34	-1.9119	-0.73
LAGESQ	-0.3739	-3.22	2.8414	6.08	-0.8220	-2.96	-0.2542	-0.75
HHSIZE	-0.2818	-9.94	-0.1414	-1.34	-0.0735	-1.25	-1.6512	-18.90
HHSIZESQ	0.0101	3.49	0.1183	9.69	-0.0227	-3.47	0.2311	21.45
CHILDREN	-0.0201	-1.22	-1.9689	-28.63	0.6743	17.55	-1.0129	-20.66
FARMER	0.4001	9.59	-1.1043	-7.29	-0.4113	-4.81	-1.9270	-18.30
SELFEMPL	0.1771	3.40	-1.6795	-8.36	0.1493	1.28	0.5147	3.41
WHCOLLAR	-0.0124	-0.39	-0.1098	-0.87	0.5248	7.06	0.4558	4.88
RETIRED	0.7071	14.41	0.1769	1.09	0.5714	5.92	-1.1123	-9.19
EDUCM	-0.0451	-1.66	0.5874	5.46	0.4532	7.09	0.7108	8.89
EDUCH	-0.3655	-8.30	1.3288	7.29	1.1283	10.34	1.0528	8.05
FEMALE	0.0737	2.27	0.0100	0.09	-0.0893	-1.39	-0.3635	-4.42
OLDAGE	0.3916	14.10	-1.0226	-10.74	-0.1617	-3.03	-0.8707	-12.52
SMHOUSE	-0.3966	-12.35	-0.8782	-7.43	-1.1138	-15.79	-1.4264	-15.23
SDHOUSE	-0.0739	-0.98	-0.6958	-2.44	0.0882	0.50	-0.2216	-1.01
TENURENT	0.0583	1.76	0.4031	3.27	0.1486	2.00	0.6111	6.34
TENURKIN	0.1355	2.62	0.0487	0.24	0.0704	0.59	0.6756	4.38
CENTHEAT	0.1130	3.34	0.1421	1.16	0.5282	7.63	0.1600	1.69
WEHOUSE	0.0039	0.14	0.1793	1.62	-0.2096	-3.34	-0.1686	-2.08
BATHROOM	0.0729	2.04	-0.7838	-5.84	-0.1360	-1.80	0.4616	4.59
MIDDLE	-0.0930	-3.69	-0.4818	-5.08	-0.0518	-0.94	-0.5831	-8.36
NORTH	-0.1588	-4.70	-0.1856	-1.45	-0.3060	-4.14	-0.5789	-6.19
RURAL	-0.2423	-9.12	0.9425	9.49	-0.1882	-3.29	-0.7702	-10.28
SPOUSENW	0.2242	8.24	0.7125	6.75	-0.8800	-14.07	0.2964	3.80
CAR	-0.2623	-8.23	7.8530	63.68	-0.5760	-8.82	-1.4720	-16.90
WINTER	0.0653	2.06	-0.4415	-3.86	0.9441	13.96	0.2529	3.00
SUMMER	-0.4208	-12.37	-0.7557	-6.20	0.3491	4.93	-0.1494	-1.66
AUTUMN	-0.2924	-9.13	-0.2652	-2.30	0.4958	7.33	-0.0084	-0.10
LNP1	-0.2873	-0.66	-5.3767	-3.87	-4.8979	-5.55	-3.6179	-3.31
LNP3	-0.4792	-1.18	-4.3894	-4.01	-1.7615	-1.92	4.2858	4.52
LNP4	0.0090	0.03	-3.4298	-4.54	-3.3354	-5.12	-5.3424	-8.24
LNP5	0.9488	2.44	-9.5613	-11.04	4.9313	6.19	0.9051	0.98
LNP6	3.7224	9.81	-2.9446	-4.84	-2.1591	-3.15	1.1900	1.85
LNP7	-2.9446	-4.84	17.2315	7.99	2.1137	1.61	6.3566	4.36
LNP8	-2.1591	-3.15	2.1137	1.61	9.7793	5.24	-4.6704	-3.24
ILNXS	0.2853	0.93	5.5040	8.91	2.6118	6.50	8.7675	15.69
ILNXCH	-0.1093	-1.25	-1.0204	-4.87	1.9636	14.27	0.1982	1.13
ILNXFEM	0.1337	0.73	1.0701	2.93	-0.4162	-1.71	-0.1414	-0.43
ILNXSIZE	0.0874	1.12	-0.4081	-2.25	-0.8870	-8.05	-0.5183	-3.40
ILNXSQ	-0.0824	-0.41	-1.8141	-4.20	-2.2497	-8.11	3.2790	8.92
LNRELX	-0.2898	-1.26	0.3198	0.68	0.2913	0.89	-0.0704	-0.16
LNP9	1.1900	1.85	6.3566	4.36	-4.6704	-3.24	0.8933	0.46

The estimator is the best unbiased linear transformation of the unrestricted estimator. Naturally we find that efficiency of estimators is increased as compared to the unrestricted case. In the following we give descriptive statistics for our predictions of the expenditure shares using estimators that have the both above restrictions imposed.

Table 9.4. Descriptive statistics for predictions.

Variable	Mean	Std Dev	Minimum	Maximum
FNW_1	0.3774	0.0974	0.087	0.716
FNW_3	0.1027	0.0239	0.007	0.198
FNW_4	0.0660	0.0293	0.000	0.155
FNW_5	0.0496	0.0078	0.011	0.088
FNW_6	0.0375	0.0107	0.006	0.074
FNW_7	0.1607	0.0534	0.000	0.313
FNW_8	0.0963	0.0257	0.000	0.172
FNW_9	0.1098	0.0452	0.000	0.300

9.3 Price and expenditure elasticities

Similarly as before we calculate the elasticities for aggregate market demand for the survey years 1966-1990 considering now the non-durable component in our eight remaining categories after dropping the category, W_2 Tobacco and Beverages. Note also that the total real expenditure and all related variables have been modified accordingly to represent how the present form of this variable is distributed among the eight consumption categories. The elasticities for individual households can be calculated using the formulae given in the previous chapter (8.5),-(8.8).

The estimates of aggregate elasticities are given in Appendix 6. To start at bottom with expenditure elasticities we find in the elasticities of market demand immediately some the effects of aggregation and the adopted functional form, see Tables A6.1.i-vi. Recall that in aggregating the individual elasticities are weighted in such manner that one will observe a kind of 'regression toward' one phenomenon. In addition, holding other variables constant (this is only an approximation) one should find expenditure elasticities that gradually get closer to one in those categories with aggregate share increasing (expenditure elasticity more than one or a favourable change in demographics). These features are clearly observable in Table A6.1.i-vi. In Figure 9.1 we show the evolution of aggregate elasticities over the 24 year time period. We pick up the aggregate expenditure elasticities in 1990 in Table 9.5.

Figure 9.1. Budget shares in 1966–90

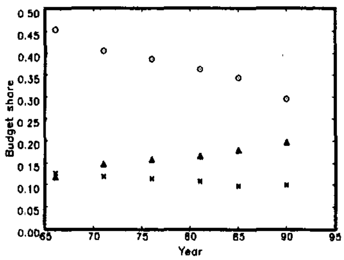


Figure 9.1. Budget shares in 1966–90

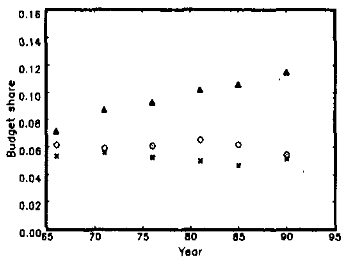


Figure 9.1. Budget shares in 1966–90

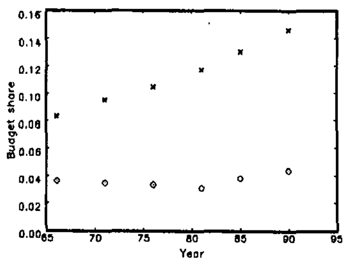


Figure 9.1. Price elasticities in 1966–90

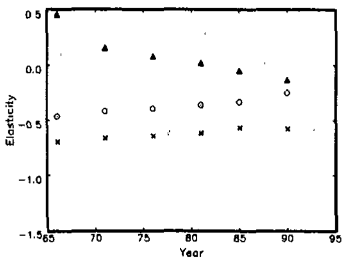


Figure 9.1. Price elasticities in 1966–90

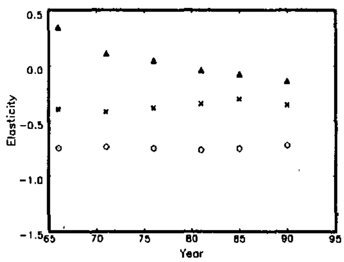


Figure 9.1. Price elasticities in 1966–90

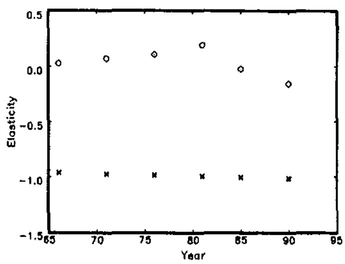


Figure 9.1. Compensated elasticities in 1966–9C

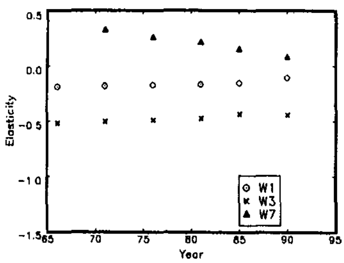


Figure 9.1. Compensated elasticities in 1966–9C

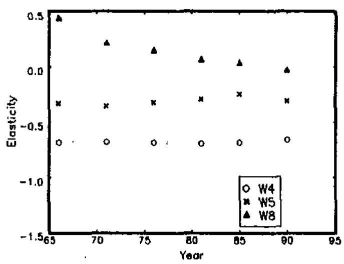


Figure 9.1. Compensated elasticities in 1966–9C

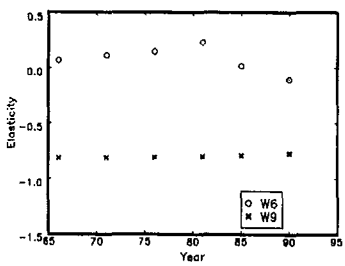


Figure 9.1. Expenditure elasticities in 1966–90

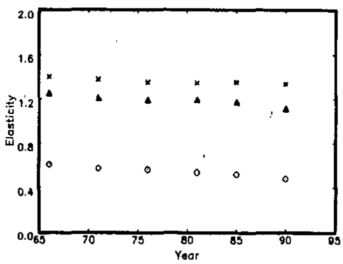


Figure 9.1. Expenditure elasticities in 1966–90

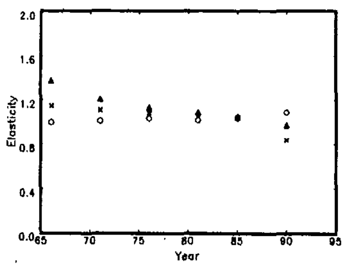


Figure 9.1. Expenditure elasticities in 1966–90

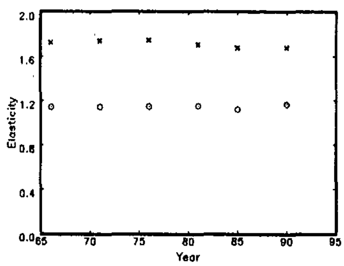


Figure 9.1. Relative exp. elasticities in 1966–90

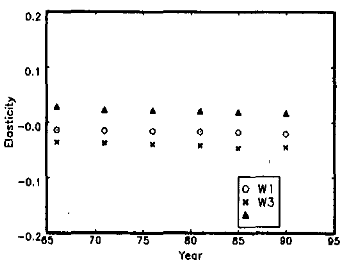


Figure 9.1. Relative exp. elasticities in 1966–90

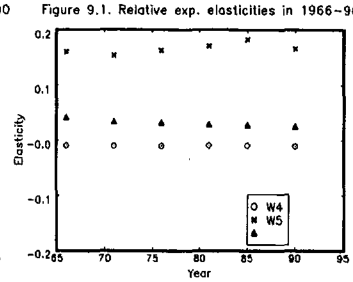


Figure 9.1. Relative exp. elasticities in 1966–90

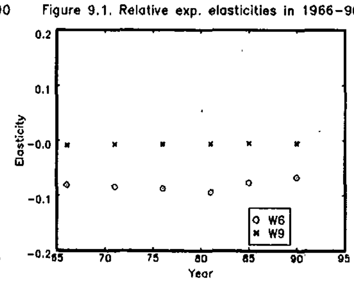


Table 9.5. Expenditure elasticities in 1990, nondurables.

Variable	Aggregate Share	Expenditure elasticities Direct	Relative
NW_1	0.295	0.479	-0.020
NW_3	0.100	1.335	-0.045
NW_4	0.054	1.087	-0.011
NW_5	0.051	0.837	0.166
NW_6	0.044	1.163	-0.066
NW_7	0.195	1.110	0.016
NW_8	0.114	0.964	0.025
NW_9	0.146	1.681	-0.005

If nondurable consumption is considered on the aggregate level the categories, NW_3 Clothing and Footwear, and NW_9 the residual category are clear luxuries. Here the expenditure elasticity in the former category NW_3 has been increased markedly if compared with the value obtained in Chapter 8 but stays at about the same level in the latter category. Contrary to the earlier analysis dropping rental costs and rent equivalents of owner-occupied housing substantially lowers the expenditure elasticity in category NW_4 which now consists of expenditure on (housing related) Energy. On the other hand, the category Food remains as a necessity with all other categories having elasticities about one. If the expenditure elasticities are compared with those in Chapter 8 one notices a marked increase in the expenditure elasticity in the category NW_7, Transport and Communication which is now a luxury having expenditure elasticity significantly above one on the aggregate level (Table 9.3). However, the actual numerical value is not too far above one. This is still somewhat less than in previous studies on non-durable consumption allocation in Finland, see Riihelä and Sullström [1993] and Sullström [1995].[2] In the remaining categories we find only minor changes.

Similarly, as discussed in Chapter 8 the conventional expenditure variables take account of gradual improvement of living standards over time but do not account those changes that result from climbing up (or down) the social ladder. Considering the estimates for the relative expenditure parameters one observes that these are now statistically significant only in the category, NW_5 Household Appliances (Table 9.3). The corresponding value is positive giving an estimate for relative expenditure elasticity of 0.17 in 1990.[3] Similar findings considering the present category were made in Chapter 8. Interpreted as before it indicates that this category may have some use as conspicuous

[2]It should be noted here that the latter study gives additionally a rather detailed and extensive analysis on the allocation of expenditures among four subcategories in the more comprehensive category of commodities W_7.

[3]Note that the uncertainty concerning the 'true' value of real total expenditure is incorporated in our EQML estimation method and particularly into the calculation of the standard errors of the estimators of those coefficients that are related to the fitted values. This is particularly important in order to prevent too hasty conclusions that would be made if the analysis would be conducted considering the smoothed values as fixed in repeated sampling.

consumption in the sense of Veblen [1899].

We are delighted to see that now when non-durable consumption is considered the relative expenditure variable is on the whole quite useless if statistical significance is at issue. This is what one would a priori expect and it gives more credence to the our interpretation of the auxiliary variable. On the other hand, one would expect that particularly the consumption of durable goods should involve distributional considerations. However, durable goods are intimately related to the demand for leisure, and the consumption, savings decision. Therefore, some of the consequences of this relationship should show up when analysis of non-durables is compared with the analysis in Chapter 8.

Table 9.6. Price elasticities in 1990, nondurables.

	Price							
Variable	LNP_1	LNP_3	LNP_4	LNP_5	LNP_6	LNP_7	LNP_8	LNP_9
Uncompensated price elasticities								
NW_1	-0.249	-0.059	0.125	-0.050	0.012	-0.087	-0.107	-0.065
NW_3	-0.432	-0.576	0.327	-0.269	-0.062	-0.502	-0.215	0.395
NW_4	0.494	0.625	-0.722	0.781	-0.000	-0.649	-0.624	-0.991
NW_5	-0.383	-0.474	0.839	-0.353	0.192	-1.831	0.979	0.195
NW_6	-0.124	-0.124	-0.007	0.209	-0.154	-0.705	-0.513	0.255
NW_7	-0.314	-0.234	-0.182	-0.495	-0.156	-0.138	0.097	0.312
NW_8	-0.418	-0.152	-0.290	0.433	-0.187	0.194	-0.141	-0.403
NW_9	-0.488	0.234	-0.401	0.027	0.053	0.307	-0.397	-1.016
Compensated price elasticities								
NW_1	-0.107	-0.012	0.151	-0.025	0.033	0.007	-0.052	0.005
NW_3	-0.038	-0.443	0.400	-0.201	-0.004	-0.241	-0.062	0.590
NW_4	0.815	0.733	-0.663	0.836	0.047	-0.437	-0.499	-0.832
NW_5	-0.136	-0.391	0.885	-0.310	0.228	-1.668	1.074	0.318
NW_6	0.219	-0.008	0.057	0.269	-0.103	-0.477	-0.380	0.425
NW_7	0.013	-0.123	-0.121	-0.438	-0.108	0.079	0.223	0.475
NW_8	-0.133	-0.056	-0.238	0.483	-0.145	0.383	-0.031	-0.262
NW_9	0.008	0.401	-0.310	0.114	0.126	0.636	-0.205	-0.770

Next we discuss the estimated price elasticities of demand. If the compensated cross-price elasticities are considered, the off-diagonal elements in the matrix given in Table 9.6, are negative when the good shown in the column is a complement to the category given by the row of the matrix. The substitutes are found similarly, looking up the positive numbers. For instance Clothing and Footwear, Household Appliances, and Education and Entertainment were found to be complements for Food (Tables 9.6) and all other categories present substitutes for the category Food, similarly as in Chapter 8.

Considering the uncompensated own price elasticities we find by direct examination that in 1990 we have all with the correct, negative signs (Table 9.6). The elasticities are rather low with only one not being inelastic (W_9) but in most cases they are larger in absolute value than the ones with the durables included. However, aggregation of commodities within categories in also here responsible for the relatively low substitution possibilities observed. The demand for the residual category, NW_9 is now the most responsive to price changes with the own-price elasticity about minus one in 1990.

Turning to compensated elasticities we have only one category with the aggregate estimate having theoretically unexpected sign which is NW_7 Transport and Communication implying an upward sloping aggregate demand curve. Earlier the sign was negative. The three culprits found in Chapter 8 have the signs reversed.[4] We have earlier found a value of the expenditure elasticity that was unexpectedly low in this category. Comparing with the earlier estimates when durables were included one finds that the category NW_3, Clothing and Footwear is estimated more price elastic than before. In addition the residual category seems elastic if compared to the other categories. Earlier the sing was not even theoretically correct. The category consists of a mixed lot of commodities so the instability in the estimates comes as no surprise if one in addition recalls that leaving out the durable subcategories somewhat reforms the nature of commodities included in the category (Section 3.2.1). On the other hand, the category NW_8 Education and Entertainment has now the value of the compensated own price elasticity quite near zero. On the whole the picture is now much brighter but we still have one dark cloud looming in the sky and preventing us from calculating the underlying expenditure function defining rational expenditure minimizing behaviour and assessing reforms in indirect taxation on household level.

Table 9.7 provides the 'Slutsky matrix related to aggregate consumption' in 1990. Note that the matrix is an artifact since in fact the conditions for exact aggregation are not met in the model we use.[5] The reason for this is that the chosen form of the quadratic model is integrable only within those household groups which have an equal slope of the Engel curve (not accounting for the second order term), i.e. when the interaction variables with total expenditure have a constant value. Therefore the matrix is not symmetric although we have calculated the Slutsky matrices as to make them symmetric at the individual level. The matrix that we obtain does not, however, differ very much from a symmetric matrix. One might say that demand aggregates 'almost exactly'. On the other hand, the Slutsky-matrix is not negative semidefinite since one of the compensated elasticities was earlier found out to be positive. In fact, the matrix has two positive eigenvalues instead of the one already produced by the positive element on the diagonal.

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[4] Recall that in the previous chapter the category W_6 was the only one to be deemed having the positive value as 'statistically significant.'

[5] Compensation has meaning at the aggregate level only if the demand equations aggregate exactly which means that therere exists a 'socially representable consumer' having a neoclassical preference ordering and generating the aggregate demand.

Table 9.7. Slutsky-matrix of aggregate consumption, in 1990.

Variable	Price LNP_1	LNP_3	LNP_4	LNP_5	LNP_6	LNP_7	LNP_8	LNP_9
NW_1	-0.032	-0.003	0.045	-0.007	0.010	0.002	-0.015	0.002
NW_3	-0.004	-0.044	0.040	-0.020	-0.000	-0.024	-0.006	0.059
NW_4	0.044	0.040	-0.036	0.045	0.003	-0.024	-0.027	-0.045
NW_5	-0.007	-0.020	0.045	-0.016	0.012	-0.086	0.055	0.016
NW_6	0.010	-0.000	0.002	0.012	-0.005	-0.021	-0.017	0.019
NW_7	0.003	-0.024	-0.024	-0.086	-0.021	0.015	0.044	0.093
NW_8	-0.015	-0.006	-0.027	0.055	-0.017	0.044	-0.004	-0.030
NW_9	0.001	0.059	-0.045	0.017	0.018	0.093	-0.030	-0.113

To conclude we present some comparisons of elasticities which have been obtained using similar data sets in the United Kingdom and some recent studies in Finland where the second author has participated.

Table 9.8. Comparison of elasticities in some categories.

Study	Expenditure elasticities			Compensated own price elasticities		
	NW_1	NW_3	NW_7	NW_1	NW_3	NW_7
Blundell et.al. [1993]	0.608	0.917	1.201	-0.354	-0.526	-0.483
Baker et.al. [1990]	0.435	1.033	1.746	-0.737	-0.942	-0.956
Browning Meghir [1991]	0.45	1.42	1.32	0.04	-0.82	-0.84
Riihelä Sullström [1993]	0.432	1.460	1.390	-0.414	-1.024	-1.270
Sullström [1995]	0.260	1.551	1.294	-0.234	-0.226	0.007
This study	0.479	1.335	1.110	-0.107	-0.443	0.079

In comparing the studies it should be noted that the first four rows correspond to elasticities that are calculated at mean values of the explanatory variables and are not directly comparable to the those given in the bottom rows which have been calculated for aggregate demand in 1990. The break-up of consumption into component categories have been made on a different basis in studies on the United Kingdom data.[6] The study by Riihelä and Sullström [1993] is based on Finnish data up to 1985 and Sullström [1995] uses the same data as here with an equal number of component categories. Differences between the present and the last mentioned studies are accounted by using a slightly different set of explanatory variables. Recall also the definition of relative expenditure

[6]They generally employ seven categories of consumption: Food, Alcohol, Fuel, Clothing, Transport, Services, and Other Goods.

elasticity which is used in the present study. Similarly, the estimation methods differ with EQML taking account of the heteroskedasticity in te present study and 2SLS in Sullström [1995]. The endogenous right hand side variables are also treated differently in these studies.

There are also some differences in actual calculation of compensated own price elasticities. The earlier study by Sullström [1993] does not take into account of the $A(q)$ term in real expenditure variables and can be seen referring to a elasticity which is compensated w.r.t. the real income and not utility as in the present study, compare (4.14) with (8.7). The former calculations produce values that are consistently lower than those obtained by the latter formula in the case of normal goods. Which is the more accurate one, if one considers the bias inherent to using the Stone price index in lieu of the using the theoretically correct index $A(q)$, in a non-linear model (4.35) is an open question in QAIDS. However, we have been able to give some arguments for the former method as having a less severe inherent bias in the ordinary AIDS-model, Section 4.1.[7]

If the Finnish studies are compared one notes that more marked differences are found in the expenditure elasticities of NW_3, Clothing and Footwear, and NW_7 Transport and Communication, with the present ones being lower than those obtained earlier. The own price substitution elasticity for Food has presently a value which is closer to zero, see the above remarks. On the other hand, NW_3 Clothing and Footwear has been earlier estimated less elastic w.r.t. own price.

[7]Both studies utilize the 'linearized version' of QAIDS (4.11) not accounting for the term $B_2(q)$ in the calculations. In contrast, the full nonlinear equation (4.6) suggests that the slope terms β_{1k} that we let vary w.r.t. the household composition should be integrated to the second order coefficients. We have to wait for an improved analysis which utilizes a version of the model fully incorporating the nonlinearities to provide more definite answers and hopefully results that conform better with the 'theory'.

Chapter 10

Conclusion

Modern approaches to the econometric analysis of the structure of household consumption adopt a representation of preferences which is flexible in the sense that it can be seen as to present a second order approximation in relative prices for the expenditure or indirect utility functions. The empirical advantage of using this type of representation for functional form is that untenable restrictions on behaviour are avoided. In effect the elasticities are measured not assumed. The model QAIDS that we use provides a flexible framework in which to explore the evolution of consumer demand. The Engel curve which relates the expenditure share of an individual consumption category to the total consumer outlay has additional flexibility in the form of allowing a second order real expenditure term and is a quadratic extension of the function presented by Working [1943]. The functional form is derived as a quadratic extension of the Almost Ideal Demand System, (AIDS) originally introduced by Deaton and Muellbauer [1980a], where consumption structure is represented by a system of equations in budget share form.

The data of the study are drawn from six cross-section surveys made in Finland in 1966, 1971, 1976, 1981, 1985, 1990, having 33420 observations in all. In many respects our work builds on the U.K. tradition which spans through several decades starting from the monumental study by Stone [1954a] and [1954b].

An appealing feature of economic research in household behaviour is the close and intimate relationship between theoretical specification and appropriate estimation technique. This is most apparent when empirical analysis takes place at the micro level. Analysis of household budgets presents an area where important advances have been made in the econometric methodology.

The econometric tools that we have used in the study introduce some novel aspects that may have added methodological interest. Allocation models are customarily estimated using Zellner's [1962] Seemingly Unrelated Regressions (SURE) model. This assumes that the covariance structure across individual equations is homoskedastic. Particularly when using microdata homoskedasticity is a untenable assumption resulting in inefficient estimators and distorted statistical inference procedures. In contrast, heteroskedasticity is unavoidable in efficient consumption share equation estimation as shown for example through the consistent stochastic specification by Chavas and Segerson [1987]. Random individually varying coefficients models produce covariance structures that fall into the heteroskedastic framework.

We introduce an econometric model and an estimation method which accommodates parametric heteroskedasticity in a single equation Estimated Quasi Maximum Likelihood (EQML). First, the heteroskedasticity in the model disturbance terms is modelled in a simple and economical but simultaneously in a relatively powerful way by connecting the fit of the budget share equation and the corresponding variance of the error by a functional relationship that is governed by a single estimable parameter per equation. One may motivate the specific functional form as arising from an approximation at the mean of a stochastic parameter model. Similarly, we account for some survey specific features in the sampling framework and methods used in collecting the actual data by estimating a variance parameter separately for each survey. The procedure has a natural counterpart in the ordinary random effect approach to modelling proper panel data. Under some specific assumptions we have been able to evaluate efficiency gain of using the heteroscedastic vis-a-vis a homoskedastic single equation model and it turned out that these gains are substantial in our data.

Second, an important econometric problem concerns the error-free measurement of the various components of consumption. In particular, total consumption expenditure should correspond to the theoretical concept which is exogenous to the allocation decision rather than to the error-prone actual expenditure measure which reflects the relatively short bookkeeping periods used in collecting the actual data. This point has been argued already by Summers [1959] and is likely to be particularly important in cross-section work where occasional large purchases affect "both sides of the Engel curve", Deaton [1986].

To account for data imperfections encountered in collecting the consumption data the statistical-econometric sampling model of the data treats nominal total expenditure similarly as in an 'errors-in-variables' problem and solves the estimation problem by incorporating the use of preliminary fits on the right hand variables in a novel way. Here we have utilized a two stage estimation procedure where a preliminary fit by instruments is used to project the error-prone variable on a linear subspace spanned by the instruments. In effect the total expenditure is replaced by a conditional expectation and the expectation should be taken in relation to a set of predetermined variables that households use to forecast the future values that affect the consumption decision in a dynamic life-cycle framework, see Bierens and Pott-Buter [1989]. These variables should account for wealth variables not neglecting human wealth variables, and conditions in the labour and financial markets.

Our method has some similarities with Blundell et. al. [1993] but for the above reasons we prefer to use a richer set of instruments and non-linear forms in the parameters and variables together with time varying parameters for each survey. At the second stage of our two-stage estimation procedure all variables that are functions of total real expenditure are replaced by the conditional expectations in contrast to having separate treatment by instrumental variables, as conventionally done. The modifications involve several aspects in the model, for example treatment of nonlinear transformations in conditional expectations. Here we make use of the properties of the conditional expectation and the distributional properties of the parameter estimates obtained at the initial stage. This is done to take into account that we are substituting preliminary estimates for the error-ridden, endogenous explanatory variables rather than the true conditional expectations. Zellner [1970] proposed a similar estimation method which utilizes information on the specification for theoretical variables in structural estimation of the model. In our EQML-method this is done by modifying the error terms in the model correspondingly and making the necessary modifications in the variance of an augmented disturbance. The quasi likelihood function that we obtain is maximized to obtain estimators for the structural parameters of the model.

The covariances of those variables estimated at the initial stage are utilized at the final stage to guarantee correct inferences in the model. In addition, we have used the functional relationship between our endogenous explanatory variables to get compensating efficiency gains at the second stage of estimation.

To give a comprehensive picture of how the structure of consumption evolved during the time period 1966-1990 we have included purchases of durables and housing costs within the nine consumption categories that we study. In the 24 year time period covered by our data labour moved from rural to urban areas, and the after-war baby boom generation have grown from youth to middle-aged with a simultaneous reduction in the average family size. These major influences as well as the impact on the individual living standards brought along massive changes in the Finnish society. While the focus in analysing the change has often been on the supply side and the key areas of economic activity as the labour and financial markets and on aggregate demand, many shifts have occurred in the composition of demand. These changes took place as incomes increased, relative prices changed and the age structure and family composition was reformed, and new goods and services were introduced.

We utilize a wide variety of explanatory variables that allow for the budget share equations to depend on other predetermined explanatory factors than just price and total expenditure. These covariates take account of the demographic characteristics: geographic location of households, the age and gender of household head, and factors related to household composition, household size, the number of children and old-aged persons. We feel that our methods of analysis provide insight into the evolution of consumption structure over the years 1966-1990.

For these purposes we have introduced two auxiliary variables, not commonly met in similar studies. The first variable is introduced to capture some cohort effects in slowly changing consumer environment where new commodities are introduced and habits and preferences evolve. The variable that we have used is the logarithm of the household head in a given year. This variable allows for a slowing creeping effect with respect to the survey years. On the other hand, using only the calender age at the time of the survey neglects the gradual overturn of population, and having in the sample people that are observed to be same age but in fact have been grown up and moulded in widely differing economic and social environments. The basic explanatory variables include logarithmic age of household head and a quadratic term in the variable. Since the natural range of the age variable is bounded then taken together these variables allow for the effect of age to be quite flexible, either monotonously decreasing or increasing, or to have the shape of either a well or a hump.

Although it may be tempting to assign differences that we observed to tastes and preferences there remains a possibility that omitted variables were influencing the results that we observe. One notable variable is household wealth. Differences in the quality of human capital across cohorts should not be overlooked either.

The principal mission is to give an analytical study of the evolution of the age and income profiles in consumption and their effects on the structure of consumption. The evolution of the Engel curves and the age profiles in consumption over the sample period 1966-1990 are examined by estimating and reporting the results on a series of models with varying degrees of parsimony. This approach is selected in order to find out which effects conveniently summarize the data without setting unreasonable restrictions on the fit. Here we have found out that diagnostic methods have to be used in a liberal and relaxed manner to avoid from producing by far too complicated models. The model that has no survey dummies but utilizes a full set of price variables does not set undue restrictions on the data and simultaneously conveniently summarizes their most salient features. It provides a parsimonious model although the data rejects it by formal tests. On the other hand, it is natural that one cannot have high hopes to estimate sensible own price elasticities using data from a single survey. It is a near futile exercise. But the study gives a very useful warning of the hazards involved in trying to estimate the Engel curves in consumption and other parameters that are in principle identifiable by variation within surveys on the basis of individual cross sections of the data. We feel that the number of surveys that we have available (six) is quite near the minimum needed to do any sensible analysis.[1]

Because we have so many complicating covariates it is clear that elasticity calculations and examination of results should be done in a multivariate framework. In comparing the Engel curves and the age profiles in consumption obtained by using the different models we resort mainly to graphical methods. The quadratic term in total real expenditure was found to have a moderating and counterbalancing effect in the Engel curve if compared with the coefficient of the ordinary real expenditure variable. Two categories of consumption, Clothing, and Education and Entertainment, were found to represent luxuries at low levels of real expenditure but necessities at higher levels of total expenditure to reflect the increased scope for substitution as the spectrum in consumption possibilities available to the consumer is widened. As people get older those component categories which are connected to consumption activities that take mainly place at home get more important, a prime example being Housind and (related) Energy. On the other hand, the share is decreased in the categories, Clothing, Transportation and Communication, and Education and Entertainment. Physical factors give a reasonable explanation why we observed a declining share in the category Beverages and Tobacco, and an increasing one in Health Care.

The gradual ageing of population and improvement in the living standards have effects

[1]The possibilities for empirical work are far better in the United Kingdom where they currently can utilize data from about twenty surveys.

which sometimes operate in opposite directions. The categories, Food, and Health Care, represent necessities while the age profile in consumption is upwards sloping w.r.t. the age variable. To augment the examination we have presented some material on the cohort and life-cycle effects on consumption by supplementary figures which present comparisons of the total, 'marginal effect' if the ageing of the households is accounted for in the surveys. We have labelled the figures as life-cycle profiles since in calculating the profiles we make predictions of all the other variables on the basis of the age variables that we allow to vary over the natural range of values. The age profiles of consumption that we have discussed earlier can be interpreted as representing ceteris paribus effects, i.e. in calculating them we hold other than age variables affecting the curves constant. In practice if we observe a typical household all through its lifecycle we see changes in other variables too. Children are born into the family, they age and finally leave to start their own independent life as consumers. The income available to a household typically increase at first and finally may have a down-turn at old age. Simultaneously, over time there is economic growth present which is reflected in higher living standards and higher levels in total consumption.

In the study we have examined the cohort path of typical households across the age profiles in individual surveys while the life-cycle profiles have been calculated to show the total effect of ageing. In the categories, Food, and Health Care, the life-cycle profiles are increasing with age but the income effects which operate in the opposite direction are much stronger. Tracking the cohort path over the survey period as people age one finds that the income (and other) effects have made households to decrease their share while they have grown older. The opposite holds for the category Education and Entertainment. Here the life-cycle profiles are downwards sloping but changes in other variables over the sample period make the cohort path to be an increasing one. In the categories, Clothing, and Housing and (related) Energy, the life-cycle effects and time evolution in other factors strenghten each other. Interestingly enough, although the life-cycle profiles are decreasing quite rapidly in the category, Transport and Communication, other favorable developments in the survey period make the cohort paths to be horizontal. Individual households have been able to maintain a relatively constant budget share even while they are 24 years older in 1990 than in 1966.

In addition, we have examined the effects of household composition. The gender of the household head has considerable influence on the consumption structure. If the head is a female it implies on the whole similar movements in the structure, as ageing does but we could not find any similarities with the income effects. The categories, Housing, and Household Appliances (Furniture), are found to be luxury items of consumption if household size is considered. In the same fashion, they represent luxuries w.r.t. total expenditure in the typical range of values. The same observation holds for Education and Entertainment but in the more recent surveys households with children seem to have elevated budget shares. Similarly, Food is a necessity both w.r.t. the household size and total expenditure. The category, Beverages and Tobacco, seems to have less substitution possibilities for children's goods, since only single males have higher budget shares than households with children. In addition, activities that take place outside home seem to be preferred by households having a single young member. In contrast, in those activities taking place mostly at home one finds both economies of scale w.r.t. the household size and more preference by older persons.

Geographic location of households has influences on the consumption structure that can be interpreted to be caused by colder weather in the more northern parts of the country (Housing and Clothing), or the needs to communicate over wider areas (Transport and Communication) in the countryside and other less densely populated areas. There are also other covariates that were observed to affect the structure of consumption. In particular, we found out that the indicators which we use to proxy for human and real capital, and indicators of labour supply variables enter the budget share equations. This suggests that separability of leisure and consumption does not necessarily hold, and additionally wealth and intertemporal decisions may affect the current allocation among the component categories of consumption. The finding is robust in relation to the inclusion of durables (and housing costs) in the component categories, and in accordance with the results by Browning ang Meghir [1991]. The corresponding decisions are treated as predetermined in the study and the budget share equations reflecting the current allocation have been conditioned on them, hopefully conforming to the causal ordering in the variables.

In the last part of the study we have examined the elasticities of demand. Here we have used models which are more constructive for the purpose of estimating the elasticities of demand. Because the induced disturbances at the second stage of estimation have a relatively complicated structure we chose to use an EQML method to estimate the parameters separately for each equation. Therefore, one cannot directly impose parameter restrictions across equations as would be needed in testing for symmetry in the price parameters as required by a model that is based on utility maximizing behaviour on the part of the household. Furthermore, the adding-up constraints of the model parameters are not necessarily valid at the estimates that we obtain by using a statistical model for heteroskedasticity. However, we have been able to use a Waldian test for these restrictions using the unrestricted form of model as the base line. Similarly, we have proposed a linear function of the unrestricted estimators which satisfies the above constraints. The corresponding estimator is the *best unbiased linear transformation* of the unrestricted estimators in the sense that it has under the null hypothesis the smallest asymptotic covariance matrix in the set of estimators that are linear functions of the unrestricted estimators and satisfy the linear constraints.

In the study we have reported expenditure and price elasticities for the nine categories that include housing expenditure and purchases of durables to give a complete picture how the structure of consumption evolved during the time period we cover 1966-1990. The results were compared with the descriptive measures that we have obtained for elasticities using time series data.

The elasticities for our second auxiliary variable may have some interest. The variable is used to examine and test our model for an early and interesting 'relative income hypothesis' in consumption behaviour which was originally put forth by Duesenberry [1949], related ideas have been propagated also by Veblen [1899]. The hypothesis suggests that a consumer's consumption habits should reflect his (or her) social reference group. When that individual's income fall below the comparison level, he feels relatively deprived. The relative deprivation theory which is a common theme in psychological and sociological literature has not made much impact into the economic literature. Alternative interpretations to the above phenomenon might involve the concept of positional goods, i.e. goods whose consumption is dependent on the consumer's position in the income distribution rather than on his actual income level.

To explore these ideas we have included a positional, 'relative expenditure' variable into the model. The variable measures the distance of the household from the median consumer. The median is estimated using the population mean of logarithmic total expenditure adjusted for the size of household. The variables are based on instrumented values and the mean is calculated separately for each survey. We have made an assumption that if the position of a household in the income distribution is unchanged the coefficient of the positional variable does not enter the calculations of the conventional expenditure elasticity. It is treated as an indexing variable and equally as any other similar variable, for example household composition and size. In contrast, it accounts for those changes in consumption that result from climbing up (or down) the social ladder while the conventional expenditure variables give the effects of the gradual improvement in living standards.

We found that if durables and housing costs are included in the data, the categories, Housing and (related) Energy, Household Appliances, and Transport and Communication have significant coefficients and positive elasticities w.r.t. 'relative expenditure' indicating that they may be used for signalling, or show-off purposes. Education and Entertainment and the residual category, Other Goods, have correspondingly negative coefficients. In the other categories the variable was found to have neither any numerical nor statistical significance to the model. When durables and housing costs are left out we noticed that the coefficient is significant and positive only in the category Household Appliances, in the other categories it is no longer significant, giving more credence to our interpretation of the auxiliary variable.

We fully recognise that consumption of durable goods exhibits different patterns from consumption of nondurables and services and their inclusion may be detrimental to obtaining price coefficients that properly characterize the current allocation. For these reasons we presented supplementary estimates for the elasticities at the aggregate level that have been obtained by not including durables. At the same time the somewhat troublesome category Beverages and Tobacco is left out since here some addictive behaviour may be present. We have observed that the 'compensated own price elasticities' have the correct, negative sign in all categories but Transport and Communication where it is slightly above zero (but not significant) if calculated at the aggregate level in 1990. The estimated compensated price elasticies are quite low in absolute value reflecting the modest substitution possibilities between the commodities when broad categories of consumption are considered at the aggregate level. Food was found out have the lowest value of expenditure elasticity and Clothing the largest if one does not consider the residual category, Other Goods which has a very mixed composition and has been found to have unstable coefficients in the survey data.

Overall our results are encouraging if one is more inclined to verify rather than falsify the neoclassical mode of household behaviour although they exhibit some of the problems encountered in the estimation of allocation systems. These are often seen when time series data are used. Symmetry and negativity of the Slutsky matrix are not confirmed by the data. Considering the problems in our data, the small number of surveys available, and the wide time period we had to cover the basic outcome is not unreasonable.

To put our results in a perspective recall what Deaton [1974] writes in his Frisch-prize winning paper (p. 341) 'Unlike most previous work, and in spite of some anomalous results, the United Kingdom experience seems broadly consistent with neoclassical demand theory'. Although tests of homogeneity and of homogeneity and symmetry jointly indicate rejection at the five per cent significance level and one of the eigenvalues of estimated matrix of substitution effects is positive. In these aspects our results are quite similar although here the micro data manage to beat the significance levels by huge orders of magnitude, the reader can actually choose any level he desires. The power of test is naturally depending on efficiency in estimation and the number of observations available (in our case 33 420).

The implications of our study for work on aggregate data are clear. Even ignoring the interaction of total expenditure variable with the other variables and the second order term, the aggregate models exclude many important explanatory factors. Therefore, particular care should be taken in interpreting estimated demand elasticities and tests of theory restrictions based on them using aggregate data. Comparisons of estimates either across differing time periods or even across countries are not on consistent basis.

There exists conditions under which the macro equations consistently estimate the price responses of demand, see Stoker [1984]. Examination of micro data has shown that these conditions are rarely met in the data Browning [1987], and Blundell et.al. [1993]. The micro model contains evolving demographic characteristics that show up in the aggregate level as the average size of demographic groups. If these characteristic are slowly changing it may well be captured by a stochastic trend component which shows up as autocorrelation or misspecified dynamics. Our descriptive examination of the Finnish time series data seems to confirm this. Estimation of parameters may be biased unless this is accounted for. When the specific distributional conditions, see Stoker [1984], are not met it is possible that demand equations based on aggregate data will be inhomogeneous without the presence of money illusion. Furthermore, symmetry conditions hold only under very restrictive assumptions, not met in our data.

Simultaneity of demand with the price variables has often argued to be a possible source of biased estimation. In extreme cases the interaction of demand and supply may be at the aggregate level such that quantity consumed becomes predetermined and the price becomes the endogenous variable. Especially the older literature was concerned with this. Simultaneity is considerably lessened if micro data is used but contrary to some opposite views in the literature the bias is not altogether avoidable. It is true that price variables are independent of the consumption of individual households. But if the sample is a representable one of the total population then prices cannot be independent of aggregated values of demand. Therefore the individual errors in the data should have a common error component which survives the summation over the sample. Unfortunately properties of estimators are also crucially dependent of the errors summed over the sample.

The models developed in this study and the empirical estimation results have an immediate application if say one needs to asses future changes in the allocation among the component categories of consumption that are due to predictable changes in economic growth, and in demography such as ageing of population.

We consider that our modelling strategy provides a steady platform to build on the experience accumulated so far. The results presented on the allocation of non-durable consumption can be used to develop analysis to the direction which we feel is the more interesting one to consider.

In follow-up studies we take a direct welfare analytic approach to aim at the distant goal to examine the effects due to a comprehensive tax reform which imply changes both in the indirect and direct (labour) taxation and subsidies given to households. Our system of demand functions (QAIDS) is based on a functional relationship for the expenditure function which allows for a theoretically consistent way of evaluating tax-reforms by a direct calculation of the welfare-based efficiency measures, for example equivalent variation, see King [1983], Baker et.al. [1990], and Suoniemi [1994], and obtaining confidence intervals for them. Our research interests include estimating and studying 'equivalence scale measures' to correct for differences in household size and composition when welfare of different households are being compared. A similar yardstick is often needed to adjust poverty lines or welfare cash transfers for differences in the needs of households having varying size and composition. In the process we plan to present a more advanced version of the model which corresponds more closely to the theoretical considerations by abandoning the linear approximation and using the formulation of the model which is nonlinear in the parameters and incorporates the mutual restrictions in the coefficients of the real expenditure variables. The analysis that is given by Pashardes [1993] and which we have developed in this study suggests that the bias inherent in using the Stone price index may have lifted the compensated elasticities to the direction which is unproductive for obtaining 'theoretically decent' values. This opens up an interesting research avenue giving us some room to manoeuvre and may even offer an escape route to explore.

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A.1 Appendix 1

The Figure A1.1 provides a description of the evolution in the budget shares and relative prices ('1938'=1.000) in eight component categories of consumption: (2) Beverages and Tobacco, (3) Clothing and Footwear, (4) Housing and (related) Energy, (5) Household Appliances, (6) Health Care, (7) Transport and Communication, (8) Education and Entertainment, and the residual category (9) Other Goods (and services).

The time series variables are up to the year 1948 constructed by Laurila. Since then they are based on the System of National Accounts (SNA), and starting with 1960 on the new SNA. The price indices are obtained as the implicit deflators which are formed by diving each expenditure series, measured in current prices by the corresponding one, in fixed prices.

The 'expenditure and price elasticities' give at most an analytic description of the time series data. They are obtained by fitting a simple loglinear filter on the consumption data over the period 1900-1990, considering each component category separately. The smoothing operator is based on a traditional functional form that conveniently produces the elasticities directly as the estimated parameters. The parameters are continuously updated in the fitting process referring to a constant term and the price and expenditure variables. They are obtained by estimating the simple loglinear function by the method of weighted least squares repeatedly with a moving window of observations. The window is centred on the particular (pivot) observation we consider and the pivot observation and the window are moving through the whole time range. The weight function is based on the density function of the normal distribution which is centred on the pivot (Chapter 2).

The smoothing implicit in the panels for the elasticities is done by both including all the observations and also by omitting the war years in 1917-1919 and 1938-1945 (the dotted lines).

Figure A1.1. Consumer demand in 1900-1990.

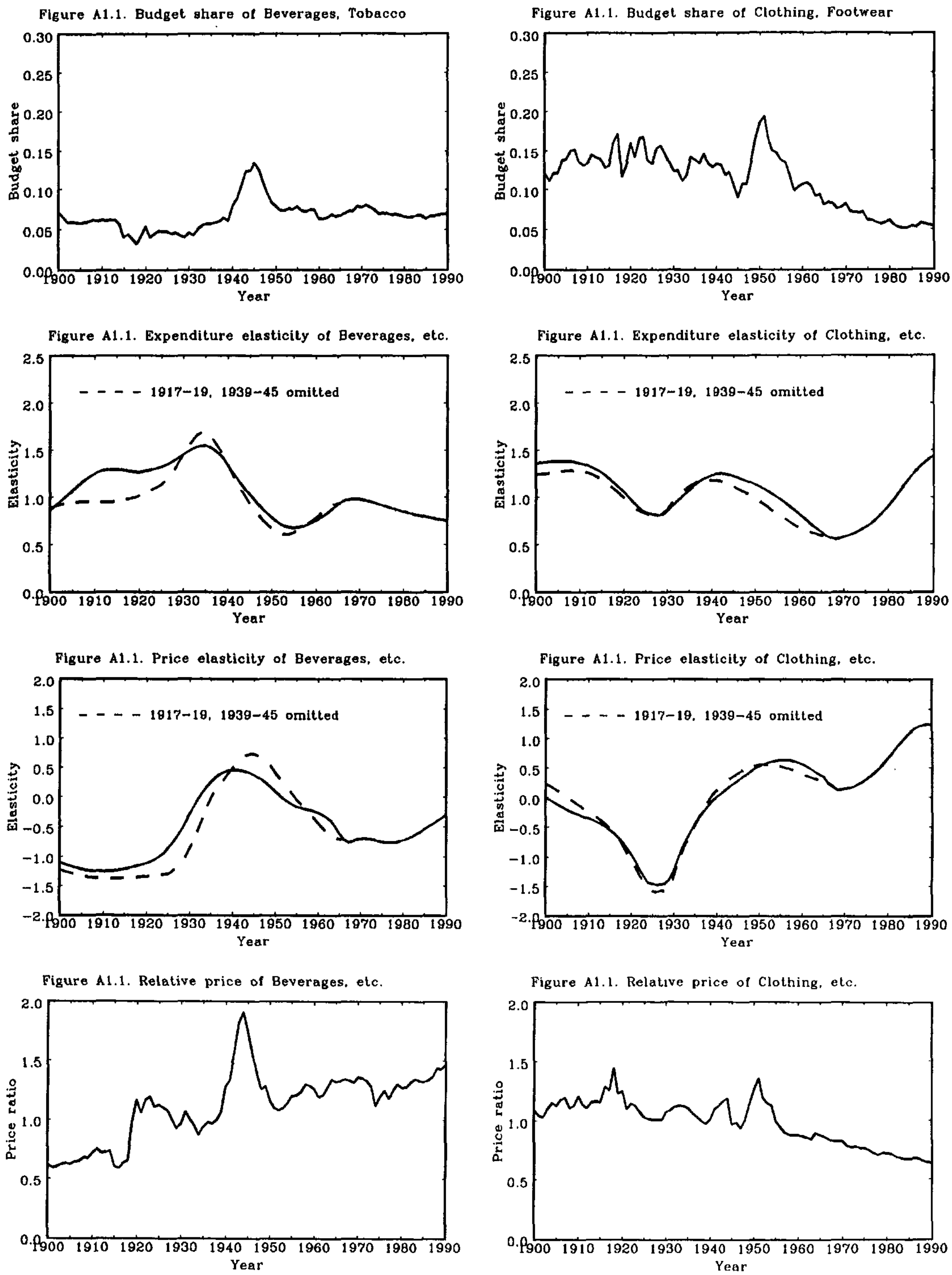


Figure A1.1. Consumer demand in 1900-1990.

Figure A1.1. Budget share of Housing. Housing Energy

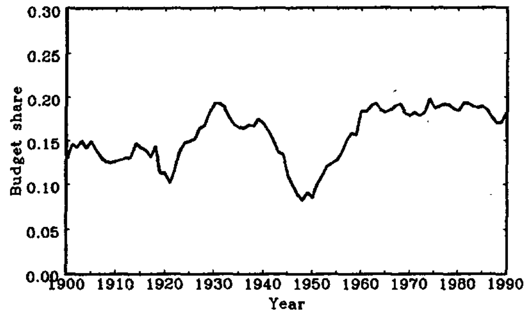


Figure A1.1. Budget share of Household Appliances

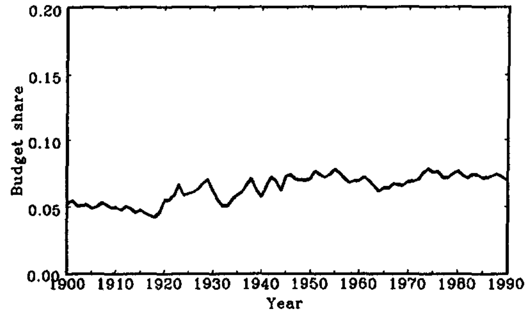


Figure A1.1. Expenditure elasticity of Housing, etc.

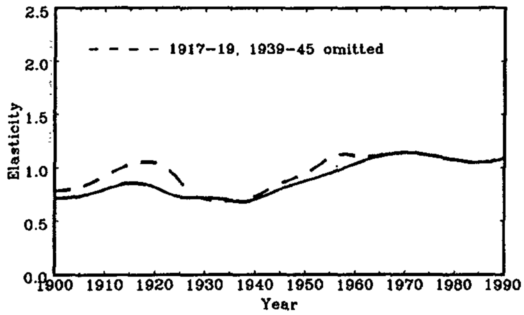


Figure A1.1. Expenditure elasticity of Household Appliances

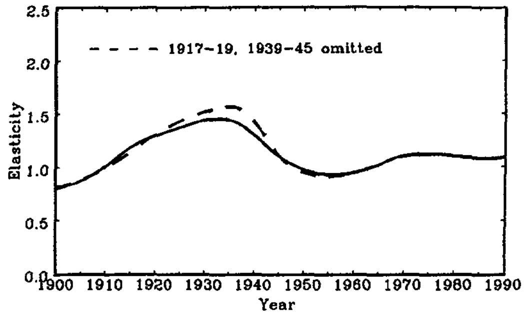


Figure A1.1. Price elasticity of Housing, etc.

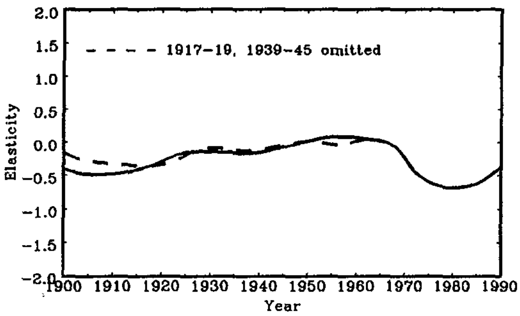


Figure A1.1. Price elasticity of Household Appliances

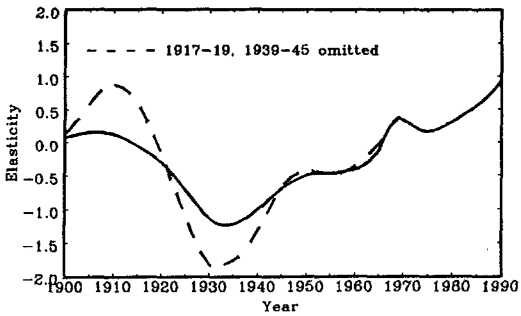


Figure A1.1. Relative price of Housing, etc.

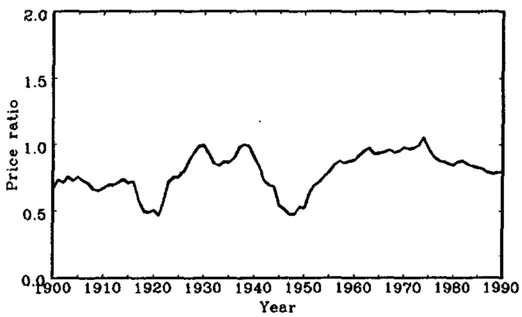


Figure A1.1. Relative price of Household Appliances

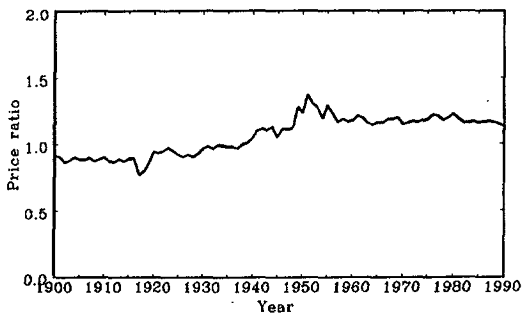


Figure A1.1. Consumer demand in 1900-1990.

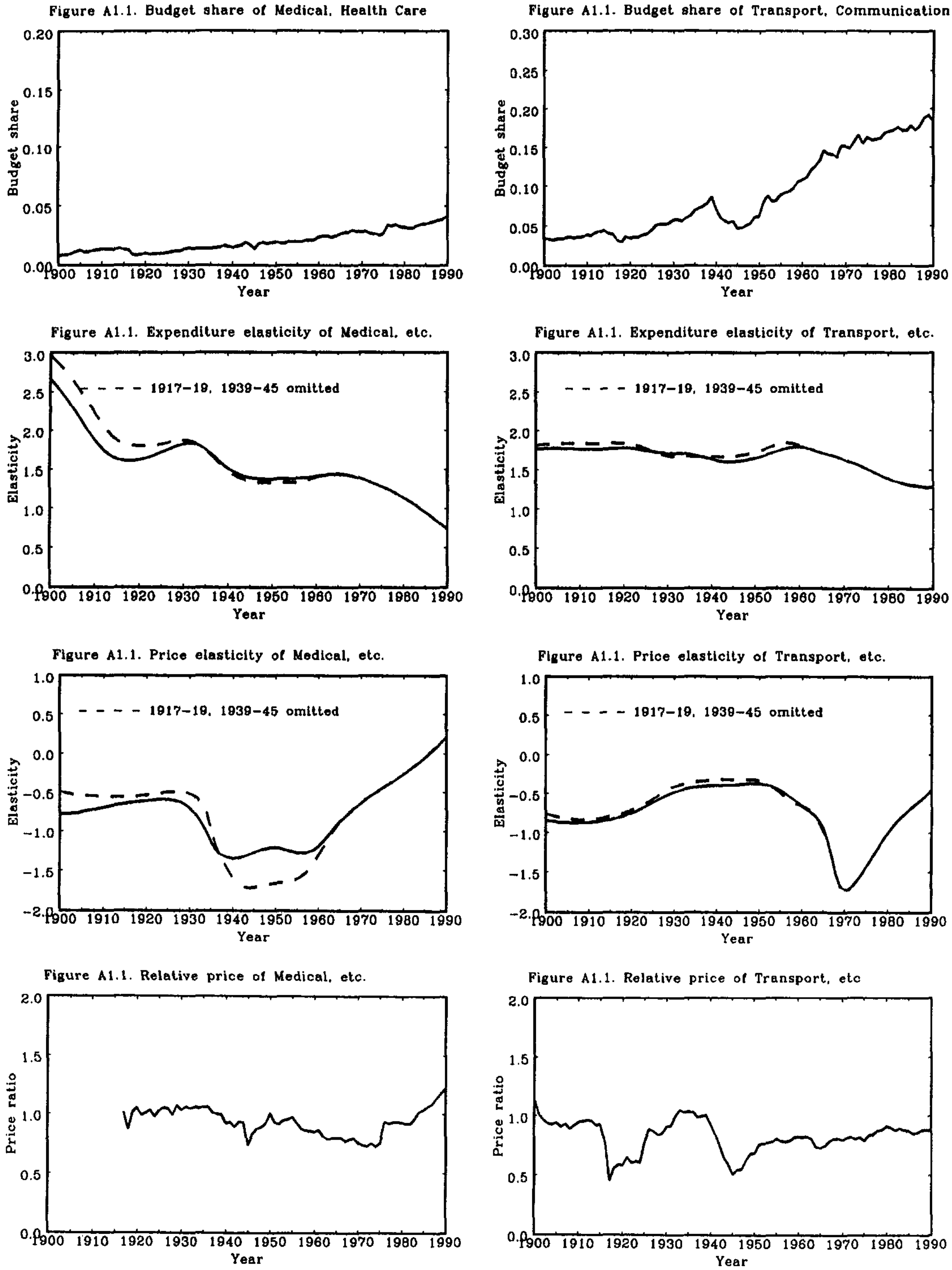
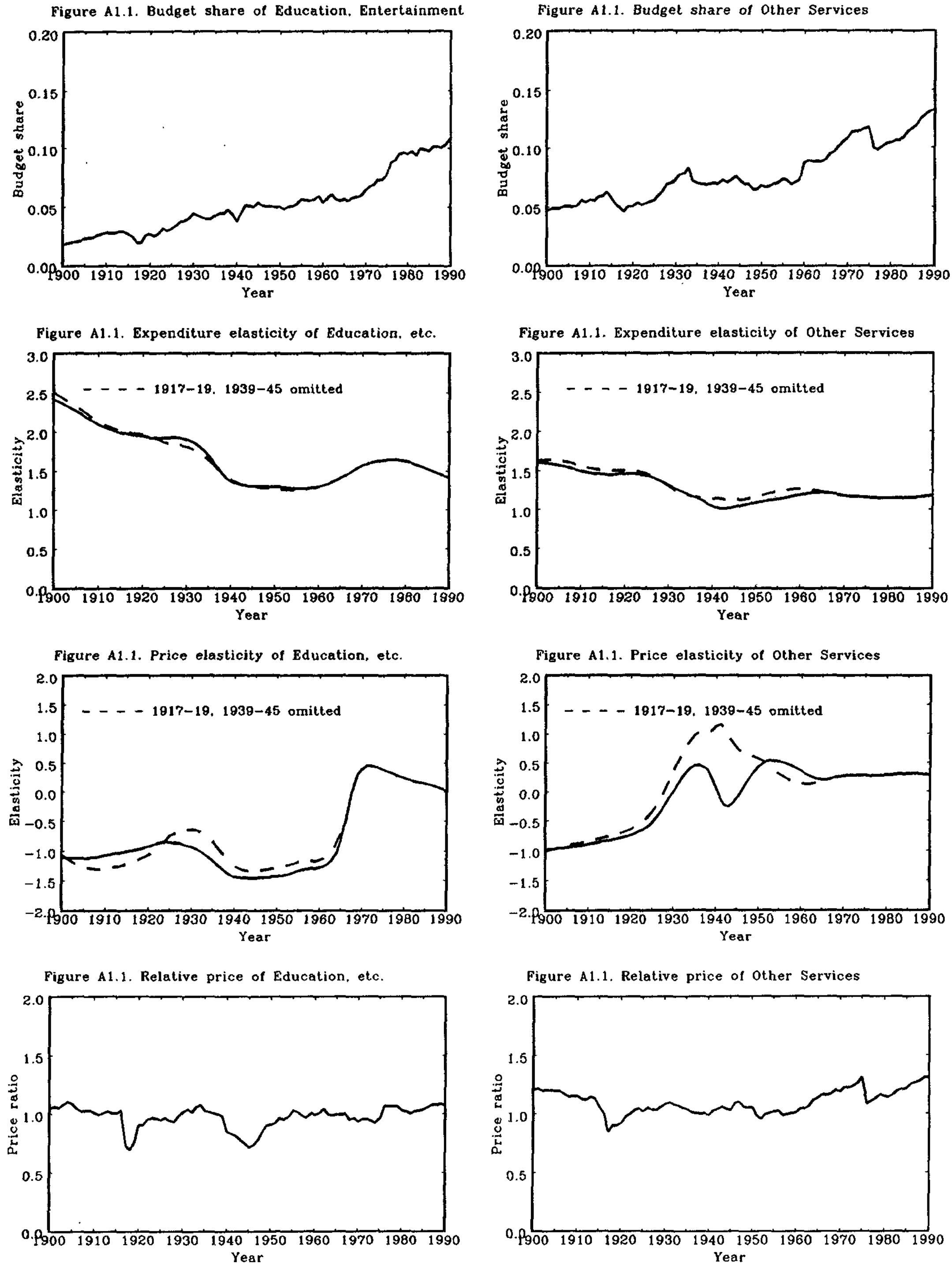


Figure A1.1. Consumer demand in 1900-1990.



A.2 Appendix 2

The following modifications are made to the original variables provided by the Statistics Finland:

The variables CHILDREN (the number of children in the household) and HHSIZE (household size) have been truncated from above in this study with limits 10 and 12, respectively. The old variables are given with a $\star$ appended to the name of the variable.

For those values in the variable DISPINC (total disposable income) that are *negative* in the 1990 survey or zero, we have substituted the value one before logarithm is taken to form the variable LNY. The latter variable and its second order term LNYSQ are used as instruments in the preliminary fits.

No other modifications are made to the data. Undoubtably, we would have obtained better 'fits' of the estimated models if the analysis had been restricted to deal with say more homogenous groups of households, for example w.r.t. the household composition, or if some obvious outliers had been removed from the data.

In Table A2.1. the variables 'LP1-LP9', ..., 'LP8-LP9' are formed by subtracting the (logarithmic) price index relating to the residual category, LP9 from the other logarithmic price variables to impose homogeneity restriction in the budget share equations. The variable 'LPSTONE' refers to the Stone price index which is calculated using the preliminary fits for the budget shares.

Table A2.1. Descriptive statistics of the data.

Variable	Mean	Std Dev	Minimum	Maximum
LCOHAGE	3.7485	0.4030	1.946	4.644
LAGE	3.7776	0.3326	2.773	4.554
LAGESQ	14.3810	2.4907	7.687	20.738
HHSIZE	3.1483	1.6144	1.000	12.000
HHSIZE*	3.1496	1.6226	1.000	18.000
HHSIZESQ	12.5180	13.4121	1.000	144.000
CHILDREN	0.9154	1.2204	0.000	10.000
CHILDREN*	0.9160	1.2251	0.000	13.000
FEMALE	0.2446	0.4299	0.000	1.000
OLDAGE	0.2747	0.5777	0.000	4.000
SPOUSENW	0.5159	0.4998	0.000	1.000
FARMER	0.1384	0.3453	0.000	1.000
SELFEMPL	0.0517	0.2214	0.000	1.000
WHCOLLAR	0.2845	0.4512	0.000	1.000
WORKER	0.3203	0.4666	0.000	1.000
RETIRED	0.2051	0.4038	0.000	1.000
EDUCB	0.5613	0.4962	0.000	1.000
EDUCM	0.3370	0.4727	0.000	1.000
EDUCH	0.1018	0.3023	0.000	1.000
SMHOUSE	0.5778	0.4939	0.000	1.000
SDHOUSE	0.0253	0.1569	0.000	1.000
FLAT	0.3969	0.4893	0.000	1.000
TENUROWN	0.7318	0.4430	0.000	1.000
TENURENT	0.2126	0.4092	0.000	1.000
TENURKIN	0.0556	0.2291	0.000	1.000
CENTHEAT	0.7360	0.4253	0.000	1.000
WEHOUSE	0.2102	0.4074	0.000	1.000
BATHROOM	0.7215	0.4483	0.000	1.000
WC	0.8273	0.3780	0.000	1.000
WWATER	0.7681	0.4220	0.000	1.000
CAR	0.6500	0.4770	0.000	1.000
RURAL	0.4598	0.4984	0.000	1.000
SOUTH	0.5444	0.4980	0.000	1.000
MIDDLE	0.3220	0.4672	0.000	1.000
NORTH	0.1336	0.3403	0.000	1.000
WINTER	0.2782	0.4481	0.000	1.000
SUMMER	0.2085	0.4063	0.000	1.000
AUTUMN	0.2666	0.4422	0.000	1.000
SURVEY	81.3478	7.5636	66.000	90.000
D66	0.0975	0.2967	0.000	1.000
D71	0.0893	0.2852	0.000	1.000
D76	0.1002	0.3002	0.000	1.000
D81	0.2205	0.4146	0.000	1.000
D85	0.2454	0.4303	0.000	1.000
D90	0.2471	0.4313	0.000	1.000
D6676	0.2871	0.4524	0.000	1.000

Table A2.1. Descriptive statistics of the data.

Variable	Mean	Std Dev	Minimum	Maximum
W1	0.2827	0.1141	0.000	0.843
W2	0.0356	0.0464	0.000	0.613
W3	0.0685	0.0611	0.000	0.612
W4	0.2369	0.1118	0.000	0.883
W5	0.0631	0.0625	0.000	0.637
W6	0.0302	0.0411	0.000	0.758
W7	0.1545	0.1432	-0.000	0.910
W8	0.0800	0.0655	0.000	0.803
W9	0.0486	0.0652	0.000	0.766
IW1	0.2827	0.0710	0.108	0.575
IW2	0.0356	0.0177	0.000	0.242
IW3	0.0685	0.0213	0.000	0.330
IW4	0.2369	0.0694	0.000	0.632
IW5	0.0631	0.0132	0.000	0.194
IW6	0.0302	0.0143	0.000	0.183
IW7	0.1544	0.0663	0.002	0.561
IW8	0.0800	0.0235	0.000	0.233
IW9	0.0486	0.0237	0.000	0.221
LP1	-0.0998	0.6499	-1.454	0.477
LP2	-0.0320	0.6543	-1.349	0.718
LP3	-0.0781	0.5631	-1.196	0.512
LP4	-0.0373	0.6016	-1.266	0.610
LP5	-0.1668	0.7536	-1.819	0.539
LP6	0.0439	0.6402	-1.192	0.758
LP7	-0.1048	0.6612	-1.508	0.555
LP8	-0.0530	0.5962	-1.265	0.569
LP9	-0.0620	0.6929	-1.482	0.685
LP1-LP9	-0.0378	0.0748	-0.208	0.079
LP2-LP9	0.0300	0.0465	-0.023	0.133
LP3-LP9	-0.0161	0.1335	-0.218	0.286
LP4-LP9	0.0247	0.0996	-0.095	0.216
LP5-LP9	-0.1048	0.0898	-0.347	0.004
LP6-LP9	0.1059	0.0818	-0.016	0.290
LP7-LP9	-0.0428	0.0475	-0.130	0.044
LP8-LP9	0.0090	0.0975	-0.116	0.216
LRELP1	-0.0255	0.0488	-0.125	0.053
LRELP2	0.0423	0.0440	-0.067	0.175
LRELP3	-0.0039	0.0819	-0.126	0.247
LRELP4	0.0369	0.0554	-0.073	0.177
LRELP5	-0.0926	0.1249	-0.467	0.037
LRELP6	0.1181	0.0733	-0.017	0.259
LRELP7	-0.0306	0.0320	-0.166	0.028
LRELP8	0.0212	0.0485	-0.048	0.186
LRELP9	0.0122	0.0570	-0.139	0.138
LPSTONE	-0.0742	0.6399	-1.440	0.585

Table A2.1. Descriptive statistics of the data.

Variable	Mean	Std Dev	Minimum	Maximum
LNY	11.0793	1.0653	0.000	15.043
LNY2	123.8856	22.6100	0.000	226.302
LNSQM	4.2563	0.5546	0.000	6.397
LNSQM2	18.4237	4.4374	0.000	40.921
LNC	10.8049	0.9905	7.046	14.077
ILNC	10.8049	0.9271	7.440	12.805
ILNC2	117.6051	19.4774	55.354	163.961
LNX	10.8793	0.6164	7.648	13.542
LNX2	118.7395	13.2962	58.493	183.397
ILNX	10.8791	0.5069	8.801	12.255
ILNX2	118.6124	10.8702	77.451	150.175
OECDSC	2.3206	0.9436	0.500	9.900
ILNXS	10.1215	0.3662	8.790	11.422
ILNXR	-0.1785	0.3662	-1.510	1.122
LNRELX	-0.0159	0.2616	-1.111	1.299
ILNXFEM	-0.0440	0.1898	-1.510	1.072
ILNXSIZE	-0.7061	1.5789	-18.116	3.210
ILNXCH	-0.2604	0.8394	-15.096	1.891
VARILNP	0.0004	0.0010	0.000	0.037
VARILNC	0.0015	0.0017	0.000	0.062
ILNXSQ	0.1641	0.2569	-0.063	2.268
CONSUMP	73903.56	63884.48	1148.00	1299375.00
DISPINC	83854.83	69368.92	404260.00	3366559.00
WEIGHT	318.2131	228.3112	14.770	2547.000

Table A2.2. The instruments used in the preliminary fits.

Variable	Product terms		
LNY			
LNY2			
LNSQM	TENUROWN*LNSQM	(FARMER+SELFEMPL)*LNSQM	
LNSQM2			
LAGE	LAGE*LNSQM	LAGE*TENUROWN	LAGE*LN(HHSIZE)
LAGESQ			
HHSIZE			
LN(HHSIZE)	LN(HHSIZE)*LNSQM	FEMALE*LN(HHSIZE)	RURAL*LN(HHSIZE)
HHSIZESQ			
CHILDREN	CHILDREN*LNSQM		
FEMALE	FEMALE*LNSQM	FEMALE*LAGE	FEMALE*CAR
OLDAGE	OLDAGE*LNSQM		
SPOUSENW			
FARMER			
SELFEMPL			
WHCOLLAR			
RETIRED			
EDUCM			
EDUCH			EDUCH*CAR
WEHOUSE	WEHOUSE*LNSQM		WEHOUSE*CAR
CAR	CAR*LNSQM	CAR*LAGE	CAR*LN(HHSIZE)
TENURENT			
TENURKIN			
		TENUROWN*LN(HHSIZE)	TENUROWN*CAR
SMHOUSE			
SDHOUSE			
CENTHEAT			
BATHROOM			BATHROOM*CAR
WC			
WWATER			
RURAL	RURAL*LNSQM	RURAL*LAGE	RURAL*CAR
MIDDLE			
NORTH			
WINTER	WINTER*LNSQM	WINTER*TENUROWN	WINTER*CAR
SUMMER	SUMMER*LNSQM	SUMMER*TENUROWN	SUMMER*CAR
AUTUMN	AUTUMN*LNSQM	AUTUMN*TENUROWN	AUTUMN*CAR

Table A2.3. The bookkeeping periods in 1981-1990.

Bookkeeping period	1981	1985	1990
1	15.01.81-28.01.81	17.01.85-30.01.85	25.01.90-07.02.90
2	29.01.81-11.02.81	31.01.85-13.02.85	08.02.90-21.02.90
3	12.02.81-25.02.81	14.02.85-27.02.85	22.02.90-07.03.90
4	23.02.81-11.03.81	28.02.85-13.03.85	08.03.90-21.03.90
5	12.03.81-25.03.81	14.03.85-27.03.85	22.03.90-04.04.90
6	26.03.81-08.04.81	28.03.85-10.04.85	05.04.90-18.04.90
7	09.04.81-22.04.81	11.04.85-24.04.85	19.04.90-02.05.90
8	23.04.81-06.05.81	25.04.85-08.05.85	03.05.90-16.05.90
9	07.05.81-20.05.81	09.05.85-22.05.85	17.05.90-30.05.90
10	21.05.81-03.06.81	23.05.85-05.06.85	31.05.90-13.06.90
11	04.06.81-17.06.81	06.06.85-19.06.85	14.06.90-27.06.90
12	18.06.81-01.07.81	20.06.85-03.07.85	28.06.90-11.07.90
13	02.07.81-15.07.81	04.07.85-17.07.85	12.07.90-25.07.90
14	16.07.81-29.07.81	18.07.85-31.07.85	26.07.90-08.08.90
15	30.08.81-12.08.81	01.08.85-14.08.85	09.08.90-22.08.90
16	13.08.81-26.08.81	15.08.85-28.08.85	23.08.90-05.09.90
17	27.08.81-09.09.81	29.08.85-11.09.85	06.09.90-19.09.90
18	10.09.81-23.09.81	12.09.85-25.09.85	20.09.90-03.10.90
19	24.09.81-07.10.81	26.09.85-09.10.85	04.10.90-17.10.90
20	08.10.81-21.10.81	10.10.85-23.10.85	18.10.90-31.10.90
21	22.10.81-04.11.81	24.10.85-06.11.85	01.11.90-14.11.90
22	05.11.81-18.11.81	07.11.85-20.11.85	15.11.90-28.11.90
23	19.11.81-02.12.81	21.11.85-04.12.85	29.11.90-12.12.90
24	03.12.81-16.12.81	05.12.85-18.12.85	13.12.90-26.12.90
25	17.12.81-30.01.81	19.12.85-01.01.86	27.12.90-09.01.91
26	31.01.81-13.01.82	02.01.86-15.01.86	10.01.91-23.01.91
27		16.01.86-29.01.86	24.01.91-06.02.91
28		30.01.86-12.02.86	07.02.91-20.02.91

Table A2.4. Descriptive statistics of nondurables.

Variable	Mean	Std Dev	Minimum	Maximum
WN1	0.3746	0.1558	0.000	0.982
WN3	0.1017	0.0844	0.000	0.758
WN4	0.0685	0.0608	0.000	0.677
WN5	0.0491	0.0537	0.000	0.708
WN6	0.0396	0.0560	0.000	0.833
WN7	0.1591	0.1148	0.000	0.917
WN8	0.0957	0.0707	0.000	0.709
WN9	0.1116	0.1067	0.000	0.951
IWN1	0.3747	0.1008	0.048	0.673
IWN3	0.1017	0.0287	0.000	0.409
IWN4	0.0685	0.0400	0.000	0.406
IWN5	0.0491	0.0131	0.000	0.219
IWN6	0.0395	0.0225	0.000	0.475
IWN7	0.1592	0.0577	0.000	0.470
IWN8	0.0957	0.0281	0.009	0.374
IWN9	0.1116	0.0584	0.000	0.420
LNP1	-0.0922	0.6565	-1.454	0.515
LNP3	-0.0968	0.5453	-1.196	0.436
LNP4	-0.1632	0.4985	-1.266	0.292
LNP5	-0.1563	0.7596	-1.819	0.556
LNP6	0.1054	0.6999	-1.192	1.003
LNP7	-0.1112	0.6532	-1.508	0.530
LNP8	-0.0300	0.6151	-1.265	0.629
LNP9	-0.0619	0.6935	-1.482	0.693
LNRELP1	-0.0087	0.0288	-0.156	0.064
LNRELP3	-0.0133	0.1010	-0.238	0.294
LNRELP4	-0.0797	0.1643	-0.428	0.224
LNRELP5	-0.0728	0.1258	-0.444	0.072
LNRELP6	0.1889	0.1389	-0.019	0.491
LNRELP7	-0.0277	0.0311	-0.194	0.042
LNRELP8	0.0535	0.0524	-0.076	0.224
LNRELP9	0.0216	0.0618	-0.122	0.207
LNPSTONE	-0.0834	0.6427	-1.619	0.816
NDCONS	46952.95	39923.12	535.00	551354.07
LNCN	10.3664	0.9653	6.282	13.220
ILNCNSQ	108.2585	17.9981	49.005	159.899
ILNCN	10.3664	0.8919	7.000	12.645
LNX	10.4499	0.6201	6.829	12.794
LNX2	118.7395	13.2962	58.493	183.397
ILNX	10.4499	0.4993	8.396	12.076
ILNXR	-0.1077	0.3182	-1.404	1.283
LNRELX	-0.0039	0.2695	-1.173	1.263
ILNXFEM	-0.0260	0.1636	-1.248	1.098
ILNXSIZE	-0.4335	1.2850	-18.368	5.132
ILNXCH	-0.1716	0.6682	-15.744	2.566
VARILNP	0.0004	0.0012	0.000	0.063
VARILNC	0.0018	0.0025	0.000	0.194
ILNXSQ	0.1107	0.1638	-0.070	1.952

A.3 Appendix 3

In the following we present the Engel curves and age profiles in consumption for the categories $W_2, ..., W_9$. In calculating the profiles the explanatory variables have 'typical' values: The household has two members, both adults, the household head is a male, and both are working until they are 65 years old. The household owns a car but the other (dummy) variables have zero values corresponding to the implicit reference groups. In calculating the age profiles in consumption the value of (nominal) total expenditure is set equal to the mean in data. The variable is deflated using the Stone price index with mean values of prices and budget shares in the data, and adjusted for the number of equivalent adults (1.7) in the household. In the Engel curves the household head is 44 years old, and the real expenditure variables are formed for each survey using separate Stone indices for the surveys.

In addition full estimation results are reported on Models A, B, C, and P, see Chapter 6. The parameter estimates of the (nine) budget share equations have been multiplied by 100 to present the results in percentage points, for ease in exposition. The other parameters correspond to the (logarithmic) variance components and are reproduced as such, having a useful interpretation in percentage points. The row LOGS0 gives the estimate for the (the logarithmic) variance component in 1985. The row YFIT0 gives the heteroskedasticity parameter connecting the (exogenous part of) fit and logarithmic variance of the error in the model.

Figure A3.1. Engel curves and age profiles in consumption.

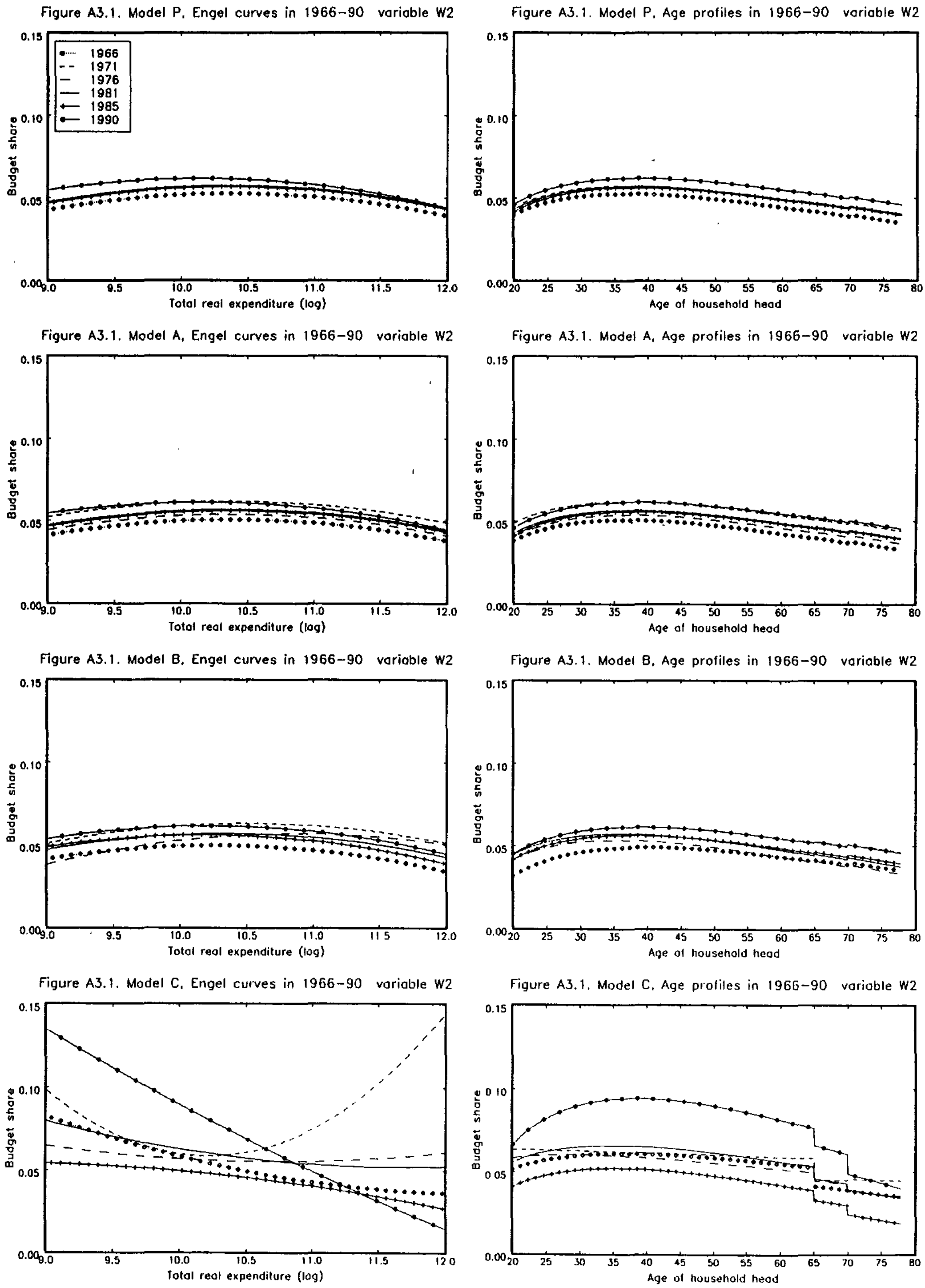


Figure A3.1. Engel curves and age profiles in consumption.

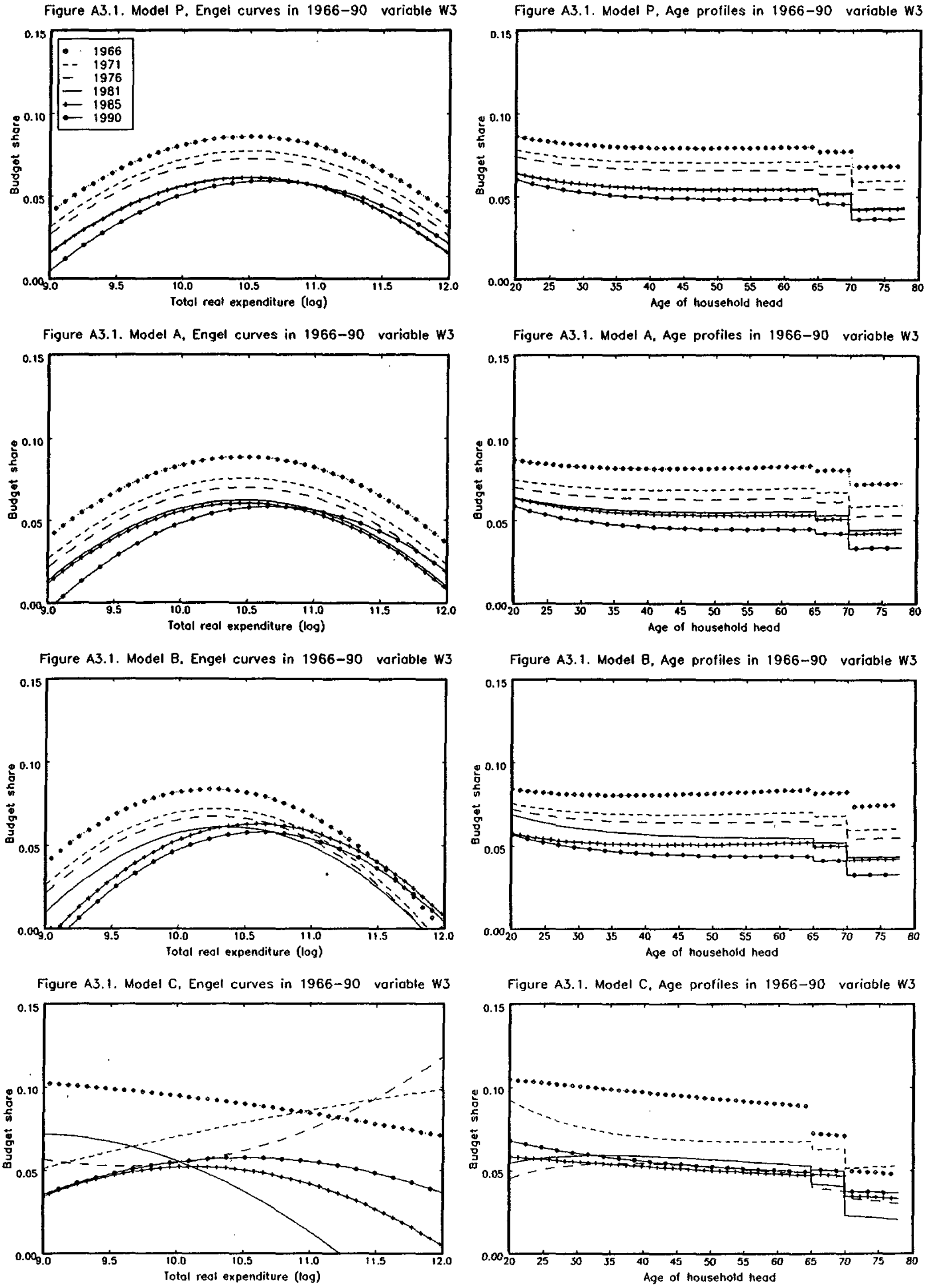


Figure A3.1. Engel curves and age profiles in consumption.

Figure A3.1. Model P, Engel curves in 1966–90 variable W4

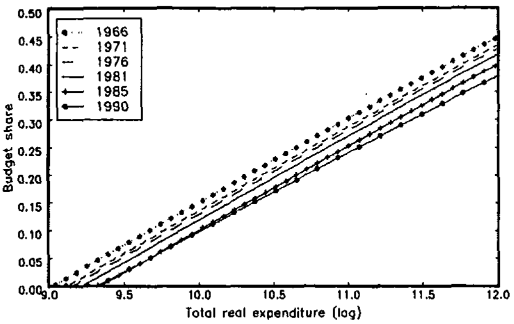


Figure A3.1. Model P, Age profiles in 1966–90 variable W4

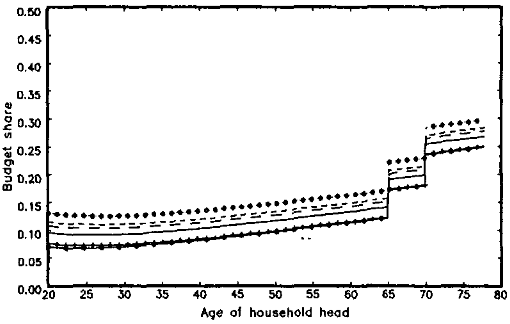


Figure A3.1. Model A, Engel curves in 1966–90 variable W4

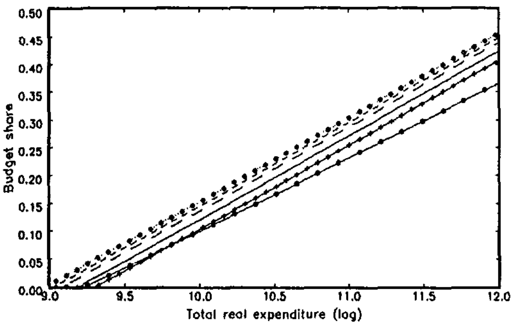


Figure A3.1. Model A, Age profiles in 1966–90 variable W4

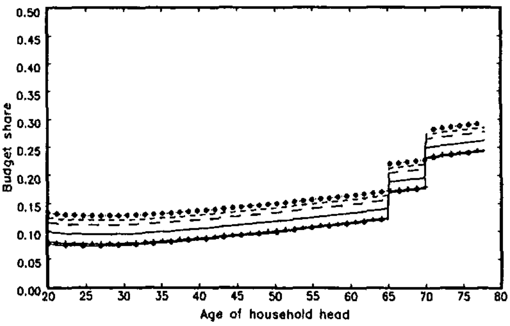


Figure A3.1. Model B, Engel curves in 1966–90 variable W4

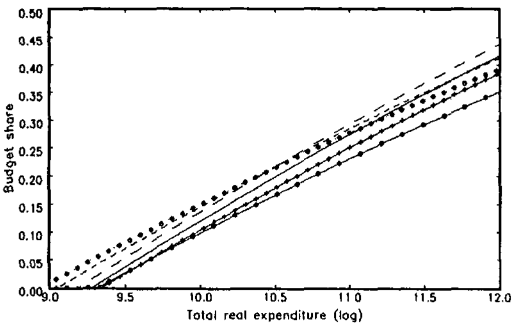


Figure A3.1. Model B, Age profiles in 1966–90 variable W4

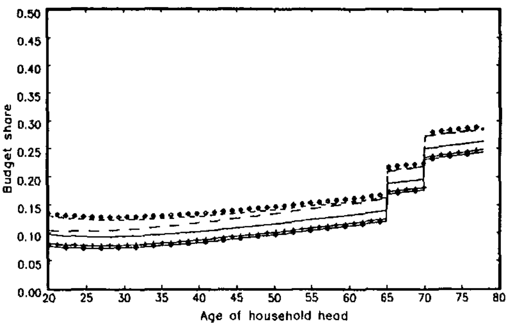


Figure A3.1. Model C, Engel curves in 1966–90 variable W4

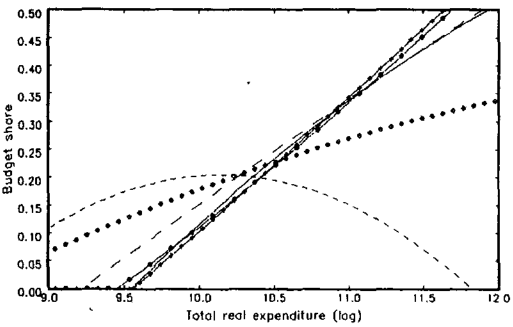


Figure A3.1. Model C, Age profiles in 1966–90 variable W4

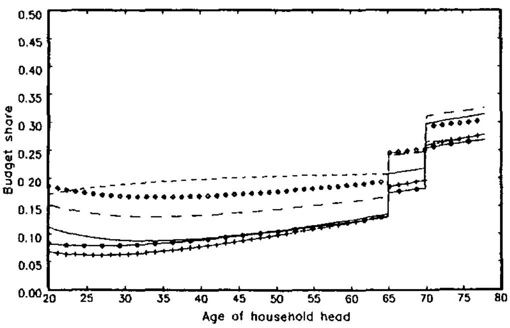


Figure A3.1. Engel curves and age profiles in consumption.

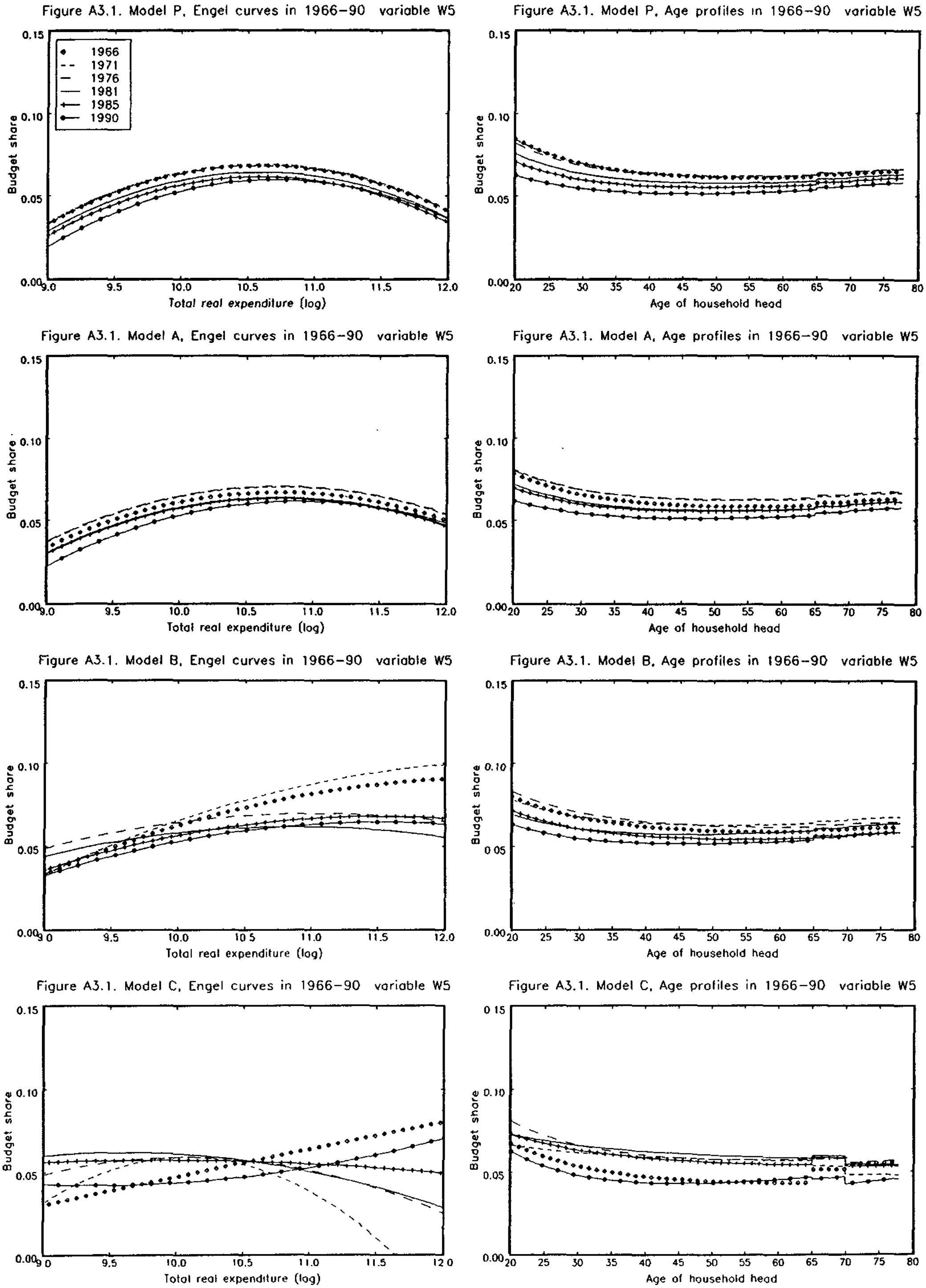


Figure A3.1. Engel curves and age profiles in consumption.

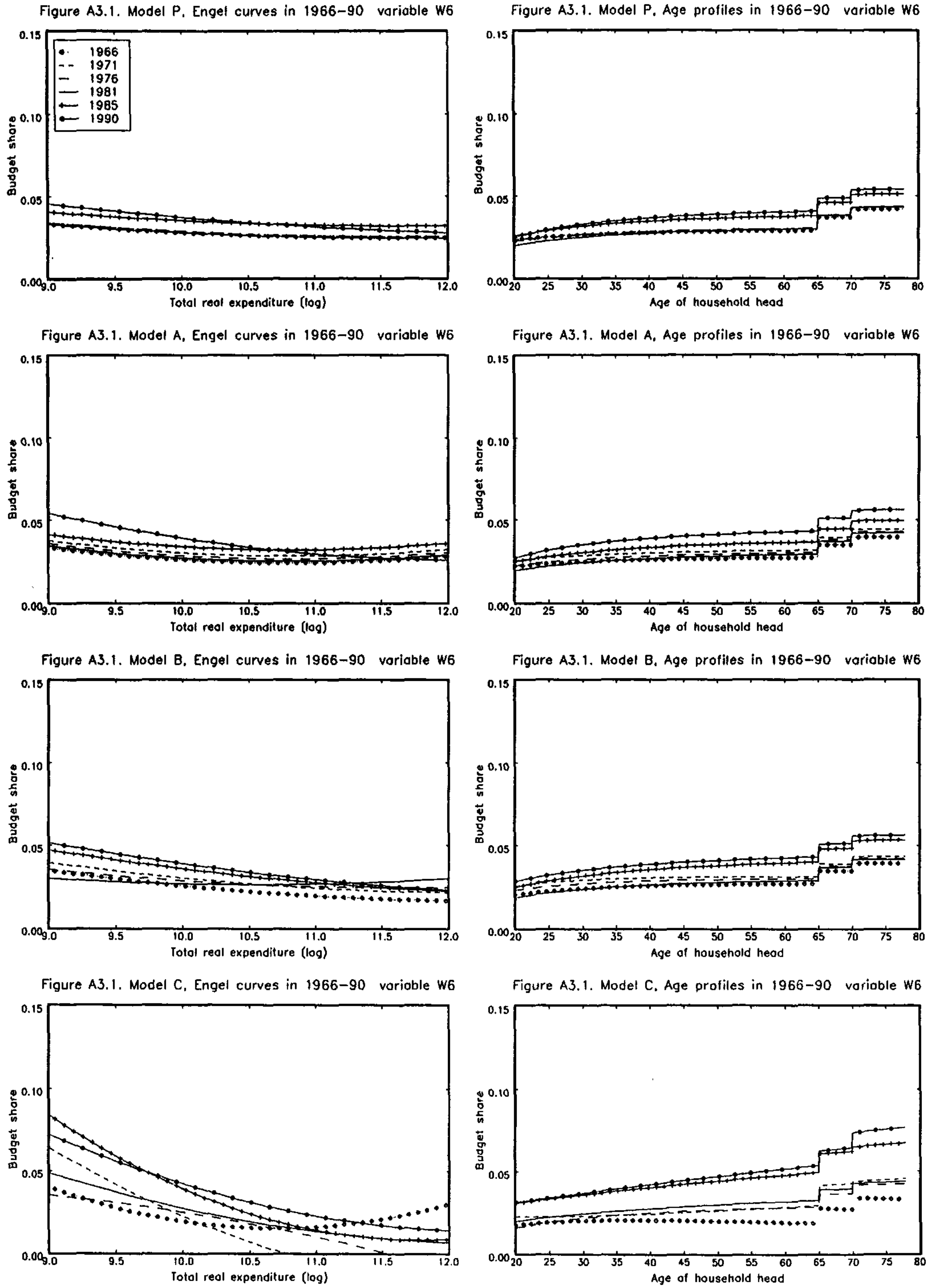


Figure A3.1. Engel curves and age profiles in consumption.

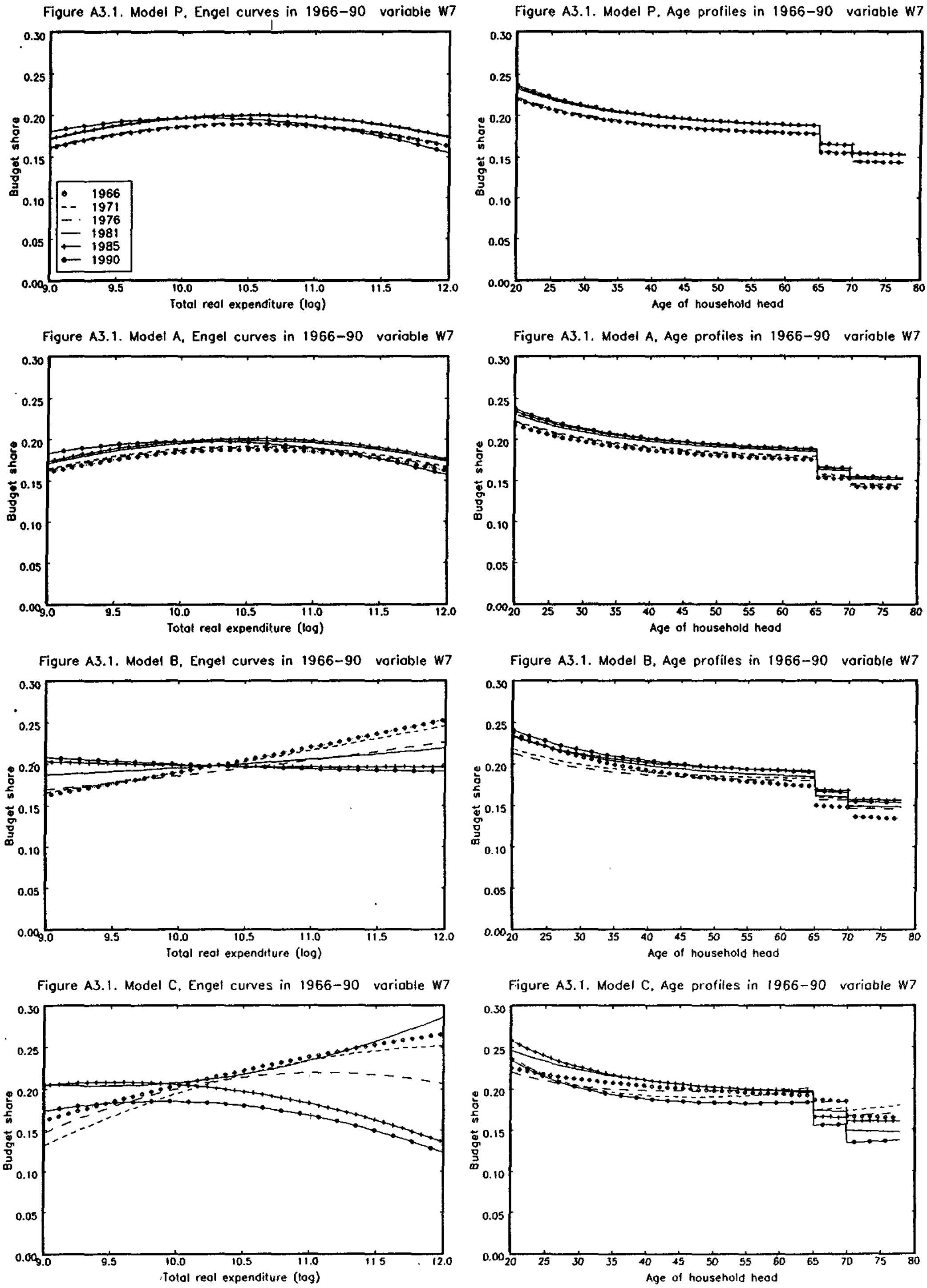


Figure A3.1. Engel curves and age profiles in consumption.

Figure A3.1. Model P, Engel curves in 1966–90 variable W8

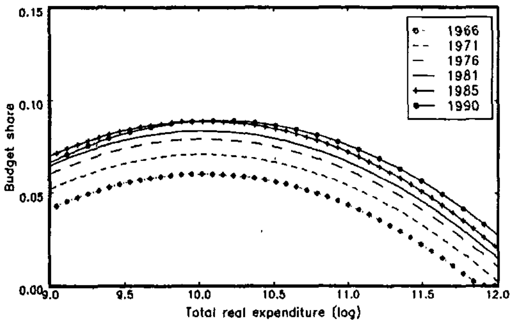


Figure A3.1 Model P, Age profiles in 1966–90 variable W8

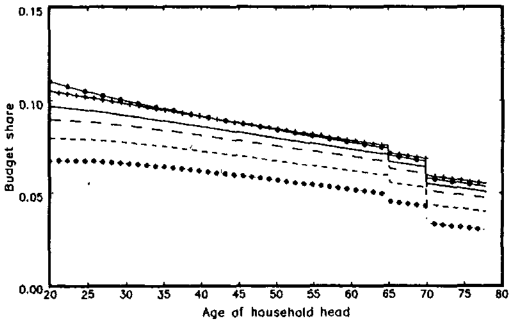


Figure A3.1. Model A, Engel curves in 1966–90 variable W8

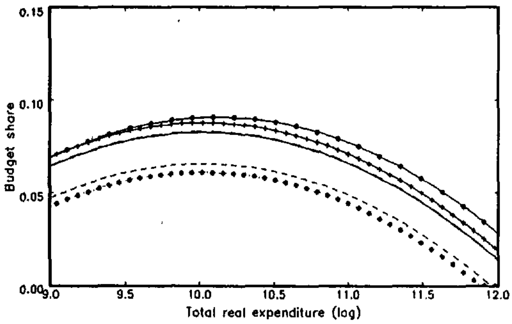


Figure A3.1. Model A, Age profiles in 1966–90 variable W8

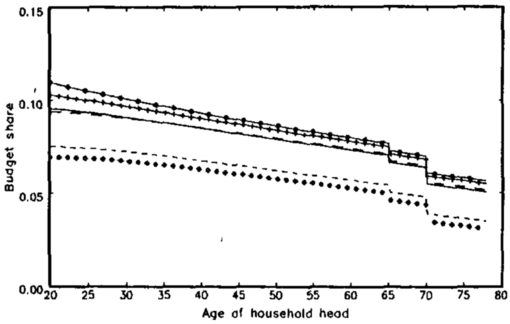


Figure A3.1. Model B, Engel curves in 1966–90 variable W8

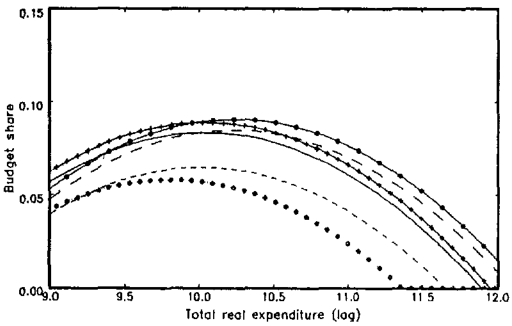


Figure A3.1. Model B, Age profiles in 1966–90 variable W8

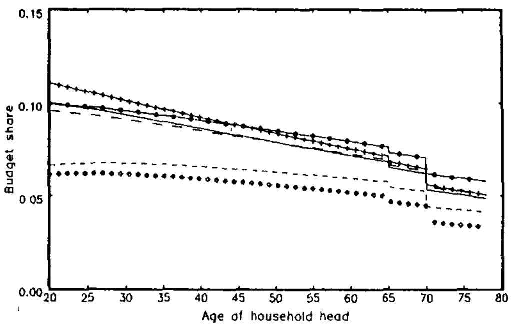


Figure A3.1. Model C, Engel curves in 1966–90 variable W8

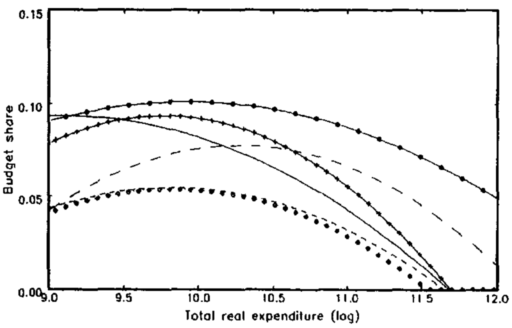


Figure A3.1. Model C, Age profiles in 1966–90 variable W8

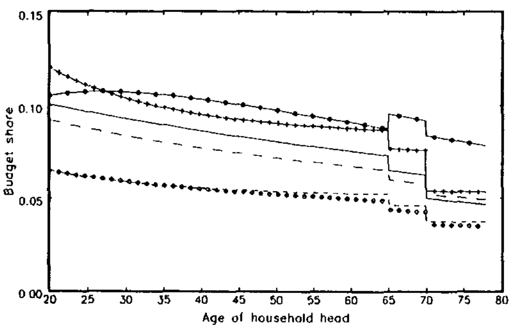


Figure A3.1. Engel curves and age profiles in consumption.

Figure A3.1. Model P, Engel curves in 1966–90 variable W9

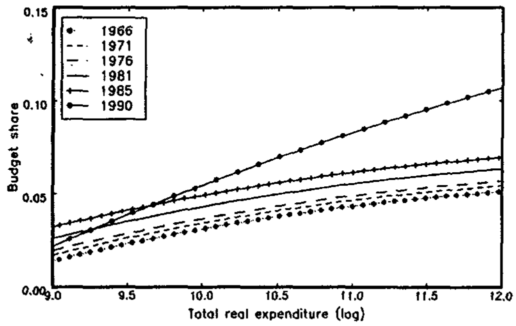


Figure A3.1. Model P, Age profiles in 1966–90 variable W9

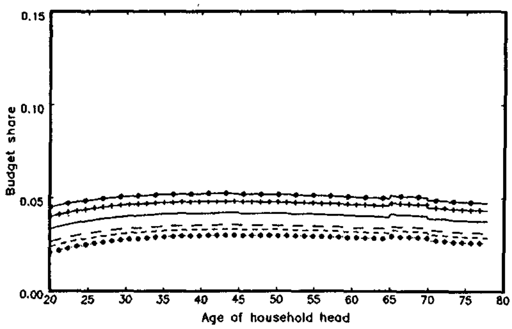


Figure A3.1. Model A, Engel curves in 1966–90 variable W9

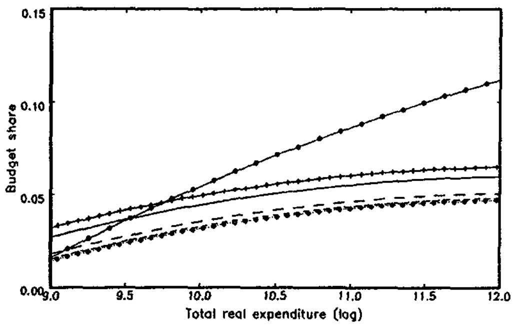


Figure A3.1. Model A, Age profiles in 1966–90 variable W9

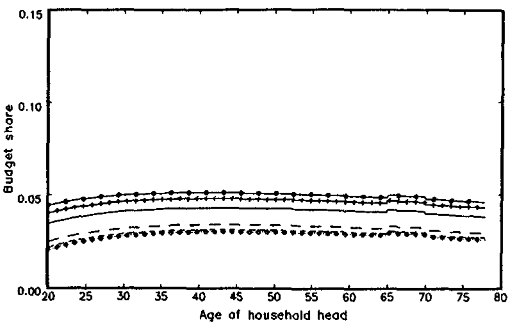


Figure A3.1. Model B, Engel curves in 1966–90 variable W9

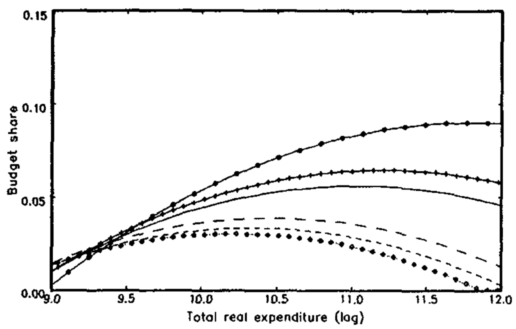


Figure A3.1. Model B, Age profiles in 1966–90 variable W9

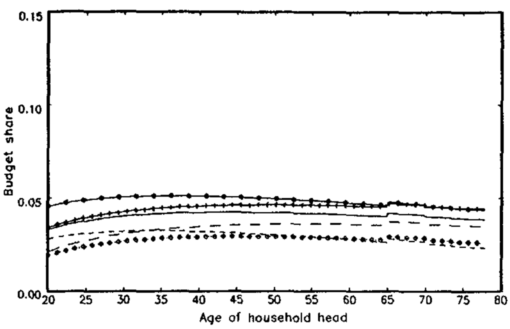


Figure A3.1. Model C, Engel curves in 1966–90 variable W9

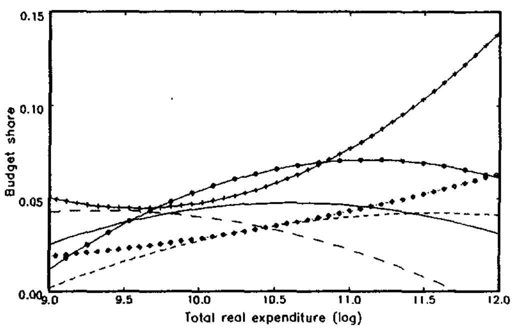


Figure A3.1. Model C, Age profiles in 1966–90 variable W9

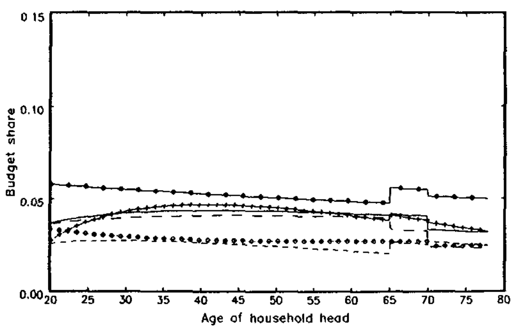


Table A3.1.a Estimation results by quasi maximum likelihood, Model A.

Variable	Food Param.	Food T	Beverages, Tobacco Param.	Beverages, Tobacco T	Clothing, Footwear Param.	Clothing, Footwear T	Housing, Energy Param.	Housing, Energy T	Household Appliances Param.	Household Appliances T
CONSTANT	-17.8159	-2.76	-39.7200	-20.19	22.2072	6.29	81.6199	10.93	36.5049	12.17
LCOHAGE	-2.3389	-3.44	0.5597	2.78	-1.2573	-3.47	0.6898	0.87	1.3335	5.01
LAGE	25.1192	6.79	24.9058	21.66	-6.8220	-3.43	-38.6538	-9.05	-15.7428	-9.35
LAGESQ	-2.7444	-5.79	-3.5093	-23.24	1.0277	3.89	5.7914	10.32	1.8332	8.72
HHSIZE	-0.1148	-1.04	-0.1452	-5.03	0.1727	2.86	-1.4389	-10.11	-0.4938	-11.18
HHSIZESQ	0.0089	0.74	0.0183	5.76	-0.0153	-2.45	-0.0015	-0.09	0.0145	3.50
CHILDREN	-0.2949	-4.10	-0.4050	-18.25	0.1231	3.19	2.7064	30.17	0.2632	9.07
FARMER	0.1797	1.14	-0.7364	-14.83	0.2618	3.23	4.7802	24.79	0.0170	0.31
SELFEMPL	0.0189	0.10	-0.1361	-2.33	0.7464	6.86	0.0350	0.15	0.1759	2.47
WHCOLLAR	-0.3493	-2.92	-0.2651	-7.27	0.4879	7.12	-1.9300	-13.49	0.1221	2.77
RETIRED	-1.0700	-6.37	0.0666	1.36	-0.0017	-0.02	2.4970	12.11	-0.0015	-0.03
EDUCM	-0.3197	-3.06	-0.1938	-6.10	0.1873	3.27	-1.3270	-10.72	0.1998	5.03
EDUCH	-0.2335	-1.41	-0.6507	-13.10	0.2486	2.68	-3.7908	-18.00	0.4028	6.05
FEMALE	-0.9763	-8.52	-0.7469	-21.06	1.1620	15.28	1.1010	7.91	-0.0301	-0.71
OLDAGE	-0.1068	-1.10	-0.0190	-0.64	-0.2891	-5.58	2.2727	17.83	0.1467	4.18
SMHOUSE	-0.1252	-1.13	-0.1872	-5.61	-0.2795	-4.58	2.6934	20.05	0.2596	5.86
SDHOUSE	0.1037	0.35	0.1506	1.68	0.7308	4.26	0.0360	0.12	0.3469	3.30
TENURENT	0.9986	8.04	1.0009	22.17	0.5320	7.41	-1.9743	-14.00	-0.1569	-3.44
TENURKIN	0.8548	4.40	0.5653	9.25	1.1659	10.14	-2.1738	-10.22	-0.1370	-1.93
CENTHEAT	-1.2726	-9.50	-0.3193	-8.52	-0.4358	-6.36	2.1501	13.38	0.0837	1.90
WEHOUSE	-0.5115	-4.88	-0.1883	-5.95	-0.1932	-3.36	0.1716	1.34	0.0400	1.02
BATHROOM	-1.6918	-11.57	-1.0665	-22.29	0.1769	2.40	2.0554	11.94	0.2458	4.87
MIDDLE	-0.0222	-0.24	-0.2293	-7.88	0.1330	2.56	1.1953	10.48	0.0176	0.52
NORTH	-0.1873	-1.49	-0.1556	-4.07	0.4112	5.74	0.5502	3.71	0.2103	4.39
RURAL	-0.0720	-0.73	-0.0811	-2.73	-0.0659	-1.25	0.3496	3.13	-0.0515	-1.47
SPOUSENW	0.2180	2.19	0.1222	4.07	-0.6273	-10.48	3.0123	25.09	-0.0859	-2.31
CAR	-2.4186	-16.48	-0.6463	-17.52	-1.0845	-15.23	-4.9395	-29.02	-0.2899	-6.33
WINTER	-0.1303	-1.14	-0.3455	-9.66	-0.2668	-4.24	1.5802	11.85	-0.2674	-5.93
SUMMER	1.8996	14.16	0.0078	0.21	-0.5850	-8.57	-1.0717	-7.67	-0.4542	-8.82
AUTUMN	0.3227	2.88	-0.1491	-4.30	0.6208	9.41	-0.3907	-2.94	-0.2997	-6.65
D6676	6.2447	10.95	0.3167	2.42	3.0476	8.49	12.6957	17.57	5.0072	8.96
D66	0.3087	1.15	-1.1942	-10.59	2.2182	7.94	0.7920	3.03	3.1215	6.87
D76	-3.7365	-11.13	-0.4893	-3.10	-1.2046	-5.49	-3.2899	-10.05	-2.2473	-7.41
D81	2.5403	11.10	0.1122	1.22	0.7832	4.86	3.1584	15.55	-0.7556	-5.41
D90	4.5439	9.26	0.4381	4.16	-0.6690	-6.37	4.8101	12.36	-0.3554	-3.16
ILNXR	-9.9913	-19.14	0.4504	2.01	3.2116	10.55	9.9320	15.53	1.6454	5.63
ILNXCH	-0.2826	-1.52	0.0954	1.48	0.1795	1.56	-1.1784	-5.90	-0.0638	-0.70
ILNXFEM	1.9340	5.50	1.1807	8.30	-0.3019	-1.31	0.0212	0.06	-0.5931	-2.90
ILNXSIZE	0.0607	0.39	-0.2921	-5.09	-0.7660	-8.19	1.5980	9.02	-0.1797	-2.28
ILNXSQ	3.3751	8.45	-0.4971	-3.23	-2.2424	-9.20	0.0914	0.22	-1.0794	-4.51
LNRELX	-1.7274	-3.76	0.2167	1.06	-0.9017	-3.26	1.8745	3.73	-0.3145	-1.04
LRELP	61.5323	15.51	2.7809	1.97	-5.9618	-2.94	-65.4101	-15.56	21.5589	8.43
LOGSO		-7.3295		-8.0739		-7.1683		-5.8120		-8.5434
D6676		-0.9283		-0.3530		-0.5856		-0.5377		-3.1051
D66		-0.0866		0.1707		-0.3724		-0.1584		-1.6841
D76		0.3446		0.0130		0.3233		0.1128		1.1337
D81		-0.2665		-0.1026		-0.3167		-0.0891		-0.3180
D90		-0.7722		0.1192		-0.1651		-0.1025		-0.5669
YFITO		10.8304		51.5643		23.9745		4.1305		46.9047

Table A3.1a: Estimation results by quasi maximum likelihood, Model A.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	-4.3074	-3.69	50.0282	8.18	1.4910	0.40	-14.9660	-6.80
LCOHAGE	1.3629	9.57	-0.7554	-1.11	-1.6932	-3.91	-0.4304	-1.85
LAGE	2.5107	3.78	-17.3062	-4.97	8.7229	4.10	11.4950	9.25
LAGESQ	-0.4237	-4.90	1.9856	4.38	-1.2818	-4.65	-1.4695	-8.91
HHSIZE	-0.2216	-10.69	-0.2898	-2.82	-0.1038	-1.77	-0.2418	-6.64
HHSIZESQ	0.0085	3.98	0.0719	6.17	-0.0318	-5.13	0.0179	4.74
CHILDREN	-0.0328	-2.52	-1.2823	-15.81	0.4021	8.86	-0.2388	-8.72
FARMER	0.2582	8.35	0.1388	0.85	-0.5374	-6.15	-0.0961	-1.88
SELFEMPL	0.0708	1.86	0.1543	0.70	0.4030	3.35	1.0229	12.35
WHCOLLAR	-0.0286	-1.21	0.1742	1.37	0.6016	7.82	0.5079	10.57
RETIRED	0.5114	13.83	-0.8610	-5.48	-0.1272	-1.35	0.3122	5.14
EDUCM	0.0252	1.25	0.0811	0.75	0.4689	7.22	0.2358	5.89
EDUCH	-0.1642	-5.16	0.2557	1.47	1.3660	12.08	0.6982	9.77
FEMALE	0.0324	1.36	-1.3678	-11.58	-0.5053	-7.23	0.5678	10.39
OLDAGE	0.2583	12.38	-1.3318	-13.97	-0.2558	-4.74	-0.1666	-4.81
SMHOUSE	-0.2121	-9.23	0.3122	2.66	-0.5325	-7.70	-0.3251	-7.07
SDHOUSE	-0.1349	-2.47	0.7378	2.55	0.3602	2.00	-0.0238	-0.24
TENURENT	0.0885	3.64	-0.0881	-0.75	0.4831	6.35	-0.0140	-0.31
TENURKIN	0.1708	4.49	0.0272	0.14	0.1617	1.36	0.1204	1.66
CENTHEAT	-0.0359	-1.42	0.0832	0.65	0.0121	0.17	0.0317	0.67
WEHOUSE	-0.0412	-1.96	0.5168	4.51	0.0108	0.17	0.1353	3.26
BATHROOM	-0.0458	-1.71	-0.3988	-2.93	-0.1966	-2.51	0.2803	5.40
MIDDLE	-0.0231	-1.23	-0.0760	-0.79	0.0167	0.30	-0.4014	-11.15
NORTH	-0.0952	-3.82	0.7781	5.79	-0.3968	-5.38	-0.4884	-10.33
RURAL	-0.1671	-8.43	1.3532	13.36	-0.2650	-4.53	-0.4932	-12.27
SPOUSENW	0.2049	10.11	0.3165	2.88	-0.6263	-9.75	0.0408	1.08
CAR	-0.2780	-11.13	10.3664	66.21	-0.6481	-9.41	-0.4490	-10.59
WINTER	0.0698	3.04	0.1919	1.66	0.7304	10.92	-0.0975	-2.38
SUMMER	-0.2534	-10.42	-0.6086	-5.03	0.3891	5.54	0.2819	6.40
AUTUMN	-0.1192	-5.22	-0.6452	-5.55	0.4052	6.10	0.1308	3.17
D6676	-1.0489	-9.18	-0.8648	-2.60	-3.4492	-9.36	0.1761	0.73
D66	-0.5624	-4.66	0.0399	0.09	-0.9329	-5.74	0.5484	4.91
D76	-0.0514	-0.38	-0.1405	-0.56	2.6981	10.62	-0.1614	-1.54
D81	-1.1584	-6.17	-0.5567	-2.27	-0.5315	-4.53	0.2301	1.79
D90	0.5784	7.62	-0.4730	-2.26	-0.2745	-2.19	0.5118	3.67
ILNXR	-0.7281	-3.66	2.2516	3.85	1.1595	3.72	4.0268	11.54
ILNXCH	0.1987	4.19	0.7335	4.10	0.9816	10.02	-0.0454	-0.83
ILNXFEM	0.0364	0.30	-1.6114	-5.06	-0.8737	-4.60	0.2738	1.81
ILNXSIZE	-0.1646	-3.82	-1.3284	-8.80	-0.9033	-11.47	-0.3523	-7.16
ILNXSQ	0.2820	2.14	-1.1777	-2.82	-1.7589	-7.83	-0.3142	-1.83
LNRELX	0.7669	4.12	0.9486	1.81	-0.3315	-1.09	-2.1107	-5.83
LRELP	-1.6691	-1.40	8.5722	1.86	17.5642	6.07	9.8372	5.77
LOGSO		-8.8486		-6.2792		-7.1709		-7.4418
D6676		0.1908		0.0712		0.0541		-1.5996
D66		-0.0377		0.1053		0.1829		-0.2439
D76		-0.9562		-0.1886		-0.1097		0.4706
D81		-0.6996		0.0436		-0.2080		-0.8573
D90		-0.6836		-0.0427		-0.2544		0.0958
YFITO		82.2269		12.7930		20.7279		41.2446

Table A3.1.b Estimation results by weighted LS, Model A.

Variable	Food		Beverages, Tobacco		Clothing, Footwear		Housing, Energy		Household Appliances	
	Param.	T	Param.	T	Param.	T	Param.	T	Param.	T
CONSTANT	-58.0523	-7.93	-36.0259	-10.95	5.4478	1.13	86.9087	11.34	44.6225	8.50
LKOH	-3.7863	-5.04	0.8721	2.41	-0.8349	-1.55	0.7966	0.97	2.7932	5.08
LAGE	47.6050	11.38	22.4307	11.86	0.9158	0.33	-41.2275	-9.38	-21.7326	-7.24
LAGESQ	-5.5042	-10.01	-3.2515	-13.28	-0.1040	-0.29	6.1238	10.62	2.3747	6.16
HHSIZE	0.1669	1.23	0.0546	0.99	0.6363	7.36	-0.5605	-3.95	-0.0431	-0.51
HHSIZESQ	-0.0344	-2.31	0.0006	0.12	-0.0275	-2.82	-0.0162	-1.00	-0.0179	-1.99
CHILDREN	-0.6052	-6.50	-0.5194	-13.18	0.0418	0.71	2.8746	30.98	0.3027	5.11
FARMER	-1.0219	-5.33	-1.4005	-18.20	0.1160	1.00	5.2537	26.54	-0.1181	-1.04
SELFEMPL	0.2434	1.05	-0.0867	-0.86	0.7020	4.61	-0.7549	-3.24	0.3319	2.18
WHCOLLAR	0.3166	2.16	-0.2667	-4.01	0.6760	6.98	-2.5012	-17.34	0.0923	0.93
RETIRED	-1.9995	-10.07	-0.4621	-5.00	-0.0455	-0.38	2.8022	13.38	0.1098	0.87
EDUCM	-0.0042	-0.03	-0.0986	-1.79	0.2299	2.91	-1.6647	-13.17	0.2190	2.62
EDUCH	0.9459	4.51	-0.3295	-3.77	0.3800	2.74	-4.8694	-23.41	0.6962	4.64
FEMALE	-1.3700	-10.15	-0.6523	-11.20	0.9940	10.81	1.2670	8.94	0.0917	0.97
OLDAGE	-0.2873	-2.37	-0.3262	-6.40	-0.4343	-6.20	2.8211	21.61	0.2709	3.65
SMHOUSE	0.0548	0.41	-0.1639	-2.76	-0.4580	-5.34	2.0828	15.29	0.3068	3.35
SDHOUSE	-0.8751	-2.56	-0.0628	-0.36	0.3372	1.34	-0.2411	-0.78	0.4378	1.95
TENURENT	0.4558	3.03	1.1242	15.14	0.2288	2.31	-1.9101	-13.18	-0.1110	-1.12
TENURKIN	0.1329	0.58	0.5835	5.25	0.8805	5.53	-2.0165	-9.19	-0.1613	-1.08
CENTHEAT	-1.0414	-6.53	-0.1874	-2.63	-0.1461	-1.55	1.5696	9.53	0.1304	1.33
WEHOUSE	-0.0964	-0.76	0.0006	0.01	-0.0427	-0.53	-0.3165	-2.42	0.1908	2.23
BATHROOM	-0.8466	-4.75	-0.5823	-7.10	0.3480	3.27	1.1677	6.67	0.4046	3.67
MIDDLE	-0.4709	-4.10	-0.4886	-9.92	0.1604	2.22	1.6454	14.14	0.2572	3.47
NORTH	-0.4653	-3.10	-0.2444	-3.76	0.5277	5.37	0.8161	5.35	0.3492	3.48
RURAL	-0.6464	-5.65	-0.2632	-5.20	-0.2171	-3.03	0.3520	3.04	-0.0306	-0.40
SPOUSENW	-0.4534	-3.65	-0.2138	-3.95	-0.8087	-10.17	3.3176	26.77	-0.2935	-3.67
CAR	-1.9512	-11.98	-0.0379	-0.53	-0.7104	-6.93	-6.1684	-37.71	-0.5407	-5.21
WINTER	-0.6343	-4.68	-0.4280	-6.76	-0.2885	-3.40	1.6909	12.34	-0.5102	-5.70
SUMMER	2.4383	16.21	-0.0206	-0.32	-0.5737	-6.13	-1.3321	-9.30	-0.6543	-6.89
AUTUMN	0.2274	1.71	-0.2774	-4.57	0.7586	8.54	-0.5489	-4.02	-0.4304	-4.78
D6676	4.0109	6.99	0.1665	1.05	3.7848	10.06	9.3454	13.64	3.4725	5.80
D66	0.3915	1.46	-1.4991	-13.09	2.6501	9.46	0.7878	3.02	1.9729	4.19
D76	-2.4183	-7.25	-0.9063	-5.45	-1.3982	-6.32	-2.2270	-7.01	-1.4897	-4.69
D81	1.6814	7.29	-0.2914	-2.92	1.1470	6.95	2.7800	13.95	-0.6058	-4.08
D90	2.4412	5.05	1.1007	9.31	-0.3805	-3.18	2.9198	7.81	-0.0692	-0.51
ILNXR	-13.6652	-23.19	-1.4002	-5.30	0.7648	2.14	11.4238	18.20	1.4771	4.04
ILNXCH	-0.1988	-0.98	0.2975	3.77	0.2260	1.72	-1.5809	-7.80	0.0044	0.04
ILNXFEM	1.2284	3.47	1.0776	7.36	-0.6150	-2.59	0.0763	0.21	-0.7000	-3.11
ILNXSIZE	-0.1952	-1.09	-0.3662	-5.05	-0.2469	-2.20	2.6484	14.84	-0.0662	-0.65
ILNXSQ	3.1541	7.61	0.3114	1.82	-1.0183	-3.94	1.0733	2.58	-0.8443	-3.16
LNRELX	-1.6923	-3.68	0.3872	1.86	-0.7380	-2.62	2.2954	4.56	-0.3935	-1.25
LRELP	39.9067	10.23	-3.6461	-2.42	-11.9539	-5.91	-42.2153	-10.74	15.3063	5.85
S.E.E		0.0876		0.0380		0.0555		0.0882		0.0568
R**2		0.3530		0.0772		0.0791		0.3023		0.0232
RESET(3)		47.8719		154.9385		24.8938		271.5205		3.8222

Table A3.1.b Estimation results by weighted LS, Model A.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	6.0125	2.41	64.3113	7.95	9.8524	2.09	-4.5132	-1.28
LCOHAGE	2.8445	9.72	-2.4742	-2.59	-1.6881	-3.16	-0.4651	-1.02
LAGE	-5.2103	-3.59	-24.8262	-5.47	2.9733	1.12	5.7532	2.91
LAGESQ	0.4627	2.45	3.2727	5.50	-0.4350	-1.26	-0.7425	-2.85
HHSIZE	-0.0935	-2.23	0.5314	3.41	0.0848	1.04	0.3003	4.68
HHSIZESQ	0.0051	1.21	0.0160	0.97	-0.0427	-5.23	0.0038	0.67
CHILDREN	-0.1878	-6.69	-1.7871	-12.82	0.6992	10.84	-0.3167	-5.88
FARMER	-0.0829	-1.45	-0.7655	-3.27	-0.6933	-6.37	-0.1076	-1.43
SELFEMPL	0.1182	1.72	-0.9973	-3.17	0.2686	1.68	0.6920	5.14
WHCOLLAR	0.1109	2.49	0.3974	2.08	0.6835	6.44	0.5507	6.64
RETIRED	0.3310	4.47	-0.3483	-1.66	-0.2255	-1.89	0.1932	1.96
EDUCM	0.1975	5.04	0.4834	3.15	0.5959	7.00	0.3919	5.79
EDUCH	0.1974	3.01	1.0206	3.71	1.6964	10.45	1.0712	7.55
FEMALE	0.1426	2.95	-0.4031	-2.23	-0.1362	-1.39	0.9530	9.20
OLDAGE	0.4726	10.76	-1.3818	-10.92	-0.3561	-5.41	-0.2177	-4.29
SMHOUSE	-0.2316	-5.33	0.1288	0.78	-0.5807	-6.23	-0.7411	-9.49
SDHOUSE	-0.1260	-1.28	0.1649	0.42	-0.0938	-0.40	-0.2736	-1.80
TENURENT	-0.1321	-2.80	0.0256	0.16	0.2704	2.64	0.1604	2.06
TENURKIN	-0.0506	-0.69	-0.1081	-0.42	-0.0269	-0.17	0.1688	1.36
CENTHEAT	0.0954	1.94	-0.0037	-0.02	0.1453	1.56	0.0426	0.60
WEHOUSE	0.0571	1.40	0.3069	1.82	0.1268	1.45	-0.0061	-0.08
BATHROOM	0.2008	3.74	-0.3142	-1.61	-0.0379	-0.36	0.1520	1.89
MIDDLE	-0.1385	-3.84	-0.2315	-1.76	-0.0702	-0.96	-0.3037	-5.56
NORTH	-0.1363	-2.99	0.3940	2.12	-0.3751	-4.00	-0.4513	-6.59
RURAL	-0.3060	-8.66	1.4923	10.74	-0.3955	-5.25	-0.5441	-9.13
SPOUSENW	-0.0073	-0.19	-0.0709	-0.44	-0.8852	-10.81	-0.1543	-2.59
CAR	0.0289	0.54	10.9384	59.57	-0.3126	-3.12	-0.6206	-8.08
WINTER	0.1311	2.90	-0.0990	-0.63	0.6404	7.50	-0.0972	-1.52
SUMMER	-0.1311	-3.02	-0.3823	-2.34	0.2720	3.04	0.1444	2.12
AUTUMN	-0.0821	-1.93	-0.4829	-3.06	0.4575	5.42	0.1531	2.37
D6676	-1.4201	-9.66	-0.1580	-0.41	-2.9228	-7.13	-0.2682	-0.95
D66	-0.5939	-4.69	0.3799	0.89	-0.8443	-4.96	0.3350	2.78
D76	-0.0175	-0.12	-0.4480	-1.73	2.4795	8.97	-0.0997	-0.90
D81	-1.4520	-6.90	-0.5080	-2.03	-0.4154	-3.42	0.0664	0.47
D90	0.8730	9.47	-0.6649	-2.92	-0.1199	-0.87	0.7629	4.96
ILNXR	-1.8057	-7.94	0.8210	1.21	0.0470	0.13	2.8284	7.24
ILNXCH	-0.0001	-0.00	0.0865	0.37	1.2781	11.25	-0.1540	-1.87
ILNXFEM	0.1108	0.84	-0.4009	-1.08	-0.5497	-2.66	0.6132	3.26
ILNXSIZE	-0.0055	-0.10	-1.0598	-5.03	-0.7676	-7.81	0.1166	1.51
ILNXSQ	0.2294	1.56	-1.5870	-3.45	-1.3463	-5.54	0.4807	2.47
LNRELX	0.4298	2.29	0.8395	1.56	-0.3685	-1.19	-1.8594	-5.05
LRELP	-2.3527	-1.79	9.6925	2.14	14.0417	4.31	5.6693	3.07
S.E.E		0.0275		0.1007		0.0558		0.0420
R**2		0.0708		0.2537		0.1160		0.1338
RESET(3)		65.2997		123.1282		100.0838		105.7522

Table A3.2.a Estimation results by quasi maximum likelihood, Model B.

Variable	Food		Beverages, Tobacco		Clothing, Footwear		Housing, Energy		Household Appliances	
	Param.	T	Param.	T	Param.	T	Param.	T	Param.	T
CONSTANT	-15.7885	-2.45	-41.4216	-20.96	22.6684	6.44	82.7591	10.99	35.5139	11.99
LAGE66	0.0979	0.17	0.4424	2.84	0.4373	1.42	-0.8756	-1.35	-0.3864	-2.01
LAGE71	0.0154	0.03	0.2782	1.94	0.0164	0.06	-0.9375	-1.56	0.1852	1.00
LAGE76	-0.0786	-0.17	-0.4561	-3.37	-0.1311	-0.48	1.1118	2.06	-0.4028	-2.39
LAGE81	0.5724	1.48	-0.3665	-3.24	-0.7493	-3.49	-0.1084	-0.25	0.5645	3.99
LAGE90	-1.0422	-2.91	0.2105	1.83	-0.6517	-3.33	0.0534	0.12	0.6018	4.36
LAGE	21.8116	6.22	26.3007	23.88	-8.5374	-4.43	-38.6580	-9.39	-13.8376	-8.91
LAGESQ	-2.6080	-5.50	-3.6178	-23.97	1.1267	4.30	5.9002	10.50	1.7372	8.45
HHSIZE	-0.1155	-1.04	-0.1301	-4.48	0.1560	2.61	-1.4302	-10.00	-0.4882	-11.11
HHSIZESQ	0.0080	0.66	0.0173	5.40	-0.0139	-2.25	0.0009	0.05	0.0140	3.41
CHILDREN	-0.2929	-4.05	-0.4102	-18.35	0.1303	3.41	2.7337	30.30	0.2557	8.90
FARMER	0.1832	1.16	-0.7583	-15.27	0.2626	3.28	4.8035	24.90	0.0165	0.30
SELFEMPL	0.0059	0.03	-0.1244	-2.12	0.7504	6.97	0.0263	0.11	0.1716	2.44
WHCOLLAR	-0.3649	-3.04	-0.2585	-7.07	0.4894	7.21	-1.9437	-13.56	0.1124	2.58
RETIRED	-1.0962	-6.49	0.0887	1.79	0.0136	0.15	2.5326	12.19	-0.0149	-0.26
EDUCM	-0.3011	-2.85	-0.2104	-6.56	0.1763	3.10	-1.3586	-10.88	0.2180	5.46
EDUCH	-0.2176	-1.31	-0.6711	-13.41	0.2359	2.57	-3.8492	-18.14	0.4137	6.21
FEMALE	-0.9776	-8.50	-0.7508	-21.17	1.1321	15.04	1.0949	7.85	-0.0204	-0.49
OLDAGE	-0.1207	-1.24	-0.0088	-0.29	-0.2851	-5.55	2.3277	18.07	0.1326	3.82
SMHOUSE	-0.1343	-1.21	-0.1814	-5.42	-0.2794	-4.63	2.6671	19.79	0.2628	5.96
SDHOUSE	0.0920	0.31	0.1525	1.70	0.7164	4.24	0.0566	0.19	0.3326	3.20
TENURENT	0.9893	7.94	1.0035	22.17	0.5338	7.51	-1.9394	-13.70	-0.1543	-3.41
TENURKIN	0.8346	4.28	0.5557	9.07	1.1750	10.30	-2.1500	-10.07	-0.1509	-2.14
CENTHEAT	-1.2704	-9.43	-0.3246	-8.64	-0.4086	-6.03	2.1437	13.30	0.0737	1.69
WEHOUSE	-0.5131	-4.88	-0.1778	-5.60	-0.1945	-3.42	0.1416	1.10	0.0387	0.99
BATHROOM	-1.7131	-11.65	-1.0661	-22.35	0.1718	2.36	1.9659	11.30	0.2511	4.97
MIDDLE	-0.0190	-0.20	-0.2367	-8.10	0.1351	2.63	1.2174	10.63	0.0194	0.58
NORTH	-0.1817	-1.44	-0.1571	-4.09	0.4184	5.90	0.5519	3.71	0.2080	4.39
RURAL	-0.0655	-0.66	-0.0905	-3.03	-0.0626	-1.20	0.3480	3.11	-0.0467	-1.35
SPOUSENW	0.2027	2.02	0.1332	4.40	-0.6060	-10.22	3.0496	25.19	-0.0924	-2.50
CAR	-2.4208	-16.45	-0.6610	-17.77	-1.0633	-15.06	-4.9815	-29.09	-0.2933	-6.41
WINTER	-0.1395	-1.22	-0.3509	-9.76	-0.2622	-4.21	1.5840	11.86	-0.2617	-5.86
SUMMER	1.9093	14.15	0.0109	0.30	-0.5922	-8.75	-1.0863	-7.76	-0.4427	-8.67
AUTUMN	0.3143	2.80	-0.1417	-4.07	0.6219	9.52	-0.3975	-2.98	-0.2917	-6.53
D66	4.9216	2.22	-2.2912	-3.78	2.3218	1.81	16.2699	6.35	10.3882	8.45
D71	5.4572	2.77	-0.3969	-0.73	2.0303	1.95	16.2942	7.03	5.1003	5.59
D76	1.9698	1.13	1.8917	3.64	1.7196	1.65	5.6395	2.75	4.3801	6.19
D81	0.0175	0.01	1.6246	3.74	3.2902	4.03	3.7896	2.33	-2.8912	-5.30
D90	8.6549	6.16	-0.4820	-1.09	1.9417	2.59	4.3967	2.61	-2.8000	-5.25
ILNXR	-10.1296	-19.32	0.4611	2.04	3.2743	10.73	10.2558	15.82	1.6090	5.51
ILNXCH	-0.2614	-1.39	0.0672	1.04	0.1629	1.42	-1.1338	-5.60	-0.0689	-0.76
ILNXFEM	1.9493	5.53	1.1548	8.09	-0.3471	-1.50	-0.0736	-0.20	-0.5332	-2.61
ILNXSIZE	0.0321	0.20	-0.2722	-4.71	-0.7577	-8.12	1.6394	9.18	-0.1900	-2.41
ILNX66	0.0369	0.05	0.0912	0.33	-1.8990	-3.90	-1.9371	-2.67	0.8750	1.83
ILNX71	0.8200	1.18	0.3460	1.20	-1.7700	-3.94	-0.6798	-0.99	1.1647	2.46
ILNX81	-0.7785	-1.20	0.7386	2.88	-1.7096	-3.88	0.9729	1.50	-0.4913	-1.08
ILNX90	-0.2075	-0.36	0.1851	0.82	-1.3189	-3.98	0.7882	1.47	-0.6512	-1.67
ILNXSQ	3.5667	7.66	-0.5226	-2.81	-2.8117	-10.00	-0.6444	-1.32	-0.5051	-1.75
LNRELX	-1.3779	-2.55	-0.0380	-0.17	-0.1247	-0.38	1.4155	2.52	-0.0021	-0.00
LRELP	59.9687	14.82	3.6023	2.53	-6.4237	-3.15	-64.7873	-15.29	21.4106	8.28

LOGSO	-7.3085	-8.0517	-7.2128	-5.7998	-8.5643
D6676	-0.9221	-0.4377	-0.4678	-0.5219	-3.3168
D66	-0.0453	0.2129	-0.3323	-0.1346	-1.6398
D76	0.3746	-0.0218	0.2798	0.0883	1.4215
D81	-0.2523	-0.1408	-0.2743	-0.0949	-0.2442
D90	-0.7486	0.1426	-0.1543	-0.0925	-0.5714
YFITO	10.7277	51.3278	24.5475	4.0527	47.5524

Table A3.2.a Estimation results by quasi maximum likelihood, Model B.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	-7.0516	-5.91	50.2016	8.15	5.2292	1.39	-16.7551	-7.45
LAGE66	-0.7198	-6.27	-1.9597	-3.60	2.3216	7.45	-0.2556	-1.45
LAGE71	-0.8205	-7.52	0.4456	0.94	2.5776	9.08	-1.1099	-6.54
LAGE76	-0.7185	-7.46	0.6688	1.50	1.0936	3.77	0.2507	1.51
LAGE81	-0.3992	-5.11	-0.7406	-1.97	0.6168	2.65	-0.3551	-2.40
LAGE90	-0.0446	-0.58	-0.8130	-2.23	1.3588	5.85	-0.9086	-5.85
LAGE	4.8815	7.61	-18.6349	-5.56	6.4181	3.15	11.7304	9.64
LAGESQ	-0.5039	-5.76	2.1108	4.64	-1.3580	-4.92	-1.5045	-9.12
HHSIZE	-0.2294	-10.91	-0.2817	-2.74	-0.0904	-1.53	-0.2564	-7.13
HHSIZESQ	0.0090	4.16	0.0708	6.08	-0.0311	-4.95	0.0198	5.29
CHILDREN	-0.0317	-2.40	-1.2855	-15.86	0.3901	8.61	-0.2274	-8.40
FARMER	0.2518	8.06	0.2028	1.24	-0.5520	-6.34	-0.0792	-1.57
SELFEMPL	0.0781	2.02	0.1445	0.65	0.4182	3.47	1.0183	12.44
WHCOLLAR	-0.0315	-1.31	0.1500	1.18	0.6489	8.39	0.5112	10.71
RETIRED	0.5187	13.81	-0.9065	-5.77	-0.0600	-0.63	0.3243	5.35
EDUCM	0.0324	1.57	0.0995	0.91	0.4330	6.66	0.2225	5.65
EDUCH	-0.1562	-4.83	0.2483	1.43	1.3309	11.76	0.6942	9.88
FEMALE	0.0349	1.44	-1.3276	-11.21	-0.4965	-7.06	0.5472	10.29
OLDAGE	0.2657	12.50	-1.3876	-14.53	-0.2387	-4.39	-0.1350	-3.94
SMHOUSE	-0.2182	-9.36	0.3089	2.63	-0.5044	-7.29	-0.3429	-7.52
SDHOUSE	-0.1256	-2.26	0.7142	2.47	0.4315	2.38	0.0181	0.18
TENURENT	0.0822	3.33	-0.1075	-0.92	0.4858	6.37	-0.0051	-0.11
TENURKIN	0.1696	4.40	-0.0206	-0.11	0.2203	1.84	0.1081	1.51
CENTHEAT	-0.0419	-1.63	0.0704	0.55	0.0231	0.32	0.0386	0.83
WEHOUSE	-0.0411	-1.93	0.5149	4.49	0.0079	0.12	0.1315	3.22
BATHROOM	-0.0480	-1.76	-0.3737	-2.73	-0.2084	-2.66	0.2635	5.19
MIDDLE	-0.0238	-1.26	-0.0833	-0.87	0.0101	0.18	-0.3857	-10.89
NORTH	-0.0957	-3.78	0.7772	5.79	-0.4011	-5.41	-0.4735	-10.15
RURAL	-0.1681	-8.36	1.3475	13.30	-0.3052	-5.20	-0.4855	-12.25
SPOUSENW	0.2055	9.97	0.3065	2.78	-0.6084	-9.48	0.0438	1.18
CAR	-0.2838	-11.21	10.4027	66.48	-0.7002	-10.10	-0.4321	-10.33
WINTER	0.0651	2.80	0.2022	1.75	0.7257	10.82	-0.0926	-2.28
SUMMER	-0.2623	-10.63	-0.5742	-4.74	0.3851	5.47	0.2689	6.18
AUTUMN	-0.1256	-5.42	-0.6381	-5.49	0.3976	5.97	0.1229	3.01
D66	1.7932	3.84	8.1266	3.87	-14.8075	-11.35	0.3471	0.49
D71	2.5728	6.06	-1.6640	-0.93	-14.0700	-12.59	3.4170	5.03
D76	2.0101	5.31	-3.1517	-1.88	-5.0436	-4.54	-1.4831	-2.31
D81	0.6429	1.83	2.5178	1.76	-3.0264	-3.41	1.4043	2.47
D90	0.4928	1.66	2.9149	2.05	-5.3728	-5.92	3.8988	6.60
ILNXR	-0.6623	-3.29	2.1689	3.69	1.4066	4.45	4.0076	11.54
ILNXCH	0.2169	4.54	0.8243	4.60	0.9231	9.36	-0.0537	-0.98
ILNXFEM	0.0154	0.13	-1.4911	-4.68	-0.9299	-4.85	0.1859	1.23
ILNXSIZE	-0.1722	-3.99	-1.3957	-9.28	-0.8549	-10.76	-0.3303	-6.74
ILNX66	0.2112	0.78	3.2194	4.18	-1.1078	-2.59	-2.2074	-6.24
ILNX71	0.2208	0.77	2.8621	3.83	-0.1137	-0.28	-1.9429	-5.79
ILNX81	0.4656	2.10	2.0948	3.00	0.9284	2.13	-1.6460	-4.78
ILNX90	0.8144	4.15	1.2667	2.04	0.0087	0.02	-0.3910	-1.20
ILNXSQ	0.1587	0.99	0.1345	0.28	-2.4264	-9.00	-1.1131	-5.26
LNRELX	0.1282	0.54	0.3666	0.59	-0.9646	-2.58	-1.3172	-3.11
LRELP	-1.4306	-1.19	9.6193	2.11	21.0690	7.30	9.5032	5.53

LOGSO	-8.8140	-6.2464	-7.2086	-7.5502
D6676	0.1075	-0.0760	0.1082	-1.2723
D66	-0.0810	0.0214	0.3037	-0.0922
D76	-0.9692	-0.1118	-0.2069	0.3200
D81	-0.8420	-0.0026	-0.2041	-0.8133
D90	-0.6412	-0.0686	-0.2037	0.1332
YFITO	80.7982	12.7812	20.6126	42.0378

Table A3.2.b Estimation results by weighted LS, Model B.

Variable	Food Param.	T	Beverages, Tobacco Param.	T	Clothing, Footwear Param.	T	Housing, Energy Param.	T	Household Appliances Param.	T
CONSTANT	-53.2053	-7.23	-38.1551	-11.62	5.9794	1.24	87.4633	11.35	42.4915	8.05
LAGE66	1.0112	1.47	0.2159	0.79	-0.4035	-0.83	0.0065	0.01	-0.3497	-0.75
LAGE71	0.8633	1.43	0.0780	0.29	-0.8011	-1.94	-0.8497	-1.39	0.7373	1.61
LAGE76	0.5693	1.05	-0.3229	-1.41	-0.3929	-0.99	1.3015	2.34	-0.5282	-1.19
LAGE81	1.2527	2.68	-0.1658	-0.85	-0.1831	-0.64	-0.4504	-0.99	0.6478	1.78
LAGE90	-1.0735	-2.54	0.1480	0.79	-0.6317	-2.34	0.4602	1.02	1.3975	4.00
LAGE	41.8291	10.40	24.3426	13.59	-0.5422	-0.21	-40.6317	-9.62	-17.5469	-6.19
LAGESQ	-5.2917	-9.64	-3.3856	-13.90	0.0249	0.07	6.1482	10.66	2.1288	5.57
HHSIZE	0.1617	1.19	0.0764	1.38	0.6164	7.10	-0.5330	-3.74	-0.0440	-0.52
HHSIZESQ	-0.0383	-2.57	-0.0026	-0.48	-0.0259	-2.64	-0.0140	-0.86	-0.0193	-2.15
CHILDREN	-0.6148	-6.59	-0.5266	-13.34	0.0508	0.86	2.8941	31.07	0.2851	4.81
FARMER	-1.0208	-5.33	-1.4180	-18.48	0.1142	0.99	5.2689	26.63	-0.1375	-1.21
SELFEMPL	0.2388	1.03	-0.0873	-0.86	0.7025	4.61	-0.7523	-3.23	0.3332	2.19
WHCOLLAR	0.3086	2.10	-0.2659	-4.00	0.6769	6.99	-2.5058	-17.37	0.0876	0.89
RETIRED	-2.0480	-10.27	-0.4539	-4.88	-0.0585	-0.48	2.8861	13.68	0.0624	0.49
EDUCM	0.0278	0.22	-0.1000	-1.80	0.2488	3.14	-1.7304	-13.59	0.2480	2.95
EDUCH	0.9980	4.74	-0.3268	-3.73	0.4058	2.93	-4.9705	-23.79	0.7286	4.85
FEMALE	-1.3591	-10.05	-0.6459	-11.09	0.9743	10.59	1.2642	8.91	0.1128	1.19
OLDAGE	-0.3431	-2.81	-0.3275	-6.38	-0.4485	-6.37	2.9035	22.06	0.2299	3.08
SMHOUSE	0.0675	0.50	-0.1520	-2.56	-0.4702	-5.49	2.0644	15.14	0.3298	3.60
SDHOUSE	-0.8878	-2.60	-0.0598	-0.34	0.3111	1.23	-0.1989	-0.64	0.4284	1.91
TENURENT	0.4113	2.73	1.1081	14.91	0.2352	2.37	-1.8566	-12.77	-0.1416	-1.43
TENURKIN	0.0816	0.36	0.5474	4.93	0.9007	5.63	-1.9836	-9.01	-0.1924	-1.30
CENTHEAT	-1.0521	-6.59	-0.1962	-2.76	-0.1228	-1.30	1.5440	9.36	0.1252	1.28
WEHOUSE	-0.0745	-0.58	0.0162	0.30	-0.0531	-0.66	-0.3460	-2.64	0.2079	2.43
BATHROOM	-0.8113	-4.53	-0.5824	-7.10	0.3527	3.30	1.0411	5.91	0.4674	4.21
MIDDLE	-0.4872	-4.24	-0.4997	-10.15	0.1692	2.34	1.6668	14.30	0.2391	3.23
NORTH	-0.4755	-3.17	-0.2529	-3.89	0.5404	5.50	0.8100	5.30	0.3401	3.40
RURAL	-0.6410	-5.60	-0.2647	-5.24	-0.2058	-2.88	0.3423	2.95	-0.0329	-0.44
SPOUSENW	-0.5074	-4.06	-0.2267	-4.17	-0.8051	-10.10	3.3770	27.08	-0.3288	-4.10
CAR	-1.9132	-11.70	-0.0546	-0.76	-0.6849	-6.65	-6.2414	-37.97	-0.5139	-4.92
WINTER	-0.6442	-4.74	-0.4330	-6.84	-0.2986	-3.52	1.7078	12.45	-0.5086	-5.69
SUMMER	2.4566	16.33	-0.0142	-0.22	-0.6035	-6.45	-1.3510	-9.42	-0.6457	-6.81
AUTUMN	0.2192	1.65	-0.2773	-4.57	0.7709	8.68	-0.5604	-4.10	-0.4274	-4.75
D66	-0.5904	-0.23	-1.3947	-1.35	7.3512	3.80	9.2925	3.51	8.0842	4.12
D71	-0.2456	-0.11	0.3064	0.30	6.1682	3.92	12.7126	5.45	1.8552	1.04
D76	-1.6542	-0.83	0.8406	0.97	3.4579	2.31	2.6838	1.28	4.3721	2.61
D81	-3.5736	-2.04	0.4448	0.60	1.6070	1.48	4.7565	2.83	-2.9131	-2.13
D90	6.9943	4.29	0.4229	0.58	2.1126	2.05	0.8148	0.47	-5.7256	-4.32
ILNXR	-14.0153	-23.62	-1.4697	-5.51	0.7572	2.10	11.8741	18.67	1.3330	3.62
ILNXCH	-0.1933	-0.94	0.2712	3.38	0.2484	1.87	-1.5756	-7.65	0.0043	0.04
ILNXFEM	1.3029	3.67	1.0986	7.48	-0.6313	-2.66	-0.0404	-0.11	-0.6434	-2.85
ILNXSIZE	-0.2670	-1.48	-0.3715	-5.06	-0.2581	-2.29	2.7261	15.19	-0.0895	-0.88
ILNX66	1.6481	2.25	1.0674	3.74	-1.3428	-2.72	-2.1721	-3.00	1.1019	2.25
ILNX71	1.6042	2.31	0.6741	2.30	-1.5781	-3.45	-0.0403	-0.06	1.2939	2.66
ILNX81	-0.4475	-0.69	0.8688	3.33	-1.4927	-3.33	1.7611	2.72	-0.4831	-1.03
ILNX90	-0.3332	-0.58	0.1402	0.62	-1.2177	-3.63	1.3220	2.47	-0.6768	-1.70
ILNXSQ	3.8684	8.11	0.6539	3.28	-1.3722	-4.65	0.1933	0.39	-0.1894	-0.61
LNRELX	-1.3190	-2.45	0.1919	0.82	0.0365	0.11	1.3856	2.47	-0.1483	-0.37
LRELP	38.7408	9.76	-3.5032	-2.28	-13.3278	-6.49	-39.9015	-10.02	14.7281	5.49

Table A3.2.b Estimation results by weighted LS, Model B.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	2.2690	0.90	65.8903	8.01	13.2734	2.76	-6.0330	-1.67
LAGE66	-1.4948	-5.72	-0.6544	-0.92	2.2041	5.57	-0.2948	-1.00
LAGE71	-1.2105	-4.39	0.7943	1.23	1.9249	5.27	-0.8120	-2.86
LAGE76	-1.0807	-5.33	1.5659	2.63	0.3227	0.80	-0.4971	-1.67
LAGE81	-0.8068	-4.51	-0.6323	-1.21	0.2803	0.87	-0.2162	-0.77
LAGE90	0.4208	2.04	-0.9901	-1.89	1.0072	3.17	-1.2656	-3.59
LAGE	-1.1923	-0.87	-28.1382	-6.34	0.5681	0.22	5.6909	2.92
LAGESQ	0.3972	2.10	3.3883	5.66	-0.4597	-1.33	-0.7264	-2.76
HHSIZE	-0.0989	-2.34	0.5188	3.32	0.1127	1.38	0.2858	4.44
HHSIZESQ	0.0064	1.50	0.0125	0.76	-0.0417	-5.07	0.0052	0.92
CHILDREN	-0.1795	-6.37	-1.7523	-12.54	0.6814	10.54	-0.3110	-5.76
FARMER	-0.0796	-1.39	-0.7207	-3.08	-0.6760	-6.23	-0.0850	-1.13
SELFEMPL	0.1225	1.78	-1.0074	-3.21	0.2806	1.76	0.6953	5.18
WHCOLLAR	0.1082	2.42	0.3450	1.81	0.7144	6.74	0.5746	6.95
RETIRED	0.3372	4.52	-0.4086	-1.94	-0.1306	-1.08	0.2436	2.45
EDUCM	0.1923	4.86	0.4967	3.22	0.5452	6.38	0.3831	5.64
EDUCH	0.1854	2.81	0.9810	3.56	1.6278	10.00	1.0940	7.70
FEMALE	0.1412	2.91	-0.3204	-1.77	-0.1473	-1.51	0.8916	8.61
OLDAGE	0.4820	10.90	-1.4447	-11.39	-0.3124	-4.69	-0.1823	-3.56
SMHOUSE	-0.2401	-5.52	0.1384	0.83	-0.5613	-6.03	-0.7805	-10.02
SDHOUSE	-0.1288	-1.30	0.1774	0.46	-0.0356	-0.15	-0.2748	-1.80
TENURENT	-0.1308	-2.77	-0.0178	-0.11	0.2907	2.83	0.1782	2.29
TENURKIN	-0.0434	-0.59	-0.1799	-0.69	0.0217	0.14	0.1896	1.53
CENTHEAT	0.0884	1.79	-0.0283	-0.16	0.1440	1.55	0.0493	0.69
WEHOUSE	0.0493	1.20	0.3179	1.89	0.1196	1.37	-0.0266	-0.36
BATHROOM	0.1863	3.44	-0.2615	-1.34	-0.0887	-0.84	0.1271	1.58
MIDDLE	-0.1368	-3.79	-0.2684	-2.04	-0.0598	-0.82	-0.2798	-5.14
NORTH	-0.1368	-3.00	0.3791	2.04	-0.3768	-4.02	-0.4373	-6.41
RURAL	-0.3082	-8.71	1.4755	10.63	-0.4209	-5.59	-0.5422	-9.12
SPOUSENW	0.0070	0.18	-0.1096	-0.67	-0.8373	-10.21	-0.1265	-2.12
CAR	0.0199	0.37	10.9792	59.50	-0.4198	-4.15	-0.6169	-7.94
WINTER	0.1279	2.83	-0.0958	-0.61	0.6308	7.39	-0.0867	-1.36
SUMMER	-0.1403	-3.22	-0.3405	-2.09	0.2722	3.04	0.1301	1.92
AUTUMN	-0.0907	-2.12	-0.4765	-3.03	0.4532	5.37	0.1514	2.35
D66	4.8672	4.94	3.6225	1.34	-13.8341	-8.52	-0.0684	-0.06
D71	4.0795	4.03	-2.9087	-1.21	-11.1998	-7.83	1.8648	1.75
D76	3.3564	4.49	-6.4314	-2.88	-1.8372	-1.19	0.8269	0.75
D81	2.0291	2.93	1.9620	1.00	-1.6588	-1.35	0.7096	0.68
D90	-1.1942	-1.58	3.6573	1.80	-3.8951	-3.14	5.5339	4.13
ILNXR	-1.6917	-7.37	0.6780	0.99	0.3996	1.10	2.8060	7.11
ILNXCH	0.0261	0.42	0.2018	0.85	1.1863	10.26	-0.1763	-2.11
ILNXFEM	0.0938	0.71	-0.2371	-0.64	-0.6263	-3.00	0.5159	2.74
ILNXSIZE	-0.0024	-0.04	-1.1642	-5.52	-0.6890	-6.91	0.1259	1.62
ILNX66	0.1408	0.51	3.4438	4.38	-1.0749	-2.47	-1.9382	-5.35
ILNX71	0.0649	0.22	2.7413	3.57	-0.2733	-0.66	-1.7937	-5.24
ILNX81	0.4173	1.88	2.4885	3.48	0.7887	1.77	-1.8037	-5.13
ILNX90	0.7335	3.75	1.2997	2.04	-0.1315	-0.36	-0.3544	-1.07
ILNXSQ	0.1207	0.71	-0.2636	-0.51	-1.9624	-6.87	-0.2586	-1.11
LNRELX	-0.1737	-0.73	0.2471	0.38	-0.8990	-2.33	-1.0030	-2.30
LRELP	-1.9008	-1.42	11.5959	2.51	18.3887	5.41	5.2238	2.75

Table A3.3.i Estimation results by weighted LS, Model C, year 1966.

Variable	Food Param.	Food T	Beverages, Tobacco Param.	Beverages, Tobacco T	Clothing, Footwear Param.	Clothing, Footwear T	Housing, Energy Param.	Housing, Energy T	Household Appliances Param.	Household Appliances T
CONSTANT	-59.2602	-2.09	-12.7948	-1.10	24.4568	1.15	124.3084	4.44	69.4867	3.90
LAGE	50.9960	3.31	11.0044	1.77	0.9205	0.08	-52.2562	-3.48	-26.4421	-2.84
LAGESQ	-6.2090	-3.00	-1.5742	-1.89	-0.3217	-0.21	7.3778	3.65	3.2875	2.66
HHSIZE	-0.3510	-0.83	0.0143	0.09	1.8271	6.29	-3.2763	-8.05	0.4255	2.04
HHSIZESQ	-0.0159	-0.42	0.0261	1.95	-0.0754	-2.81	0.1161	3.04	-0.0408	-2.16
CHILDREN	0.1241	0.42	-0.6480	-5.71	-0.8073	-3.80	2.8184	10.06	0.1731	1.15
FARMER	-0.5339	-0.87	-0.9918	-3.96	-1.7615	-4.07	4.7489	8.14	-0.1647	-0.53
SELFEMPL	-0.5215	-0.61	-0.2102	-0.60	0.5076	0.80	0.1890	0.23	0.4703	0.99
WHCOLLAR	-1.8122	-2.93	-0.4368	-1.64	1.0754	2.30	-1.8492	-3.20	0.2925	0.83
RETIRED	-3.3310	-4.39	-0.7896	-2.51	-0.7865	-1.49	2.8504	3.80	0.1902	0.47
EDUCM	0.1882	0.22	0.0884	0.26	0.4019	0.61	-2.4648	-2.96	0.6330	1.26
EDUCH	0.8295	0.45	-0.1722	-0.26	0.9360	0.66	-4.4126	-2.45	0.6332	0.57
FEMALE	-2.0815	-3.41	-2.0553	-8.82	2.1358	4.74	1.9095	3.14	0.8598	2.53
OLDAGE	-0.4032	-1.05	-0.3873	-2.74	-0.8241	-3.14	2.3016	6.06	0.4747	2.43
SMHOUSE	-0.0822	-0.13	-0.6377	-2.35	-0.1448	-0.30	1.1661	1.88	0.4893	1.31
SDHOUSE	0.6158	0.62	-0.3326	-0.68	1.5915	2.03	-2.6455	-3.02	0.0590	0.11
TENURENT	0.3669	0.62	0.8955	3.41	1.4670	3.42	-4.2205	-7.61	0.3326	1.04
TENURKIN	-1.3507	-0.94	-0.1906	-0.31	1.6348	1.55	-4.5291	-3.45	0.5545	0.72
CENTHEAT	-2.0529	-3.77	-0.3117	-1.42	-1.0994	-2.87	3.7562	7.17	0.3621	1.27
WEHOUSE	-0.2082	-0.35	0.0215	0.09	0.3687	0.84	0.6790	1.17	0.2670	0.80
BATHROOM	-0.0109	-0.02	-0.3054	-1.30	0.1969	0.44	1.0164	1.69	0.4173	1.19
MIDDLE	-0.2849	-0.71	-0.3837	-2.48	0.0240	0.08	0.9280	2.42	0.0986	0.47
NORTH	0.0655	0.13	-0.0690	-0.35	0.9302	2.51	-0.6039	-1.24	0.2495	0.92
RURAL	-0.9288	-1.73	-0.6923	-3.06	0.1661	0.44	-0.3830	-0.76	-0.2706	-0.94
SPOUSENW	0.2280	0.50	0.1852	0.98	-1.1241	-3.48	1.8267	4.22	-0.1835	-0.76
CAR	-3.9242	-4.89	-0.0257	-0.08	1.1106	1.95	-5.2118	-6.66	-1.0494	-2.71
WINTER	0.1638	0.23	-0.5143	-2.91	-0.9445	-2.89	3.5313	7.96	-0.4711	-1.89
SUMMER	3.9534	7.91	0.0307	0.13	-0.4231	-1.26	-2.4645	-5.43	-1.0113	-4.02
AUTUMN	2.2691	2.69	-0.0268	-0.10	1.2153	3.15	-1.7502	-3.88	-0.9386	-2.10
LRELXCH	-0.2790	-0.42	-0.2803	-1.20	0.2074	0.43	-0.9353	-1.44	-0.1364	-0.40
LRELXFEM	-1.3077	-0.88	0.2809	0.55	-1.3151	-1.15	3.0317	1.98	-1.0398	-1.20
LRELXSIZ	-0.1153	-0.18	0.2414	1.05	-0.4310	-0.96	1.8244	2.98	0.2516	0.80
LRELXSQ	2.9647	1.89	0.3004	0.51	-0.8882	-0.79	-1.1592	-0.75	-0.0683	-0.08
LNRELX	-15.4958	-7.80	-2.6264	-3.48	-0.1206	-0.09	7.5369	3.94	1.4320	1.34
LRELP	78.1623	2.90	-6.9604	-0.64	-94.5565	-5.04	-52.3076	-1.94	28.7601	2.50
S.E.E		0.0924		0.0358		0.0658		0.0878		0.0484
R**2		0.4038		0.0887		0.0790		0.3417		0.0671
RESET(3)		10.3083		33.2908		2.1464		42.5540		1.6377

Table A3.3.i Estimation results by weighted LS, Model C, year 1966.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	2.6366	0.26	21.9777	0.78	9.0913	0.64	8.3032	1.04
LAGE	1.0024	0.18	-5.1542	-0.34	-0.3354	-0.04	-4.2604	-0.99
LAGESQ	-0.1462	-0.20	0.3267	0.16	-0.1174	-0.12	0.5340	0.93
HHSIZE	0.0720	0.52	1.1242	2.87	0.6155	3.28	0.6356	5.79
HHSIZESQ	0.0033	0.28	-0.0210	-0.61	-0.0354	-2.15	-0.0325	-3.47
CHILDREN	-0.2834	-3.01	-1.0784	-3.37	-0.2012	-1.42	-0.2164	-2.60
FARMER	0.3201	1.65	-0.2448	-0.42	-0.4585	-1.58	-0.2869	-1.76
SELFEMPL	0.0564	0.20	0.4484	0.50	0.2654	0.59	-0.0474	-0.17
WHCOLLAR	0.0689	0.34	0.4058	0.63	1.4310	4.19	0.3903	1.97
RETIRED	0.5720	1.87	0.4644	0.72	-0.1628	-0.47	0.1098	0.50
EDUCM	0.1884	0.62	0.5788	0.65	1.0769	2.29	0.5773	2.05
EDUCH	-0.0477	-0.08	1.6768	0.84	1.5149	1.43	0.8874	1.32
FEMALE	-0.3791	-1.62	-0.8057	-1.44	0.2199	0.77	0.6566	3.16
OLDAGE	0.4269	3.19	-0.9998	-2.87	-0.3008	-1.82	-0.1695	-1.75
SMHOUSE	0.1164	0.52	0.3724	0.58	-0.5202	-1.49	-0.6068	-2.88
SDHOUSE	0.5041	1.56	0.7211	0.73	0.9412	1.69	-0.6735	-2.20
TENURENT	0.0121	0.06	0.3138	0.57	0.3104	1.03	0.4792	2.72
TENURKIN	0.7692	1.56	2.4521	1.98	-0.2392	-0.36	0.1635	0.41
CENTHEAT	0.1097	0.63	-0.1002	-0.18	-0.2831	-1.07	-0.0073	-0.05
WEHOUSE	-0.0035	-0.02	-0.6867	-1.05	0.2408	0.76	-0.2205	-1.17
BATHROOM	0.1137	0.56	-0.2964	-0.46	-0.5488	-1.70	-0.2442	-1.30
MIDDLE	-0.1613	-1.25	-0.0429	-0.11	-0.0146	-0.08	0.0265	0.25
NORTH	-0.0336	-0.21	-0.1048	-0.21	-0.4777	-2.06	0.0393	0.31
RURAL	-0.1231	-0.71	2.2132	4.24	-0.0544	-0.20	-0.2650	-1.73
SPOUSENW	0.3917	2.58	-0.7821	-1.76	-0.4361	-1.96	0.0259	0.20
CAR	-0.0336	-0.13	11.6030	13.15	-0.2442	-0.63	-0.1290	-0.57
WINTER	0.4210	2.74	-0.7887	-1.78	0.2793	1.30	-0.1836	-1.54
SUMMER	-0.3252	-1.70	-1.0925	-1.91	0.7799	2.73	0.1922	1.15
AUTUMN	0.0308	0.14	-1.8887	-2.99	1.1089	3.49	0.2918	1.58
LRELXCH	0.1313	0.64	1.2714	1.77	0.3173	1.00	-0.1065	-0.58
LRELXFEM	0.8384	1.47	-1.0079	-0.75	-0.9943	-1.39	0.5707	1.11
LRELXSIZ	-0.0200	-0.10	-1.5113	-2.25	-0.3215	-1.12	-0.0275	-0.16
LRELXSQ	0.7307	1.28	-0.4490	-0.27	-2.0636	-2.66	0.3607	0.73
LNRELX	-1.2617	-1.84	6.3215	3.20	1.0741	1.17	1.1902	2.11
LRELP	-11.3287	-1.22	13.8794	0.51	-11.9842	-0.90	-16.9670	-2.14
S.E.E		0.0298		0.0878		0.0436		0.0247
R**2		0.0576		0.2148		0.0623		0.0810
RESET(3)		6.8472		4.6395		5.8626		7.1424

Table A3.3.ii Estimation results by weighted LS, Model C, year 1971.

Variable	Food Param.	T	Beverages, Tobacco Param.	T	Clothing, Footwear Param.	T	Housing, Energy Param.	T	Household Appliances Param.	T
CONSTANT	-50.8351	-2.15	6.1310	0.54	36.8421	2.24	5.2590	0.22	22.0106	1.30
LAGE	49.1929	3.79	0.4147	0.07	-13.6503	-1.52	13.9603	1.08	-8.0842	-0.89
LAGESQ	-6.1257	-3.44	-0.1173	-0.14	1.6783	1.38	-1.5116	-0.85	0.9349	0.77
HHSIZE	0.1788	0.36	0.0301	0.14	0.9058	2.81	-2.9552	-6.07	0.1218	0.43
HHSIZESQ	-0.0524	-0.99	0.0212	0.93	-0.0027	-0.08	0.0929	1.74	-0.0351	-1.19
CHILDREN	0.4481	1.64	-0.5951	-4.89	-0.2446	-1.31	2.0146	7.55	0.1007	0.62
FARMER	1.5175	2.67	-1.4775	-5.58	-0.2059	-0.56	2.7990	5.02	-0.2437	-0.73
SELFEMPL	-0.1206	-0.12	-0.6060	-1.29	0.7037	1.02	-0.1224	-0.13	0.9529	1.57
WHCOLLAR	-1.0472	-1.80	-0.4499	-1.55	-0.1416	-0.33	0.5539	0.98	0.3582	0.89
RETIRED	-0.2603	-0.33	-0.7136	-1.92	-0.1427	-0.29	3.2541	4.12	-0.3908	-0.82
EDUCM	-1.2869	-2.93	-0.1770	-0.85	-0.3795	-1.24	-0.4818	-1.11	0.4747	1.65
EDUCH	-3.4921	-3.70	-0.7926	-1.86	-0.3122	-0.45	-0.3412	-0.36	2.5523	3.72
FEMALE	-2.8430	-5.00	-2.2928	-8.86	2.1048	5.38	2.1969	3.86	0.5565	1.53
OLDAGE	0.0826	0.21	-0.4676	-2.67	-0.1974	-0.81	0.6183	1.53	0.2236	0.99
SMHOUSE	-0.5638	-1.00	0.0554	0.21	0.0699	0.17	0.4308	0.76	0.5848	1.53
SDHOUSE	-0.5147	-0.51	-0.7354	-1.31	2.0383	2.53	-1.4625	-1.59	0.6520	0.95
TENURENT	0.8149	1.44	1.1749	4.10	1.7625	4.57	-5.4001	-10.30	-0.1193	-0.33
TENURKIN	1.4050	1.70	1.1312	2.79	2.3527	3.85	-7.0862	-9.49	0.0809	0.15
CENTHEAT	-0.7331	-1.22	-0.4970	-1.74	-0.8372	-2.18	2.8183	5.02	0.5117	1.46
WEHOUSE	-0.9609	-1.60	-0.1094	-0.40	-0.3205	-0.76	2.1622	3.60	0.4120	1.05
BATHROOM	-1.0051	-1.69	0.0196	0.07	-0.2420	-0.60	2.5234	4.30	0.0871	0.23
MIDDLE	-0.3718	-0.93	-0.3995	-2.14	0.1303	0.49	0.1046	0.26	-0.0393	-0.16
NORTH	-0.6985	-1.33	-0.2575	-1.06	0.3075	0.86	-0.4221	-0.83	-0.0959	-0.29
RURAL	-1.1871	-2.51	-0.4165	-1.90	0.0400	0.13	-1.2554	-2.86	0.5628	1.97
SPOUSENW	0.8229	1.90	0.2885	1.38	-0.9068	-3.14	1.3104	3.13	-0.5830	-2.19
CAR	-4.4048	-7.69	-0.2176	-0.81	-1.4245	-3.72	-2.3570	-4.26	-0.5445	-1.54
WINTER	-1.1685	-2.37	-0.7722	-2.66	-0.8791	-1.99	0.8457	1.17	-0.3287	-0.99
SUMMER	3.2063	6.54	-0.5735	-2.45	-2.2759	-5.01	2.0670	3.36	-1.0235	-2.56
AUTUMN	1.8016	3.03	-0.5070	-1.64	1.3291	2.82	0.4690	0.77	-0.2043	-0.55
LRELXCH	0.5402	0.70	0.3192	0.98	0.0203	0.04	-0.7488	-0.98	-0.4837	-1.06
LRELXFEM	-2.6964	-1.83	1.3589	2.08	2.7590	2.66	-2.6012	-1.72	-0.9295	-0.95
LRELXSIZ	-0.1682	-0.24	-0.2246	-0.74	0.2693	0.58	0.6025	0.89	0.0788	0.19
LRELXSQ	7.8057	4.89	2.4423	3.51	-0.2952	-0.27	-6.9311	-4.32	-1.4042	-1.30
LNRELX	-10.0034	-4.70	-1.5552	-1.56	1.3602	0.97	2.8164	1.32	1.4483	1.07
LRELP	165.7913	5.03	7.0965	0.74	-33.1134	-2.04	-74.6600	-3.51	-5.8512	-0.40
S.E.E		0.0894		0.0419		0.0602		0.0875		0.0549
R**2		0.3768		0.0920		0.1138		0.3329		0.0451
RESET(3)		6.1110		29.5309		11.6424		39.5505		2.0423

Table A3.3.ii Estimation results by weighted LS, Model C, year 1971.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	2.6395	0.26	84.7418	3.49	12.9573	1.06	-8.9923	-1.28
LAGE	-0.4176	-0.07	-40.9870	-3.09	-4.3665	-0.66	6.9901	1.81
LAGESQ	0.1124	0.15	5.2962	2.95	0.4592	0.51	-1.0259	-1.95
HHSIZE	-0.1841	-0.90	1.1501	2.49	0.8055	3.53	0.2549	1.82
HHSIZESQ	0.0241	1.17	-0.0626	-1.22	-0.0656	-2.73	0.0119	0.84
CHILDREN	-0.3242	-3.07	-0.9336	-2.73	-0.0341	-0.24	-0.1019	-1.24
FARMER	-0.0424	-0.19	0.3423	0.57	-0.9996	-3.65	-0.1275	-0.82
SELFEMPL	-0.2812	-0.75	0.2580	0.23	-0.0348	-0.07	0.4307	1.27
WHCOLLAR	0.4637	1.87	-0.7837	-1.18	0.8315	2.41	-0.0119	-0.06
RETIRED	0.9656	2.46	-1.3661	-1.95	-0.1051	-0.28	0.3743	1.57
EDUCM	0.5376	2.91	1.1170	2.34	0.2635	1.11	0.0893	0.64
EDUCH	1.1670	2.80	1.0868	0.98	0.9284	1.62	0.7986	2.19
FEMALE	0.0635	0.23	-0.5911	-1.09	0.0798	0.28	1.3030	6.47
OLDAGE	0.4282	2.44	-0.7230	-1.96	-0.5187	-2.99	-0.0201	-0.19
SMHOUSE	0.0818	0.34	0.3397	0.55	0.2658	0.83	-0.6115	-3.09
SDHOUSE	-0.4786	-1.14	0.5581	0.50	0.9104	1.51	-0.3706	-1.08
TENURENT	0.1190	0.49	-0.1034	-0.20	0.2524	0.83	0.6255	3.42
TENURKIN	0.2082	0.60	-0.4478	-0.49	0.2036	0.44	1.1688	4.24
CENTHEAT	0.3089	1.30	-0.4085	-0.68	0.3427	1.18	-0.3848	-2.28
WEHOUSE	-0.0845	-0.33	0.2573	0.34	0.3192	0.96	-0.1875	-0.93
BATHROOM	0.2334	0.94	-0.1708	-0.27	0.0984	0.31	-0.0577	-0.31
MIDDLE	0.1019	0.61	0.2642	0.64	-0.2118	-1.06	-0.0261	-0.22
NORTH	-0.0460	-0.22	1.0488	1.88	-0.2726	-1.07	-0.3567	-2.40
RURAL	-0.2090	-1.08	1.6460	3.41	-0.4958	-2.08	-0.1472	-1.04
SPOUSENW	-0.0799	-0.45	0.3836	0.80	-0.3993	-1.79	0.0252	0.20
CAR	-0.0314	-0.13	11.0098	16.67	-0.3189	-1.07	-0.9877	-5.82
WINTER	-0.0548	-0.21	0.6648	1.18	0.3596	1.50	0.1199	0.79
SUMMER	-0.4952	-2.29	-0.5319	-0.96	0.0824	0.31	-0.0401	-0.19
AUTUMN	-0.2185	-0.86	-1.2888	-1.96	0.8061	3.30	0.1907	0.85
LRELXCH	-0.0184	-0.06	0.3923	0.45	0.8481	2.16	-0.0021	-0.00
LRELXFEM	0.8446	1.17	-0.1700	-0.12	-0.0293	-0.04	2.1052	3.93
LRELXSIZ	0.4031	1.42	-1.4349	-1.81	-0.5440	-1.62	0.2456	1.16
LRELXSQ	0.5809	0.77	-1.2103	-0.70	-1.8504	-2.23	-0.2361	-0.43
LNRELX	-4.0974	-4.17	6.8034	3.14	0.5086	0.48	1.4025	2.12
LRELP	2.3792	0.20	9.1103	0.39	16.8623	1.21	-1.2782	-0.17
S.E.E		0.0370		0.0914		0.0450		0.0266
R**2		0.0553		0.2590		0.0797		0.1314
RESET(3)		1.0560		4.1384		7.3190		6.4979

Table A3.3.iii Estimation results by weighted LS, Model C, year 1976.

Variable	Food Param.	Food T	Beverages, Tobacco Param.	Beverages, Tobacco T	Clothing, Footwear Param.	Clothing, Footwear T	Housing, Energy Param.	Housing, Energy T	Household Appliances Param.	Household Appliances T
CONSTANT	-46.6656	-2.19	-8.8633	-0.95	-22.9244	-1.37	131.7778	6.03	51.0193	3.12
LAGE	38.6472	3.27	8.8249	1.72	14.7515	1.61	-55.4340	-4.58	-20.7732	-2.33
LAGESQ	-4.7841	-2.95	-1.3224	-1.88	-1.9873	-1.59	7.8932	4.74	2.5836	2.14
HHSIZE	1.0584	2.62	0.3711	2.24	1.1454	3.87	-1.1912	-2.82	0.2464	0.98
HHSIZESQ	-0.0850	-1.94	-0.0209	-1.27	-0.0624	-1.95	0.0180	0.38	-0.0669	-2.57
CHILDREN	-0.8657	-3.12	-0.4359	-3.83	-0.0120	-0.06	3.3631	11.95	0.3299	1.84
FARMER	-1.0640	-1.65	-0.9934	-3.95	0.5378	1.17	5.5504	8.42	-0.4186	-1.06
SELFEMPL	-1.5731	-2.04	0.0516	0.16	-0.0361	-0.06	0.9395	1.20	1.0878	2.06
WHCOLLAR	0.2410	0.55	-0.1721	-0.88	0.1535	0.44	-1.0042	-2.33	0.3050	0.96
RETIRED	-1.3292	-2.24	-0.2322	-0.88	-0.5396	-1.28	4.0248	6.61	-0.2774	-0.72
EDUCM	-0.2067	-0.56	-0.4107	-2.57	-0.0923	-0.32	-0.9684	-2.60	0.5207	1.93
EDUCH	0.6908	1.04	-0.4523	-1.68	-1.2356	-2.28	-3.8815	-5.89	0.9337	1.82
FEMALE	-2.2110	-5.58	-0.9692	-5.82	1.9564	6.27	0.7050	1.73	0.6478	2.33
OLDAGE	-0.9135	-2.38	-0.1783	-1.10	-0.2570	-0.98	3.2631	8.08	0.2951	1.22
SMHOUSE	0.1587	0.38	-0.3344	-1.89	-0.4896	-1.52	1.6397	3.86	0.3684	1.22
SDHOUSE	-0.6166	-0.84	-0.4128	-1.16	-0.3328	-0.55	0.8814	1.30	-0.3385	-0.66
TENURENT	0.7027	1.68	1.2082	6.06	0.8038	2.46	-4.3067	-10.15	-0.1023	-0.35
TENURKIN	-0.2923	-0.51	0.7113	2.73	1.2952	2.65	-2.5472	-4.59	0.8693	2.11
CENTHEAT	-1.0519	-2.27	-0.3845	-1.91	0.2994	0.89	0.3320	0.74	0.0733	0.24
WEHOUSE	-0.1034	-0.25	0.1658	0.96	-0.3373	-1.05	1.3845	3.23	0.0668	0.23
BATHROOM	-0.2668	-0.59	-0.7107	-3.46	0.3427	1.03	1.0672	2.40	0.3074	1.01
MIDDLE	-0.1267	-0.37	-0.5932	-4.09	0.4645	1.80	0.9092	2.62	0.6809	2.90
NORTH	0.0003	0.00	-0.3181	-1.60	0.0473	0.13	1.1955	2.59	0.7428	2.27
RURAL	-0.1540	-0.44	-0.2533	-1.67	0.2850	1.09	0.2758	0.79	0.0171	0.07
SPOUSENW	0.0034	0.00	-0.1942	-1.16	-0.1939	-0.65	3.1523	8.15	-0.3917	-1.48
CAR	-2.3192	-4.41	-0.4882	-2.14	-1.7707	-4.43	-6.0252	-11.24	-0.3414	-0.99
WINTER	1.1910	2.24	-0.8921	-3.73	-1.2863	-3.87	3.8887	7.90	-0.0161	-0.05
SUMMER	2.1198	2.63	-0.2101	-0.98	0.2131	0.40	-4.1326	-6.19	-0.7396	-2.45
AUTUMN	-0.5780	-0.80	-0.1725	-0.86	1.2293	3.80	-5.4941	-7.05	-0.3632	-1.26
LRELXCH	1.7667	2.02	0.7295	2.19	0.1517	0.23	-4.6757	-5.25	-1.0123	-1.84
LRELXFEM	0.7887	0.64	0.5136	0.99	0.3533	0.37	-0.1517	-0.12	0.2987	0.35
LRELXSIZ	-1.3450	-1.78	-0.8092	-2.67	0.2841	0.52	5.6233	7.50	0.3188	0.70
LRELXSQ	5.3873	3.61	-0.0326	-0.05	0.9739	0.91	0.3828	0.25	-0.6904	-0.67
LNRELX	-15.0742	-8.11	1.4800	1.86	0.7238	0.55	7.3712	3.95	-0.1191	-0.10
LRELP	49.3348	2.96	12.8113	1.49	45.7251	3.43	-143.5816	-6.91	25.5110	2.94
S.E.E		0.0818		0.0352		0.0620		0.0822		0.0567
R**2		0.3444		0.1027		0.0803		0.4078		0.0436
RESET(3)		8.2652		6.9320		1.9926		42.2102		0.4303

Table A3.3.iii Estimation results by weighted LS, Model C, year 1976.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	-1.8250	-0.30	34.1484	1.52	15.8225	1.03	-5.6867	-0.61
LAGE	1.5627	0.47	-10.6681	-0.87	-1.8821	-0.22	4.9298	0.96
LAGESQ	-0.1008	-0.22	1.2594	0.76	-0.0652	-0.06	-0.6660	-0.95
HHSIZE	-0.0185	-0.17	-0.3175	-0.76	0.1252	0.49	-0.0191	-0.12
HHSIZESQ	-0.0003	-0.03	0.0422	0.85	-0.0045	-0.18	0.0198	1.22
CHILDREN	-0.1792	-2.58	-1.1602	-3.19	0.3609	1.72	-0.4402	-3.67
FARMER	-0.1251	-0.79	-0.9807	-1.33	-0.3050	-0.72	-0.6926	-2.91
SELFEMPL	0.0011	0.00	-1.2785	-1.19	0.0645	0.11	0.6482	1.72
WHCOLLAR	0.1160	1.04	-0.2477	-0.48	0.5179	1.48	0.8242	3.94
RETIRED	0.2650	1.46	-0.4012	-0.71	-0.3015	-0.78	-0.0213	-0.08
EDUCM	-0.0283	-0.29	0.6063	1.45	0.4193	1.47	0.4367	2.59
EDUCH	0.0052	0.03	1.1507	1.42	1.0217	1.79	1.1179	3.12
FEMALE	0.2114	1.87	0.1611	0.39	-0.4982	-1.80	0.7653	3.90
OLDAGE	0.5615	4.91	-0.9818	-2.75	-0.3203	-1.34	-0.4094	-2.73
SMHOUSE	-0.2037	-1.87	0.6212	1.29	-0.6767	-2.15	-0.6011	-3.09
SDHOUSE	-0.0276	-0.15	-0.0118	-0.01	-0.6153	-1.08	-0.0057	-0.02
TENURENT	0.3429	2.96	-0.2029	-0.46	0.5959	1.85	0.3588	1.84
TENURKIN	0.0030	0.02	-1.3104	-2.04	0.2715	0.61	0.1765	0.66
CENTHEAT	0.0775	0.68	-0.0579	-0.11	0.2100	0.67	0.3699	1.96
WEHOUSE	0.1130	1.02	0.1309	0.25	-0.1027	-0.33	-0.0330	-0.16
BATHROOM	0.2555	2.22	0.4060	0.82	-0.0956	-0.30	0.2168	1.13
MIDDLE	-0.2423	-2.71	-0.6455	-1.80	-0.0003	-0.00	-0.4353	-2.96
NORTH	-0.4106	-3.57	-0.4442	-0.85	-0.5973	-1.87	-0.7139	-3.76
RURAL	-0.1433	-1.61	1.0987	2.94	-0.6156	-2.52	-0.3132	-2.10
SPOUSENW	-0.0907	-0.91	-0.4030	-0.84	-0.3554	-1.20	-0.3278	-1.94
CAR	-0.1016	-0.69	11.5960	18.60	-0.9859	-2.44	-0.2529	-1.11
WINTER	0.3488	2.44	-0.7624	-1.79	1.0855	3.23	0.0401	0.24
SUMMER	0.0262	0.18	-0.0082	-0.02	0.9183	1.53	0.0389	0.21
AUTUMN	0.0402	0.31	0.5338	1.01	0.0795	0.26	0.0494	0.26
LRELXCH	-0.0159	-0.08	0.2256	0.23	0.6883	1.16	0.0216	0.06
LRELXFEM	-0.2506	-0.68	0.4053	0.34	-1.5041	-1.83	1.0269	1.73
LRELXSIZ	-0.0156	-0.08	-1.1770	-1.43	-0.0778	-0.16	-0.4657	-1.52
LRELXSQ	-0.1912	-0.44	-1.3770	-0.89	-2.3514	-2.37	-0.5381	-0.80
LNRELX	-1.1289	-2.11	2.0484	1.09	1.1494	0.97	0.2656	0.34
LRELP	0.2226	0.03	84.9990	2.91	32.8101	1.72	-8.5695	-1.45
S.E.E		0.0215		0.0854		0.0581		0.0360
R**2		0.0939		0.2925		0.1162		0.0934
RESET(3)		8.3933		42.3289		7.3524		7.2361

Table A3.3.iv Estimation results by weighted LS, Model C, year 1981.

Variable	Food Param.	T	Beverages, Tobacco Param.	T	Clothing, Footwear Param.	T	Housing, Energy Param.	T	Household Appliances Param.	T
CONSTANT	-40.1238	-2.35	-30.5244	-4.17	-12.9743	-1.30	139.7867	8.71	24.0633	2.19
LAGE	34.7130	3.68	20.2620	5.03	10.0214	1.83	-67.9092	-7.66	-7.6080	-1.27
LAGESQ	-4.1626	-3.23	-2.8677	-5.23	-1.3922	-1.88	9.7484	8.03	0.8433	1.04
HHSIZE	0.6692	2.08	0.4155	3.25	0.3729	2.07	-0.5069	-1.62	-0.6708	-3.73
HHSIZESQ	-0.0858	-2.34	-0.0294	-2.15	-0.0023	-0.11	-0.0834	-2.29	0.0457	2.33
CHILDREN	-0.7528	-4.18	-0.5786	-8.12	-0.0479	-0.47	4.0306	24.28	0.1323	1.32
FARMER	-1.7901	-3.90	-1.6139	-9.33	0.2891	1.18	7.1106	16.18	0.0579	0.23
SELFEMPL	0.7668	1.41	-0.3859	-1.76	1.1447	3.62	0.7578	1.50	0.2280	0.72
WHCOLLAR	-0.1110	-0.34	-0.3990	-2.84	1.0438	5.36	-2.1366	-7.27	0.3880	1.96
RETIRED	-2.5779	-5.79	-0.3284	-1.67	-0.2147	-0.88	3.0905	7.19	0.0122	0.05
EDUCM	0.0769	0.27	-0.1098	-0.91	0.4150	2.52	-2.5135	-9.42	0.0567	0.33
EDUCH	1.2068	2.52	-0.5182	-2.76	0.7514	2.61	-5.5566	-12.89	0.9607	3.15
FEMALE	-0.7934	-2.63	-0.7308	-5.93	0.9202	5.07	1.0193	3.56	0.2365	1.30
OLDAGE	-0.4843	-1.70	-0.3106	-2.71	-0.8942	-6.06	4.2341	15.16	0.2180	1.37
SMHOUSE	0.2132	0.69	-0.2893	-2.26	-0.1990	-1.12	1.6460	5.73	0.2937	1.57
SDHOUSE	-0.9701	-1.17	0.1562	0.36	0.0241	0.05	-1.1207	-1.64	0.8396	1.71
TENURENT	0.3498	1.06	0.9471	6.12	-0.0654	-0.34	-1.0652	-3.66	-0.3161	-1.62
TENURKIN	0.5409	1.01	0.5677	2.33	0.4069	1.25	-0.6525	-1.41	-0.4990	-1.61
CENTHEAT	-1.3335	-3.47	-0.4794	-3.03	0.1798	0.88	0.9955	2.90	0.1693	0.80
WEHOUSE	0.0659	0.23	-0.0691	-0.60	0.3195	1.96	-0.3381	-1.26	0.4082	2.39
BATHROOM	-0.5078	-1.26	-0.6300	-3.50	0.8600	4.06	-0.0247	-0.07	0.4584	2.09
MIDDLE	-0.4275	-1.62	-0.3661	-3.41	0.2322	1.57	1.6038	6.55	0.4192	2.74
NORTH	-0.3020	-0.85	-0.5583	-3.85	0.4063	1.97	0.0654	0.20	0.7703	3.63
RURAL	-0.9252	-3.60	-0.3047	-2.86	-0.0825	-0.57	0.6240	2.62	-0.2030	-1.35
SPOUSENW	-0.5791	-1.98	-0.1157	-0.95	-0.8664	-5.21	3.6851	13.76	-0.6424	-3.77
CAR	-1.7299	-4.68	-0.0524	-0.34	-0.2772	-1.34	-7.0299	-20.65	-0.2612	-1.22
WINTER	-1.2674	-3.47	-0.8979	-4.79	-0.7994	-4.35	1.3392	4.50	-0.5945	-2.77
SUMMER	4.0511	11.36	0.3856	2.08	-0.2461	-1.18	-2.0871	-6.37	-0.4176	-1.97
AUTUMN	2.6094	6.13	0.7432	2.75	0.7344	3.54	-2.1761	-5.99	-0.2756	-1.25
LRELXCH	0.1229	0.20	0.2133	0.91	0.0867	0.25	-1.9692	-3.37	0.1231	0.37
LRELXFEM	0.3530	0.34	0.7125	1.73	0.0753	0.12	1.6477	1.67	0.0445	0.07
LRELXSIZ	-0.5582	-1.07	-0.5868	-2.86	-0.1039	-0.37	3.5606	7.60	-0.2905	-1.08
LRELXSQ	5.1353	4.21	0.6512	1.33	-1.0731	-1.65	-2.1208	-1.85	-0.6222	-0.87
LNRELX	-17.1560	-11.36	-0.0834	-0.13	-2.6770	-3.34	16.4918	11.78	-0.0747	-0.09
LRELP	-34.0940	-1.96	20.7996	3.39	2.9906	0.52	7.2541	0.63	15.1192	2.00
S.E.E		0.0939		0.0387		0.0531		0.0865		0.0548
R**2		0.2229		0.0792		0.0760		0.3083		0.0202
RESET(3)		4.9202		37.3574		6.9469		41.9258		0.9598

Table A3.3.iv Estimation results by weighted LS, Model C, year 1981.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	1.7084	0.45	38.3532	2.15	10.5164	1.03	-12.9989	-1.65
LAGE	-0.6081	-0.29	-13.2797	-1.36	1.1211	0.20	9.6132	2.21
LAGESQ	0.2258	0.77	1.3395	1.01	-0.4735	-0.63	-1.2856	-2.17
HHSIZE	-0.1146	-1.69	0.5675	1.68	0.1357	0.78	0.0706	0.50
HHSIZESQ	0.0092	1.28	0.0943	2.30	-0.0354	-1.87	0.0162	1.09
CHILDREN	-0.1814	-5.22	-2.1335	-8.78	0.3668	3.38	-0.4314	-5.19
FARMER	-0.1358	-1.52	-2.0227	-3.49	-0.9093	-3.69	-0.0812	-0.44
SELFEMPL	0.0931	0.90	-2.2790	-3.25	0.0873	0.26	0.8609	3.09
WHCOLLAR	0.0686	1.04	0.7747	1.92	0.4536	2.09	0.7732	4.64
RETIRED	0.1723	1.54	0.4369	0.97	-0.4356	-1.76	0.4100	1.98
EDUCM	0.3127	5.29	0.8509	2.56	0.7403	4.19	0.6411	4.76
EDUCH	0.2969	3.05	1.1684	2.04	1.6791	5.06	1.3161	4.94
FEMALE	0.2190	3.18	-0.8403	-2.51	-0.0363	-0.20	0.4821	3.00
OLDAGE	0.3843	5.64	-1.8969	-6.63	-0.4423	-3.01	-0.2716	-2.22
SMHOUSE	-0.2699	-4.16	-0.0680	-0.19	-0.4574	-2.36	-0.7149	-4.60
SDHOUSE	-0.2446	-1.47	0.1818	0.20	-0.4587	-0.85	0.1207	0.31
TENURENT	-0.1865	-2.68	-0.1413	-0.41	0.4606	2.18	-0.1448	-0.88
TENURKIN	-0.0997	-0.86	-0.5157	-0.94	-0.0674	-0.22	-0.4297	-1.72
CENTHEAT	0.0586	0.77	0.1909	0.46	0.1633	0.79	0.3058	1.90
WEHOUSE	-0.0322	-0.54	-0.1203	-0.33	0.1216	0.69	0.0417	0.29
BATHROOM	0.1122	1.35	-0.5876	-1.42	0.3661	1.71	0.3654	2.15
MIDDLE	-0.0829	-1.52	-0.6010	-2.07	-0.0223	-0.14	-0.2917	-2.41
NORTH	-0.0829	-1.18	0.5549	1.31	-0.1844	-0.90	-0.4210	-2.70
RURAL	-0.3734	-7.16	1.6822	5.74	-0.5772	-3.79	-0.7298	-6.14
SPOUSENW	-0.0347	-0.59	0.1638	0.44	-0.8379	-4.64	-0.4544	-3.32
CAR	0.1549	1.90	10.6473	27.48	-0.1962	-0.93	-0.6689	-3.84
WINTER	0.1658	2.10	0.5314	1.50	0.1562	0.74	0.1102	0.56
SUMMER	0.0328	0.50	-0.7898	-1.93	0.6845	3.40	0.2610	1.42
AUTUMN	-0.1355	-1.88	-0.2364	-0.35	0.7724	3.78	0.1597	0.89
LRELXCH	-0.0980	-0.83	1.2556	1.62	1.3209	3.76	-0.8000	-3.00
LRELXFEM	-0.1486	-0.60	-2.0474	-2.02	1.3203	2.31	0.2928	0.55
LRELXSIZ	0.1698	1.59	-2.0484	-3.37	-0.5970	-2.19	0.1637	0.72
LRELXSQ	0.2467	0.84	1.7451	1.42	-1.5471	-2.35	-0.8525	-1.48
LNRELX	-1.8003	-5.03	4.9954	3.30	-1.6150	-2.03	0.7436	1.09
LRELP	-11.3182	-2.35	5.6772	0.28	40.4396	3.80	7.8929	0.87
S.E.E		0.0194		0.1035		0.0557		0.0438
R**2		0.0914		0.2632		0.0997		0.0889
RESET(3)		3.1799		50.0180		8.4863		6.4345

Table A3.3.v Estimation results by weighted LS, Model C, year 1985.

Variable	Food		Beverages, Tobacco		Clothing, Footwear		Housing, Energy		Household Appliances	
	Param.	T	Param.	T	Param.	T	Param.	T	Param.	T
CONSTANT	-48.8404	-2.71	-31.9918	-4.42	1.5527	0.14	101.1961	6.13	38.4678	2.45
LAGE	41.9586	4.28	22.0391	5.59	2.6881	0.44	-50.5433	-5.53	-14.3248	-1.65
LAGESQ	-5.4061	-4.04	-3.0959	-5.78	-0.4400	-0.53	7.8025	6.23	1.7326	1.47
HHSIZE	-0.5362	-1.77	0.1673	1.47	0.5129	2.69	0.4978	1.69	-0.2939	-1.20
HHSIZESQ	0.0203	0.64	-0.0123	-1.15	-0.0181	-0.88	-0.1057	-3.22	-0.0002	-0.00
CHILDREN	-0.6941	-3.95	-0.4127	-6.12	0.0618	0.57	3.1661	20.23	0.3927	2.84
FARMER	-1.4989	-3.45	-1.1677	-7.55	0.5751	2.26	4.8321	11.61	0.0429	0.13
SELFEMPL	0.4667	1.03	0.0362	0.20	0.5021	1.70	-1.0202	-2.46	0.4353	1.16
WHCOLLAR	1.0962	3.56	-0.1851	-1.49	0.5062	2.53	-3.5394	-12.81	0.2439	0.93
RETIRED	-1.4242	-3.19	-0.2950	-1.55	0.1515	0.56	3.0833	7.12	0.4487	1.24
EDUCM	0.1551	0.62	-0.0799	-0.80	0.4858	3.10	-1.3962	-6.05	0.3779	1.84
EDUCH	0.9238	2.12	-0.3374	-2.06	0.7785	2.71	-5.2620	-13.52	0.6167	1.61
FEMALE	-1.6970	-6.00	-0.3409	-3.14	1.2733	6.76	0.6386	2.40	-0.2625	-1.09
OLDAGE	-0.2930	-1.06	-0.3609	-3.40	-0.2242	-1.45	2.3225	8.54	0.0629	0.29
SMHOUSE	0.8424	3.05	0.1131	1.03	-0.4959	-2.83	1.0755	4.25	0.1190	0.51
SDHOUSE	-1.0779	-1.30	0.0664	0.17	-0.3173	-0.54	0.9408	1.36	0.5338	0.77
TENURENT	0.6227	1.91	1.1531	7.81	-0.2651	-1.25	-0.1103	-0.38	-0.2564	-0.96
TENURKIN	-1.1468	-1.83	0.4062	1.52	1.0157	2.38	-1.0352	-1.91	-1.0730	-2.07
CENTHEAT	-0.9737	-2.16	-0.2477	-1.39	0.3990	1.55	0.3435	0.86	-0.4720	-1.41
WEHOUSE	0.3249	1.26	-0.0117	-0.12	-0.0424	-0.26	-0.9784	-4.08	0.0460	0.21
BATHROOM	-1.0649	-2.53	-0.6178	-3.32	0.2618	1.09	-0.1787	-0.49	0.9129	2.89
MIDDLE	-0.3092	-1.28	-0.4681	-4.93	-0.0624	-0.42	1.7821	8.02	0.0310	0.16
NORTH	-0.9580	-3.01	-0.0705	-0.56	0.2315	1.13	2.7900	9.52	-0.2284	-0.83
RURAL	-0.3385	-1.42	-0.1757	-1.86	-0.2277	-1.53	0.4704	2.16	-0.0106	-0.05
SPOUSENW	-0.9068	-3.33	-0.2469	-2.32	-1.0465	-6.11	4.1223	16.59	-0.4925	-2.20
CAR	-1.7458	-4.53	0.0433	0.28	-0.5811	-2.44	-6.8706	-19.51	-0.8169	-2.61
WINTER	-1.9333	-5.52	0.9137	4.16	0.0823	0.40	1.7279	6.25	-0.6108	-1.55
SUMMER	2.1259	6.80	-0.0502	-0.39	-0.2162	-1.16	-2.9206	-10.09	-0.0321	-0.13
AUTUMN	-1.2499	-3.41	-0.0012	-0.01	0.3823	1.38	0.0682	0.24	-0.3286	-0.75
LRELXCH	0.5071	0.88	0.4799	2.25	-0.4268	-1.20	-2.4407	-4.66	0.0460	0.11
LRELXFEM	2.8252	2.99	0.4185	1.15	0.4977	0.82	0.1552	0.17	-0.6630	-0.85
LRELXSIZ	-1.0200	-1.99	-0.6782	-3.45	0.1488	0.49	3.4428	7.54	-0.0488	-0.13
LRELXSQ	2.8750	2.46	-0.1331	-0.29	-1.2078	-1.74	0.9061	0.84	-0.3290	-0.35
LNRELX	-15.8156	-10.27	0.4443	0.72	-0.5624	-0.63	16.2493	11.69	0.4796	0.39
LRELP	28.2302	1.03	-60.5267	-6.90	8.6724	0.83	3.2262	0.23	56.7814	2.06
S.E.E		0.0917		0.0360		0.0575		0.0845		0.0754
R**2		0.1785		0.0719		0.0510		0.2716		0.0168
RESET(3)		11.4012		38.4695		5.6170		30.2905		3.1447

Table A3.3.v Estimation results by weighted LS, Model C, year 1985.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	8.9160	1.06	77.2689	3.90	37.3925	2.91	-50.5031	-4.16
LAGE	-5.0928	-1.11	-33.9075	-3.13	-12.0826	-1.72	28.8609	4.36
LAGESQ	0.9136	1.45	4.0295	2.74	1.2888	1.36	-3.8815	-4.30
HHSIZE	-0.1518	-1.14	0.9159	2.64	0.1878	0.90	0.4753	2.34
HHSIZESQ	-0.0009	-0.07	0.0174	0.45	-0.0562	-2.64	0.0035	0.18
CHILDREN	-0.1106	-1.52	-2.2626	-8.91	0.6630	5.13	-0.6576	-5.33
FARMER	-0.0625	-0.35	-2.7148	-4.50	-0.5445	-1.91	0.5164	2.04
SELFEMPL	0.2611	1.42	-2.2785	-3.72	0.8906	2.54	1.2619	3.64
WHCOLLAR	0.3645	2.81	-0.2895	-0.70	0.5919	2.39	0.5466	2.39
RETIRED	0.5804	2.39	-1.5792	-3.22	-0.3777	-1.26	0.3910	1.26
EDUCM	0.1368	1.28	-0.3343	-1.05	0.5314	2.84	0.5011	2.91
EDUCH	-0.0744	-0.41	1.3940	2.42	1.9407	5.29	1.0576	3.03
FEMALE	0.0861	0.65	-0.0217	-0.06	0.0342	0.16	0.7173	3.16
OLDAGE	0.6304	4.37	-1.0055	-3.39	-0.5440	-3.21	-0.1963	-1.14
SMHOUSE	-0.4104	-3.37	0.4441	1.27	-0.6444	-3.02	-0.6445	-3.11
SDHOUSE	-0.5330	-1.55	-0.0158	-0.02	-0.3158	-0.48	-0.0726	-0.13
TENURENT	-0.5933	-4.07	-0.2710	-0.76	0.0772	0.30	0.0421	0.17
TENURKIN	0.1651	0.58	-0.3908	-0.56	0.6330	1.41	0.9211	2.08
CENTHEAT	0.4135	2.16	-0.2543	-0.51	0.1645	0.59	0.5850	2.19
WEHOUSE	0.0983	0.87	0.4569	1.35	0.0266	0.14	-0.1288	-0.68
BATHROOM	0.0693	0.38	0.5135	1.12	-0.0711	-0.26	0.1887	0.73
MIDDLE	-0.1608	-1.54	-0.3614	-1.25	-0.2263	-1.27	-0.5197	-3.08
NORTH	-0.1395	-1.05	0.3450	0.83	-0.6249	-2.68	-0.9816	-4.55
RURAL	-0.3811	-3.78	1.4214	4.77	-0.5909	-3.33	-0.8050	-4.85
SPOUSENW	-0.1759	-1.54	0.6618	1.75	-1.6976	-8.15	0.0426	0.22
CAR	-0.0528	-0.29	11.0665	28.15	-0.7695	-2.89	-0.7850	-2.84
WINTER	-0.2340	-1.11	-0.0180	-0.05	0.6779	1.91	-1.1278	-4.02
SUMMER	-0.5218	-3.94	0.5110	1.21	0.0359	0.16	0.2650	1.20
AUTUMN	-0.3186	-1.61	-0.3173	-0.73	0.2116	0.60	-0.2982	-1.11
LRELXCH	-0.3895	-1.64	-0.5563	-0.77	2.1788	5.52	-0.4431	-1.19
LRELXFEM	0.4332	0.92	-0.8836	-0.90	-0.8933	-1.41	-0.8103	-1.14
LRELXSIZ	0.2283	0.99	-0.6308	-1.03	-1.3618	-4.18	0.1145	0.34
LRELXSQ	0.6137	1.03	-0.5368	-0.44	-2.5160	-3.25	2.0077	2.45
LNRELX	-2.6569	-3.50	-0.1067	-0.07	0.2926	0.29	1.8775	1.82
LRELP	6.8379	0.89	8.7524	0.65	43.0882	2.21	39.6559	2.73
S.E.E		0.0397		0.1113		0.0673		0.0639
R**2		0.0484		0.2312		0.0964		0.0521
RESET(3)		6.6131		19.6757		9.3482		19.8863

Table A3.3.vi Estimation results by weighted LS, Model C, year 1990.

Variable	Food Param.	Food T	Beverages, Tobacco Param.	Beverages, Tobacco T	Clothing, Footwear Param.	Clothing, Footwear T	Housing, Energy Param.	Housing, Energy T	Household Appliances Param.	Household Appliances T
CONSTANT	-44.5274	-3.57	-68.1196	-10.74	13.7398	1.72	96.1487	6.42	45.3423	5.14
LAGE	41.9936	6.08	42.1478	11.93	-3.2065	-0.73	-40.7596	-4.93	-22.0492	-4.52
LAGESQ	-5.3527	-5.63	-5.7886	-11.90	0.2604	0.43	6.2308	5.46	2.8831	4.32
HHSIZE	-0.4269	-1.48	-0.1986	-1.40	0.7460	4.13	0.7942	2.28	0.3339	1.78
HHSIZESQ	0.0300	0.82	0.0163	0.99	-0.0715	-3.00	-0.1331	-2.90	-0.0631	-2.69
CHILDREN	-0.5310	-3.19	-0.5986	-7.33	0.1682	1.60	2.6354	14.00	0.2999	2.84
FARMER	-0.8398	-2.10	-1.4999	-8.23	0.2998	1.28	4.8138	9.65	-0.3409	-1.39
SELFEMPL	0.7190	1.75	0.0921	0.43	0.8970	3.35	-3.7271	-8.10	0.0553	0.21
WHCOLLAR	0.4612	1.70	-0.3446	-2.42	0.8446	4.91	-3.6201	-12.10	-0.1325	-0.70
RETIRED	-1.7597	-4.93	-0.4253	-2.17	0.4804	2.24	1.3200	3.07	-0.0187	-0.08
EDUCM	0.1426	0.64	-0.0943	-0.81	0.3018	2.21	-2.4910	-9.69	0.2568	1.73
EDUCH	1.0850	3.08	-0.1381	-0.82	0.4346	1.94	-6.0728	-15.49	0.6799	2.67
FEMALE	-0.9460	-4.50	-0.6191	-6.01	0.6681	4.78	1.8083	7.30	0.0446	0.31
OLDAGE	0.1668	0.71	-0.3660	-3.17	-0.3117	-2.40	3.1248	10.50	-0.0093	-0.05
SMHOUSE	-0.3490	-1.47	-0.2080	-1.71	-0.6552	-4.43	3.3483	12.45	0.1916	1.20
SDHOUSE	-1.9144	-2.27	1.4363	2.86	-0.1417	-0.24	0.8233	0.95	0.0973	0.17
TENURENT	0.0662	0.21	1.1877	6.49	-0.1357	-0.68	-0.5306	-1.60	-0.3006	-1.51
TENURKIN	0.1116	0.30	0.4281	2.05	0.6754	2.67	-1.7907	-4.62	-0.4112	-1.72
CENTHEAT	0.4030	1.13	-0.0360	-0.20	-0.4221	-2.05	-1.2066	-2.59	0.5563	2.25
WEHOUSE	-0.0905	-0.43	0.0865	0.81	-0.2447	-1.86	-1.6024	-6.54	0.1461	1.04
BATHROOM	-0.0976	-0.23	-1.1283	-4.63	0.0783	0.34	-0.5716	-1.17	0.7659	2.94
MIDDLE	-0.9771	-4.65	-0.6066	-5.72	0.2324	1.79	3.1670	13.02	0.1174	0.85
NORTH	-0.7468	-2.74	-0.1835	-1.33	0.9140	5.25	0.4310	1.37	0.3968	2.11
RURAL	-0.9462	-4.76	-0.1198	-1.18	-0.4155	-3.38	0.6224	2.72	-0.0541	-0.41
SPOUSENW	-0.5327	-2.21	-0.5793	-4.81	-0.9240	-6.16	4.1749	15.26	-0.3823	-2.22
CAR	-1.6555	-4.85	0.1136	0.65	-0.7532	-3.71	-7.2763	-18.33	-0.2132	-0.83
WINTER	0.2138	0.77	-0.3530	-2.53	0.5070	2.80	1.4566	5.24	-0.8018	-4.86
SUMMER	2.2105	6.20	0.0783	0.50	0.2378	1.24	-0.5509	-1.60	-1.0174	-5.30
AUTUMN	1.6044	4.57	-0.3886	-2.93	0.4572	2.76	0.3627	1.22	-1.2733	-6.43
LRELXCH	-0.4298	-0.73	0.8742	3.09	-0.0229	-0.06	-2.3819	-3.46	-0.6864	-1.86
LRELXFEM	1.0916	1.49	0.9808	2.74	-0.5869	-1.24	-0.0105	-0.01	-0.1850	-0.37
LRELXSIZ	-0.0461	-0.10	-0.6870	-2.91	-0.2677	-0.95	1.8489	3.36	-0.0257	-0.09
LRELXSQ	2.0947	2.25	0.1367	0.29	-0.9034	-1.64	1.5583	1.40	0.3845	0.61
LNRELX	-12.9909	-10.41	-1.7924	-2.83	0.9313	1.29	17.8240	12.07	0.9252	1.06
LRELP	139.6438	7.15	-11.4273	-3.41	1.8836	0.39	-110.7522	-4.56	-44.6306	-1.72
S.E.E		0.0787		0.0403		0.0489		0.0898		0.0518
R**2		0.1618		0.0828		0.0789		0.3345		0.0197
RESET(3)		4.3018		73.1872		23.1506		56.5209		2.3316

Table A3.3.vi Estimation results by weighted LS, Model C, year 1990.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	6.4543	1.10	90.7217	5.65	-17.8777	-1.92	3.9151	0.32
LAGE	-3.4381	-1.04	-41.1706	-4.68	17.1958	3.37	1.3519	0.20
LAGESQ	0.7234	1.57	5.1033	4.27	-2.6006	-3.75	-0.3173	-0.34
HHSIZE	-0.2361	-1.85	0.0427	0.11	-0.2201	-1.05	0.5173	1.86
HHSIZESQ	0.0078	0.54	0.0949	1.88	-0.0503	-1.89	-0.0182	-0.56
CHILDREN	-0.1520	-2.28	-2.0643	-7.32	1.1766	8.95	-0.2234	-1.37
FARMER	-0.2393	-1.42	-0.5178	-0.76	-0.5453	-2.01	-0.3518	-1.05
SELFEMPL	0.2409	1.46	0.3388	0.51	0.2593	0.79	1.8923	4.28
WHCOLLAR	-0.0691	-0.62	0.9332	2.21	0.6612	2.88	1.3394	4.82
RETIRED	0.2679	1.43	-0.3324	-0.71	0.6296	2.38	0.8313	2.31
EDUCM	0.0566	0.58	0.7123	2.30	0.4439	2.61	0.3148	1.44
EDUCH	0.2047	1.35	0.2800	0.54	1.6947	5.62	1.3774	3.49
FEMALE	0.0383	0.39	-0.6964	-2.27	0.0079	0.05	0.7558	3.24
OLDAGE	0.6902	5.49	-1.7917	-5.75	0.1463	0.84	-0.0242	-0.11
SMHOUSE	-0.1390	-1.31	0.1792	0.53	-0.7022	-3.85	-1.2379	-4.97
SDHOUSE	-0.4832	-1.31	1.9519	1.76	-1.0135	-1.56	-0.8863	-1.06
TENURENT	-0.5373	-3.87	0.1254	0.34	-0.0343	-0.14	-0.1445	-0.45
TENURKIN	-0.1281	-0.78	0.2449	0.52	-0.2149	-0.76	-0.2601	-0.67
CENTHEAT	-0.2285	-1.38	0.6905	1.39	-0.3955	-1.55	-0.2113	-0.64
WEHOUSE	0.1919	2.01	0.9621	3.06	0.2168	1.37	0.3039	1.38
BATHROOM	0.4473	2.25	0.1496	0.30	-0.3633	-1.35	0.6494	1.76
MIDDLE	-0.1709	-1.82	-0.0535	-0.19	0.0682	0.44	-1.2394	-5.86
NORTH	-0.0472	-0.41	0.6192	1.56	-0.3842	-1.90	-1.2574	-4.82
RURAL	-0.2812	-3.27	1.1623	4.08	-0.1223	-0.83	-0.7354	-3.73
SPOUSENW	0.2231	2.26	0.0329	0.08	-0.9764	-4.71	-0.4636	-1.94
CAR	0.0095	0.06	10.4286	26.36	-0.0766	-0.28	-0.6319	-1.82
WINTER	-0.0947	-0.85	-0.2966	-0.89	0.5997	3.31	-0.1386	-0.55
SUMMER	-0.1737	-1.27	-0.2396	-0.57	-0.0112	-0.05	0.8866	2.93
AUTUMN	-0.2556	-1.93	-0.2501	-0.72	0.0536	0.29	0.6260	2.38
LRELXCH	-0.3172	-1.31	0.0480	0.06	1.8061	4.16	-1.0187	-1.82
LRELXFEM	0.5068	1.37	-1.9202	-2.11	-0.4464	-0.86	0.1888	0.24
LRELXSIZ	0.2778	1.27	-0.7964	-1.20	-0.3946	-1.19	0.5674	1.23
LRELXSQ	0.3662	0.73	-0.8644	-0.75	-1.0065	-1.57	-1.2015	-1.28
LNRELX	-2.5234	-3.90	1.0376	0.66	-0.4013	-0.43	0.7485	0.61
LRELP	1.0612	0.38	63.1147	3.19	75.3203	2.59	21.2366	2.47
S.E.E		0.0349		0.1067		0.0582		0.0795
R**2		0.0825		0.2545		0.1014		0.0649
RESET(3)		18.6950		34.6314		10.8938		1.1156

Table A3.4. Summary diagnostics by preliminary OLS.

Model	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
Model P									
S.E.E	0.0901	0.0412	0.0571	0.0907	0.0639	0.0390	0.1207	0.0580	0.0597
R^2	0.3660	0.0831	0.0770	0.3105	0.0182	0.0827	0.2211	0.1094	0.1010
DW	1.8719	1.9698	1.9947	1.6998	1.9772	1.9776	1.7314	1.9809	1.9544
Model A									
S.E.E	0.0904	0.0412	0.0570	0.0906	0.0642	0.0388	0.1209	0.0584	0.0599
R^2	0.3670	0.0844	0.0768	0.3142	0.0175	0.0822	0.2202	0.1109	0.1013
DW	1.8725	1.9727	1.9957	1.6979	1.9781	1.9771	1.7314	1.9826	1.9548
Model B									
S.E.E	0.0903	0.0413	0.0571	0.0906	0.0641	0.0383	0.1208	0.0580	0.0593
R^2	0.3679	0.0855	0.0772	0.3150	0.0185	0.0823	0.2209	0.1118	0.1043
DW	1.8701	1.9733	1.9959	1.6958	1.9793	1.9764	1.7325	1.9835	1.9574
Year 1966									
S.E.E	0.0937	0.0384	0.0670	0.0891	0.0495	0.0329	0.0960	0.0439	0.0257
R^2	0.3915	0.1009	0.0802	0.3448	0.0671	0.0599	0.2499	0.0611	0.0924
DW	1.8400	2.0297	1.9890	1.9401	2.0160	2.0093	1.7597	1.9134	1.9897
Year 1971									
S.E.E	0.0923	0.0436	0.0621	0.0885	0.0559	0.0420	0.1071	0.0452	0.0288
R^2	0.3774	0.1043	0.1222	0.3326	0.0368	0.0680	0.2729	0.0789	0.1364
DW	1.8632	1.9653	2.0215	1.9385	1.9936	1.9896	1.8300	2.0050	1.8808
Year 1976									
S.E.E	0.0841	0.0379	0.0627	0.0844	0.0583	0.0252	0.1177	0.0576	0.0386
R^2	0.3599	0.1070	0.0812	0.4186	0.0437	0.1061	0.2493	0.1168	0.0967
DW	1.8264	1.9862	2.0137	1.9402	1.9956	1.9899	1.7907	1.9662	2.0112
Year 1981									
S.E.E	0.0965	0.0415	0.0541	0.0897	0.0565	0.0227	0.1237	0.0565	0.0456
R^2	0.2425	0.0885	0.0797	0.3250	0.0185	0.1111	0.2220	0.1001	0.0923
DW	1.9384	1.9613	1.9911	1.5713	1.9856	1.9513	1.7228	1.9790	1.9847
Year 1985									
S.E.E	0.0943	0.0392	0.0582	0.0869	0.0766	0.0454	0.1272	0.0662	0.0661
R^2	0.2039	0.0800	0.0567	0.2854	0.0153	0.0693	0.1870	0.0943	0.0542
DW	1.8358	1.9896	1.9807	1.5673	1.9693	1.9924	1.7300	2.0030	1.9958
Year 1990									
S.E.E	0.0800	0.0443	0.0505	0.0914	0.0538	0.0401	0.1298	0.0592	0.0780
R^2	0.1718	0.0963	0.0768	0.3431	0.0197	0.1065	0.1779	0.0957	0.0667
DW	1.8565	1.9523	2.0051	1.5821	1.9609	1.9376	1.6876	1.9718	1.9247

Table A 3.5. Summary diagnostics by weighted LS.

Model	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9
Model P									
S.E.E	0.0880	0.0380	0.0555	0.0885	0.0567	0.0275	0.1006	0.0558	0.0420
R^2	0.3514	0.0762	0.0789	0.2999	0.0233	0.0695	0.2542	0.1153	0.1336
RESET(3)	43.831	165.332	27.026	263.208	6.480	74.022	114.876	95.860	110.135
Model A									
S.E.E	0.0876	0.0380	0.0555	0.0882	0.0568	0.0275	0.1007	0.0558	0.0420
R^2	0.3530	0.0772	0.0791	0.3023	0.0232	0.0708	0.2537	0.1160	0.1338
RESET(3)	47.872	154.938	24.894	271.520	3.822	65.300	123.128	100.084	105.752
Model B									
S.E.E	0.0876	0.0380	0.0554	0.0882	0.0567	0.0275	0.1005	0.0557	0.0418
R^2	0.3535	0.0785	0.0800	0.3033	0.0245	0.0722	0.2550	0.1167	0.1360
RESET(3)	52.466	164.140	22.676	256.395	2.536	49.301	118.993	60.102	78.204
Year 1966									
S.E.E	0.0924	0.0358	0.0658	0.0878	0.0484	0.0298	0.0878	0.0436	0.0247
R^2	0.4038	0.0887	0.0790	0.3417	0.0671	0.0576	0.2148	0.0623	0.0810
RESET(3)	10.308	33.291	2.146	42.554	1.638	6.847	4.639	5.863	7.142
Year 1971									
S.E.E	0.0894	0.0419	0.0602	0.0875	0.0549	0.0370	0.0914	0.0450	0.0266
R^2	0.3768	0.0920	0.1138	0.3329	0.0451	0.0553	0.2590	0.0797	0.1314
RESET(3)	6.111	29.531	11.642	39.550	2.042	1.056	4.138	7.319	6.498
Year 1976									
S.E.E	0.0818	0.0352	0.0620	0.0822	0.0567	0.0215	0.0854	0.0581	0.0360
R^2	0.3444	0.1027	0.0803	0.4078	0.0436	0.0939	0.2925	0.1162	0.0934
RESET(3)	8.265	6.932	1.993	42.210	0.430	8.393	42.329	7.352	7.236
Year 1981									
S.E.E	0.0939	0.0387	0.0531	0.0865	-0.0548	0.0194	0.1035	0.0557	0.0438
R^2	0.2229	0.0792	0.0760	0.3083	0.0202	0.0914	0.2632	0.0997	0.0889
RESET(3)	4.920	37.357	6.947	41.926	0.960	3.180	50.018	8.486	6.434
Year 1985									
S.E.E	0.0917	0.0360	0.0575	0.0845	0.0754	0.0397	0.1113	0.0673	0.0639
R^2	0.1785	0.0719	0.0510	0.2716	0.0168	0.0484	0.2312	0.0964	0.0521
RESET(3)	11.401	38.469	5.617	30.290	3.145	6.613	19.676	9.348	19.886
Year 1990									
S.E.E	0.0787	0.0403	0.0489	0.0898	0.0518	0.0349	0.1067	0.0582	0.0795
R^2	0.1618	0.0828	0.0789	0.3345	0.0197	0.0825	0.2545	0.1014	0.0649
RESET(3)	4.302	73.187	23.151	56.521	2.332	18.695	34.631	10.894	1.116

Table A3.6. Estimation results by quasi maximum likelihood, Model P.

Variable	Food		Beverages, Tobacco		Clothing, Footwear		Housing, Energy		Household Appliances	
	Param.	T	Param.	T	Param.	T	Param.	T	Param.	T
CONSTANT	-17.2483	-2.61	-39.4615	-20.07	23.1298	6.48	85.1195	11.38	40.0848	13.02
LKOH	-2.6876	-4.03	0.5575	2.86	-0.6924	-1.97	1.4408	1.89	1.7740	6.41
LAGE	26.2995	6.95	24.8426	21.63	-7.4930	-3.72	-39.5713	-9.26	-18.3405	-10.52
LAGESQ	-2.8584	-5.84	-3.4996	-23.15	1.0377	3.89	5.8517	10.39	2.1120	9.68
HHSIZE	0.0562	0.49	-0.1437	-4.93	0.1794	2.97	-1.4608	-10.19	-0.4969	-11.29
HHSIZESQ	-0.0085	-0.68	0.0180	5.58	-0.0155	-2.47	-0.0015	-0.10	0.0120	2.75
CHILDREN	-0.3337	-4.34	-0.4045	-18.18	0.1169	3.00	2.7402	30.43	0.2791	9.41
FARMER	0.0164	0.10	-0.7477	-15.02	0.2622	3.21	4.8312	24.86	0.0102	0.17
SELFEMPL	0.0161	0.08	-0.1376	-2.34	0.7619	6.94	-0.0460	-0.20	0.2090	2.78
WHCOLLAR	-0.3196	-2.54	-0.2627	-7.16	0.5004	7.26	-2.0257	-14.07	0.1529	3.27
RETIRED	-1.2616	-7.24	0.0561	1.14	-0.0001	-0.00	2.6335	12.70	-0.0067	-0.11
EDUCM	-0.3145	-2.89	-0.1846	-5.80	0.1895	3.28	-1.3422	-10.83	0.2206	5.30
EDUCH	-0.1625	-0.93	-0.6557	-13.17	0.2463	2.63	-3.9167	-18.56	0.4672	6.66
FEMALE	-1.0541	-8.81	-0.7499	-20.99	1.1765	15.48	1.1720	8.40	-0.0263	-0.58
OLDAGE	-0.1468	-1.45	-0.0200	-0.66	-0.3105	-5.97	2.3625	18.39	0.1315	3.57
SMHOUSE	-0.0974	-0.84	-0.1863	-5.55	-0.2752	-4.48	2.6722	19.77	0.2591	5.65
SDHOUSE	0.0992	0.32	0.1352	1.50	0.7400	4.28	0.0376	0.12	0.3498	3.17
TENURENT	1.1388	8.82	1.0048	22.13	0.5334	7.39	-2.0802	-14.66	-0.1653	-3.44
TENURKIN	0.9665	4.78	0.5707	9.30	1.1705	10.14	-2.2613	-10.59	-0.1208	-1.61
CENTHEAT	-1.4125	-10.26	-0.3277	-8.70	-0.4750	-6.87	2.2211	13.79	0.0603	1.30
WEHOUSE	-0.5290	-4.82	-0.1910	-6.00	-0.1781	-3.07	0.1723	1.34	0.0289	0.69
BATHROOM	-1.8654	-12.36	-1.0827	-22.46	0.1971	2.65	2.0735	12.00	0.2703	5.13
MIDDLE	-0.0089	-0.09	-0.2255	-7.71	0.1193	2.28	1.2057	10.51	0.0217	0.60
NORTH	-0.1427	-1.08	-0.1495	-3.89	0.4064	5.64	0.4949	3.32	0.2143	4.25
RURAL	-0.0583	-0.57	-0.0767	-2.57	-0.0726	-1.37	0.2691	2.40	-0.0279	-0.75
SPOUSENW	0.1521	1.45	0.1208	3.99	-0.6439	-10.72	3.1545	26.14	-0.1027	-2.60
CAR	-2.3842	-17.14	-0.6431	-17.44	-1.1024	-15.43	-5.3120	-30.97	-0.2851	-6.17
WINTER	-0.4484	-3.64	-0.4037	-10.67	-0.1986	-2.92	1.9146	13.46	-0.2660	-5.31
SUMMER	2.2231	15.69	-0.0392	-1.02	-0.6599	-9.50	-1.2525	-8.71	-0.4938	-8.75
AUTUMN	0.7010	5.24	-0.1833	-4.48	0.4605	6.04	-0.6120	-3.99	-0.5751	-9.58
LP1	22.5150	12.39	-1.0494	-1.85	2.0876	2.19	5.3265	2.64	-4.3136	-5.49
LP2	17.3431	3.72	4.3876	3.05	-13.2010	-5.07	16.2499	3.08	-9.0824	-4.79
LP3	7.7099	2.78	-3.6047	-3.90	-9.4759	-5.88	17.5728	5.52	-3.0703	-2.58
LP4	-2.8818	-1.21	4.4406	6.00	-2.1978	-1.69	11.8027	4.47	-2.4136	-2.42
LP5	-14.6673	-4.25	3.5838	3.34	-9.0788	-4.82	6.2311	1.59	10.6614	7.13
LP6	-13.4857	-5.23	-2.2864	-2.66	-4.5888	-3.28	0.1440	0.05	4.4083	3.64
LP7	4.5893	1.06	-7.5623	-5.96	-0.0111	-0.00	-3.5807	-0.74	-11.4420	-6.57
LP8	-22.3403	-3.38	1.9826	0.97	27.7637	7.47	-24.9378	-3.30	21.0344	7.51
ILNXR	-10.3348	-19.72	0.4602	2.07	2.9385	9.73	11.0699	17.37	1.6755	5.81
ILNXCH	-0.2755	-1.45	0.1066	1.66	0.2134	1.86	-1.1810	-5.84	-0.0202	-0.22
ILNXFEM	1.9573	5.55	1.1812	8.31	-0.2751	-1.20	-0.1522	-0.41	-0.5650	-2.78
ILNXSIZE	-0.0891	-0.56	-0.3053	-5.33	-0.7800	-8.34	1.6203	9.04	-0.2782	-3.57
ILNXSQ	3.5162	8.85	-0.5206	-3.40	-2.0414	-8.41	-0.2303	-0.55	-1.3868	-5.89
LNRELX	-0.7659	-1.70	0.2366	1.17	-0.5785	-2.12	0.8813	1.77	-0.3058	-1.03
LP9	1.2178	0.20	0.1083	0.06	8.7021	2.57	-28.8086	-4.02	-5.7821	-2.26

LOGSO	-7.1445	-8.1252	-7.2229	-5.8287	-7.8918
D6676	-0.0740	-0.0957	-0.3808	-0.0775	-0.9155
D66	-0.1940	-0.1577	-0.0841	-0.1332	-0.1253
D76	-0.1765	-0.2546	0.2045	-0.0496	0.0579
D81	0.0018	-0.0415	-0.1836	-0.0265	-0.7455
D90	-0.0222	0.0496	-0.1944	0.1239	-0.6671
YFITO	9.2519	51.1724	23.5451	3.8856	43.0368

Table A3.6. Estimation results by quasi maximum likelihood, Model P.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	-5.7485	-4.90	50.6671	8.30	1.0163	0.27	-14.2389	-6.53
LCOHAGE	1.2882	9.32	-0.9700	-1.47	-2.2474	-5.34	-0.3467	-1.56
LAGE	2.8080	4.17	-17.7458	-5.12	9.3324	4.39	10.9864	8.91
LAGESQ	-0.4509	-5.11	2.0771	4.59	-1.2961	-4.68	-1.4110	-8.59
HHSIZE	-0.2277	-10.77	-0.2771	-2.70	-0.0921	-1.56	-0.2162	-5.96
HHSIZESQ	0.0085	3.88	0.0695	5.98	-0.0341	-5.52	0.0153	4.07
CHILDREN	-0.0314	-2.36	-1.2728	-15.70	0.4118	9.01	-0.2404	-8.78
FARMER	0.2574	8.17	0.1451	0.89	-0.5822	-6.64	-0.1117	-2.19
SELFEMPL	0.0555	1.43	0.1633	0.74	0.4165	3.43	1.0449	12.61
WHCOLLAR	-0.0374	-1.56	0.1713	1.34	0.6332	8.15	0.5142	10.75
RETIRED	0.5268	14.02	-0.8711	-5.56	-0.1300	-1.37	0.3272	5.36
EDUCM	0.0246	1.20	0.0983	0.91	0.4421	6.79	0.2328	5.82
EDUCH	-0.1620	-5.00	0.2846	1.64	1.3611	11.98	0.6910	9.69
FEMALE	0.0386	1.59	-1.3728	-11.63	-0.5105	-7.23	0.5856	10.72
OLDAGE	0.2770	13.09	-1.3281	-13.96	-0.2546	-4.70	-0.1819	-5.23
SMHOUSE	-0.2074	-8.90	0.3194	2.72	-0.5330	-7.65	-0.3288	-7.13
SDHOUSE	-0.1268	-2.28	0.7189	2.49	0.4005	2.22	-0.0456	-0.46
TENURENT	0.0846	3.41	-0.0620	-0.53	0.5233	6.83	0.0082	0.18
TENURKIN	0.1761	4.56	0.0444	0.23	0.1930	1.62	0.1474	2.03
CENTHEAT	-0.0291	-1.13	0.0983	0.78	0.0000	0.00	0.0213	0.45
WEHOUSE	-0.0352	-1.64	0.5163	4.51	0.0039	0.06	0.1464	3.52
BATHROOM	-0.0415	-1.52	-0.4243	-3.12	-0.2084	-2.65	0.2715	5.22
MIDDLE	-0.0218	-1.14	-0.0632	-0.66	0.0369	0.66	-0.4015	-11.19
NORTH	-0.0916	-3.61	0.7914	5.89	-0.3848	-5.19	-0.4852	-10.30
RURAL	-0.1717	-8.53	1.3558	13.40	-0.2505	-4.26	-0.4754	-11.94
SPOUSENW	0.2072	10.07	0.3195	2.91	-0.6459	-9.99	0.0381	1.00
CAR	-0.2852	-11.26	10.4214	67.64	-0.6038	-8.78	-0.4249	-10.27
WINTER	0.0258	1.03	0.0889	0.72	0.8349	11.72	-0.1923	-4.41
SUMMER	-0.3313	-12.61	-0.4934	-3.94	0.3340	4.57	0.3375	7.36
AUTUMN	-0.1630	-5.73	-0.5973	-4.53	0.2742	3.54	0.1927	4.05
LP1	-0.4638	-1.13	0.4760	0.27	-4.1860	-4.01	-4.3246	-5.97
LP2	-0.4778	-0.51	12.5634	2.79	-14.3682	-5.37	3.6025	2.22
LP3	-1.0984	-1.74	8.3205	2.98	-4.3520	-2.78	6.7597	6.51
LP4	1.4630	2.81	-3.7118	-1.59	-6.1643	-4.54	1.4954	1.64
LP5	-1.1958	-1.65	12.4959	3.75	1.6621	0.88	-1.3799	-1.14
LP6	3.6110	6.06	5.0583	1.92	6.0525	3.99	1.0883	1.02
LP7	1.0270	1.16	-9.3178	-2.19	9.0554	3.67	0.7344	0.48
LP8	-8.4037	-5.91	-9.0757	-1.43	9.1433	2.48	-17.4903	-7.34
ILNXR	-0.3232	-1.71	2.3129	3.98	1.3161	4.24	3.7032	11.05
ILNXCH	0.1865	3.93	0.7206	4.03	0.9989	10.22	-0.0308	-0.57
ILNXFEM	0.0183	0.15	-1.5999	-5.03	-0.8226	-4.35	0.3472	2.30
ILNXSIZE	-0.1625	-3.76	-1.3394	-8.89	-0.9568	-12.24	-0.3859	-7.87
ILNXSQ	0.1299	1.01	-1.2333	-2.97	-1.7746	-7.97	-0.2267	-1.33
LNRELX	0.3064	1.75	0.9262	1.79	-0.3631	-1.21	-1.5961	-4.61
LP9	5.5383	4.22	-16.8089	-2.85	3.1573	0.94	9.5145	4.20

LOGSO	-8.6817	-6.2407	-7.0959	-7.6100
D6676	0.2885	0.1105	-0.4081	-1.1430
D66	-0.3029	0.1332	0.1694	-0.0162
D76	-1.1615	-0.2310	0.3251	0.4057
D81	-0.9151	-0.0122	-0.2542	-0.6066
D90	-0.4612	-0.0537	-0.2762	-0.0368
YFITO	80.0854	12.7834	20.2516	41.0775

Table A3.6. Estimation results by weighted LS, Model P.

Variable	Food Param.	T	Beverages, Tobacco Param.	T	Clothing, Footwear Param.	T	Housing, Energy Param.	T	Household Appliances Param.	T
CONSTANT	-55.3258	-7.58	-36.1264	-10.99	6.1794	1.29	88.8334	11.61	45.7685	8.76
LKOH	-4.1338	-5.75	0.8226	2.38	-0.4796	-0.93	1.5881	2.04	3.1677	6.06
LAGE	47.2832	11.36	22.3761	11.85	0.8036	0.29	-41.5350	-9.49	-22.9557	-7.69
LAGESQ	-5.4386	-9.91	-3.2337	-13.20	-0.1355	-0.38	6.0806	10.54	2.4797	6.46
HHSIZE	0.2406	1.79	0.0461	0.84	0.6032	6.99	-0.6121	-4.31	-0.0197	-0.24
HHSIZESQ	-0.0414	-2.83	0.0010	0.18	-0.0255	-2.62	-0.0114	-0.70	-0.0211	-2.40
CHILDREN	-0.6322	-6.72	-0.5126	-13.01	0.0321	0.54	2.8749	30.93	0.2978	5.03
FARMER	-1.0998	-5.73	-1.3915	-18.09	0.1053	0.91	5.2847	26.62	-0.1612	-1.42
SELFEMPL	0.2656	1.14	-0.0832	-0.82	0.7265	4.77	-0.7769	-3.34	0.3318	2.18
WHCOLLAR	0.3535	2.39	-0.2700	-4.06	0.6949	7.17	-2.5411	-17.58	0.1211	1.22
RETIRED	-2.0775	-10.51	-0.4717	-5.11	-0.0425	-0.35	2.8689	13.68	0.0642	0.51
EDUCM	0.0152	0.12	-0.0846	-1.54	0.2277	2.89	-1.6543	-13.12	0.2290	2.75
EDUCH	1.0173	4.82	-0.3337	-3.83	0.3773	2.73	-4.8965	-23.55	0.7595	5.07
FEMALE	-1.4148	-10.41	-0.6565	-11.27	0.9962	10.83	1.2905	9.09	0.0956	1.01
OLDAGE	-0.3553	-2.95	-0.3224	-6.33	-0.4456	-6.38	2.8639	21.90	0.2240	3.05
SMHOUSE	0.0861	0.64	-0.1638	-2.76	-0.4386	-5.11	2.0559	15.07	0.2836	3.10
SDHOUSE	-0.8687	-2.56	-0.0787	-0.45	0.3142	1.25	-0.2754	-0.89	0.3927	1.75
TENURENT	0.5468	3.63	1.1105	14.98	0.2042	2.07	-1.9955	-13.76	-0.1042	-1.06
TENURKIN	0.1995	0.87	0.5781	5.20	0.8348	5.26	-2.0698	-9.43	-0.1295	-0.87
CENTHEAT	-1.0813	-6.80	-0.1724	-2.42	-0.1519	-1.62	1.6322	9.94	0.0919	0.95
WEHOUSE	-0.0867	-0.68	0.0045	0.08	-0.0196	-0.24	-0.3033	-2.32	0.1780	2.09
BATHROOM	-0.9192	-5.17	-0.5867	-7.16	0.4165	3.92	1.1954	6.83	0.3907	3.56
MIDDLE	-0.4492	-3.90	-0.4897	-9.94	0.1323	1.84	1.6356	14.03	0.2498	3.38
NORTH	-0.4275	-2.83	-0.2430	-3.74	0.5055	5.15	0.7660	5.01	0.3572	3.58
RURAL	-0.6010	-5.23	-0.2679	-5.30	-0.2405	-3.36	0.2868	2.48	0.0019	0.03
SPOUSENW	-0.5007	-4.00	-0.2090	-3.87	-0.8224	-10.36	3.3980	27.38	-0.3283	-4.11
CAR	-1.7596	-10.97	-0.0539	-0.76	-0.7324	-7.18	-6.3565	-38.98	-0.4371	-4.26
WINTER	-0.8509	-6.17	-0.6439	-10.59	-0.2146	-2.39	1.9774	13.60	-0.4384	-4.69
SUMMER	2.5875	16.73	-0.0844	-1.28	-0.5222	-5.68	-1.3786	-9.39	-0.7647	-7.92
AUTUMN	0.6859	4.53	-0.2495	-3.61	0.5101	4.99	-0.5705	-3.66	-0.7858	-7.65
LP1	21.9597	10.91	-3.2919	-3.73	-1.5945	-1.27	5.9508	2.89	-6.3907	-5.04
LP2	17.1093	3.36	6.0735	2.73	-20.2091	-5.78	18.9280	3.54	-14.5959	-4.32
LP3	5.3971	1.80	-8.4272	-6.26	-13.3956	-6.47	18.6324	5.79	-7.1695	-3.58
LP4	-0.1023	-0.04	3.4483	3.16	-5.2950	-3.16	11.2421	4.23	-1.6352	-0.97
LP5	-19.6523	-5.24	4.3886	2.68	-9.0762	-3.54	5.4947	1.40	13.3032	5.09
LP6	-14.1819	-5.09	-1.7964	-1.43	-5.4040	-2.93	-1.5893	-0.53	7.7797	4.18
LP7	13.5968	2.78	-5.4412	-2.56	-0.3092	-0.09	-2.7732	-0.56	-11.5573	-3.34
LP8	-26.9770	-3.74	7.4147	2.33	40.4395	8.08	-26.8038	-3.50	26.7356	5.40
ILNXR	-14.0630	-24.13	-1.3912	-5.31	0.6351	1.79	11.9016	19.06	1.3062	3.62
ILNXCH	-0.1533	-0.75	0.3116	3.95	0.2429	1.85	-1.6064	-7.85	0.0354	0.31
ILNXFEM	1.2417	3.52	1.0835	7.40	-0.6066	-2.56	-0.0726	-0.20	-0.6943	-3.10
ILNXSIZE	-0.2891	-1.61	-0.3686	-5.09	-0.2574	-2.29	2.7208	15.14	-0.1160	-1.15
ILNXSQ	3.3051	8.01	0.3461	2.03	-0.9133	-3.54	0.8118	1.95	-0.8547	-3.23
LNRELX	-1.0814	-2.38	0.3751	1.82	-0.6955	-2.48	1.4857	3.00	-0.2499	-0.81
LP9	2.8505	0.43	-2.3685	-0.81	14.8441	3.23	-29.0818	-4.07	-6.4699	-1.46
S.E.E		0.0880		0.0380		0.0555		0.0885		0.0567
R**2		0.3514		0.0762		0.0789		0.2999		0.0233
RESET(3)		43.8306		165.3322		27.0256		263.2076		6.4802

Table A3.6. Estimation results by weighted LS, Model P.

Variable	Health Care,		Transport, Communication		Education, Entertainm.		Other Services	
	Param.	T	Param.	T	Param.	T	Param.	T
CONSTANT	4.0798	1.65	64.7310	8.02	9.6828	2.06	-4.4304	-1.26
LCOHAGE	2.4416	8.96	-2.5847	-2.81	-2.2145	-4.29	-0.4336	-1.00
LAGE	-4.4848	-3.11	-25.2129	-5.58	3.4486	1.31	5.6182	2.86
LAGESQ	0.4195	2.22	3.3374	5.62	-0.4358	-1.27	-0.7308	-2.81
HHSIZE	-0.0929	-2.21	0.5584	3.60	0.1088	1.35	0.3192	5.01
HHSIZESQ	0.0050	1.18	0.0128	0.78	-0.0451	-5.60	0.0016	0.29
CHILDREN	-0.1846	-6.57	-1.7821	-12.80	0.6918	10.73	-0.3247	-6.04
FARMER	-0.0765	-1.34	-0.7643	-3.27	-0.7360	-6.77	-0.1271	-1.69
SELFEMPL	0.1048	1.53	-0.9979	-3.18	0.2729	1.70	0.7127	5.28
WHCOLLAR	0.1057	2.37	0.3961	2.08	0.7061	6.65	0.5615	6.77
RETIRED	0.3479	4.69	-0.3636	-1.74	-0.2212	-1.86	0.1890	1.92
EDUCM	0.1898	4.85	0.4956	3.25	0.5520	6.51	0.3935	5.83
EDUCH	0.1895	2.89	1.0508	3.84	1.6737	10.35	1.0823	7.64
FEMALE	0.1520	3.14	-0.4038	-2.24	-0.1301	-1.33	0.9717	9.40
OLDAGE	0.4894	11.11	-1.3870	-11.00	-0.3567	-5.43	-0.2358	-4.66
SMHOUSE	-0.2239	-5.15	0.1323	0.80	-0.5834	-6.26	-0.7393	-9.47
SDHOUSE	-0.1206	-1.23	0.1465	0.38	-0.0512	-0.22	-0.2912	-1.92
TENURENT	-0.1370	-2.91	0.0560	0.35	0.3143	3.08	0.1776	2.29
TENURKIN	-0.0540	-0.74	-0.0850	-0.33	0.0129	0.08	0.1870	1.51
CENTHEAT	0.1122	2.29	-0.0077	-0.04	0.1175	1.27	0.0294	0.42
WEHOUSE	0.0569	1.39	0.3005	1.78	0.1149	1.32	0.0042	0.06
BATHROOM	0.1953	3.64	-0.3474	-1.79	-0.0532	-0.51	0.1524	1.90
MIDDLE	-0.1334	-3.70	-0.2198	-1.67	-0.0583	-0.80	-0.3099	-5.67
NORTH	-0.1328	-2.91	0.4090	2.20	-0.3588	-3.83	-0.4505	-6.57
RURAL	-0.3102	-8.77	1.5053	10.87	-0.3737	-4.98	-0.5248	-8.82
SPOUSENW	0.0006	0.02	-0.0761	-0.47	-0.9064	-11.09	-0.1690	-2.83
CAR	0.0133	0.25	10.9878	60.22	-0.2463	-2.50	-0.5697	-7.55
WINTER	0.0464	1.01	-0.1989	-1.23	0.7889	8.90	-0.2471	-3.74
SUMMER	-0.2164	-4.76	-0.3265	-1.95	0.1913	2.09	0.2510	3.51
AUTUMN	-0.1702	-3.36	-0.4580	-2.64	0.2512	2.59	0.2460	3.40
LP1	-2.8610	-4.62	0.6807	0.30	-4.4204	-3.40	-6.4884	-5.95
LP2	-2.0083	-1.32	11.8989	2.12	-17.3449	-5.12	1.0241	0.44
LP3	-3.3264	-3.10	3.5874	1.04	-3.9113	-1.97	10.1738	6.53
LP4	2.2707	2.84	-5.3924	-1.86	-3.1968	-1.89	1.2581	0.99
LP5	0.6012	0.47	10.7606	2.52	2.3891	0.97	-0.1905	-0.11
LP6	4.3310	4.78	5.0066	1.52	5.9804	3.11	2.6965	1.72
LP7	-1.2054	-0.63	-6.4753	-1.14	6.0488	1.90	0.9331	0.40
LP8	-5.1741	-2.12	0.3091	0.04	8.5072	1.81	-20.5731	-5.95
ILNXR	-1.6135	-7.22	0.7968	1.18	0.1064	0.30	2.4967	6.54
ILNXCH	-0.0085	-0.14	0.0774	0.33	1.2659	11.19	-0.1482	-1.81
ILNXFEM	0.1137	0.87	-0.3779	-1.02	-0.5100	-2.48	0.6429	3.43
ILNXSIZE	0.0052	0.09	-1.0690	-5.09	-0.7964	-8.15	0.0969	1.26
ILNXSQ	0.1956	1.34	-1.5891	-3.47	-1.3479	-5.59	0.5312	2.75
LNRELX	0.2178	1.19	0.9071	1.71	-0.3354	-1.09	-1.4790	-4.12
LP9	7.3723	3.39	-20.3757	-2.77	5.9479	1.37	11.1663	3.66
S.E.E		0.0275		0.1006		0.0558		0.0420
R**2		0.0695		0.2542		0.1153		0.1336
RESET(3)		74.0217		114.8757		95.8599		110.1346

A.4 Appendix 4

In the following we present the Engel curves in consumption for the categories $W_2, ..., W_9$. These are shown for six different household types. The values in total consumption which are *not adjusted for the number of equivalent adult members* in the household are shown in the picture for a typical range of values in the data, the mean ± 2 SD's, in the group under consideration. In those households having a single young member, or children the household head is thirty years old. The households with old-aged members have a household head who is seventy years old. Adults are working if they are under 65 years old. All households except the one with a single old-aged female own a car but the other (dummy) variables have zero values corresponding to the implicit reference groups. Note that in calculating the Engel curves in consumption we naturally use the relevant real expenditure variables. First deflating using separate Stone indices for the surveys, and subsequently adjusting for the relevant number of equivalent adults in the household. However, the variable shown in the x-axis corresponds to the undeflated and unadjusted nominal expenditure variable.

In addition full estimation results are reported on the price and expenditure elasticities of household demand which have been calculated at the aggregate level. The results are based on Model P with both symmetry and adding-up constraints imposed, see Chapter 8.

The 'Slutsky-matrix' is calculated as $D(w)\Xi$, where $D(w)$ is a diagonal matrix with the vector of budget shares on the diagonal, and Ξ is the matrix having the compensated price elasticities as elements.

Figure A4.1. Engel curves in consumption and household type.

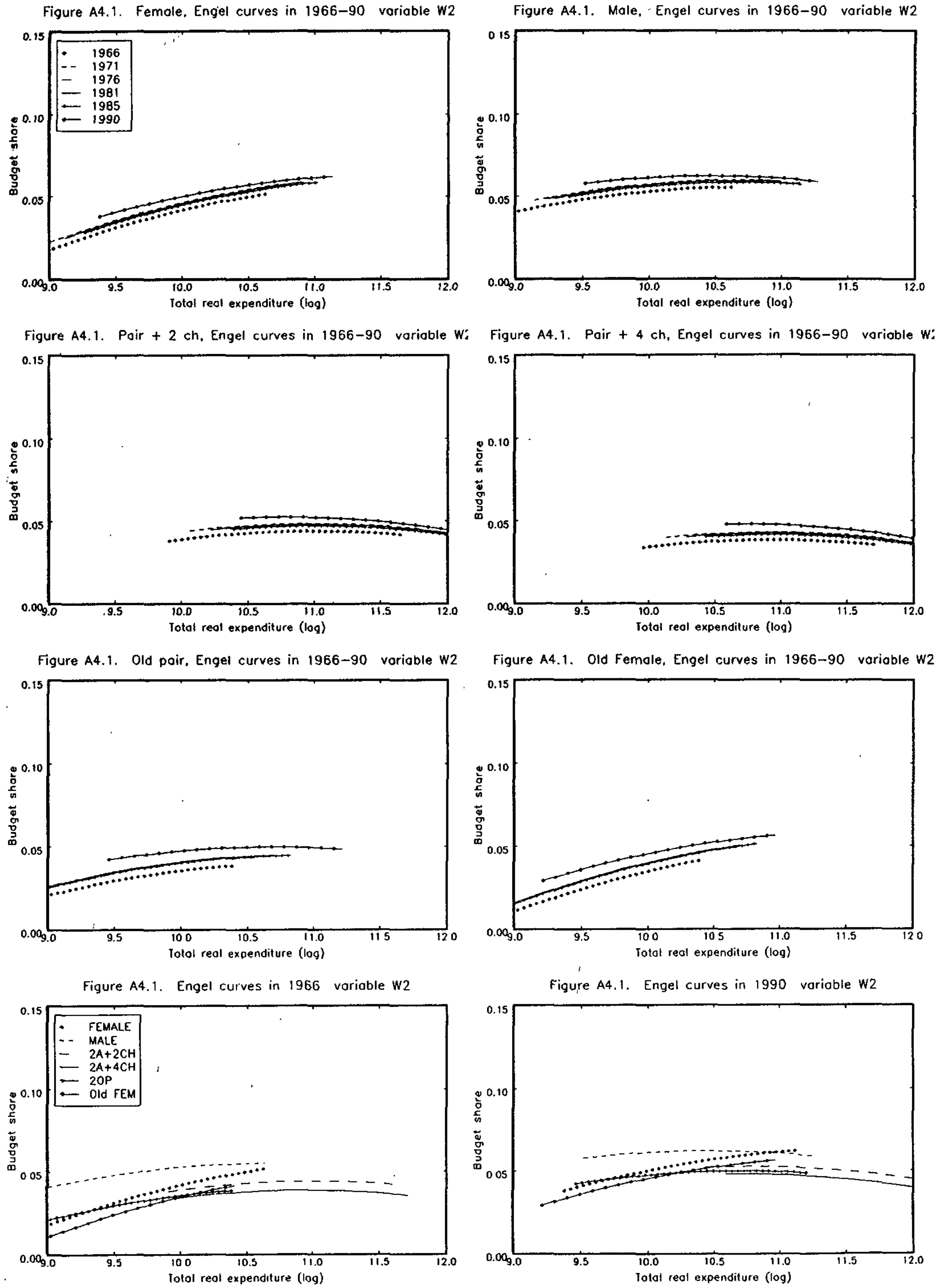


Figure A4.1. Engel curves in consumption and household type.

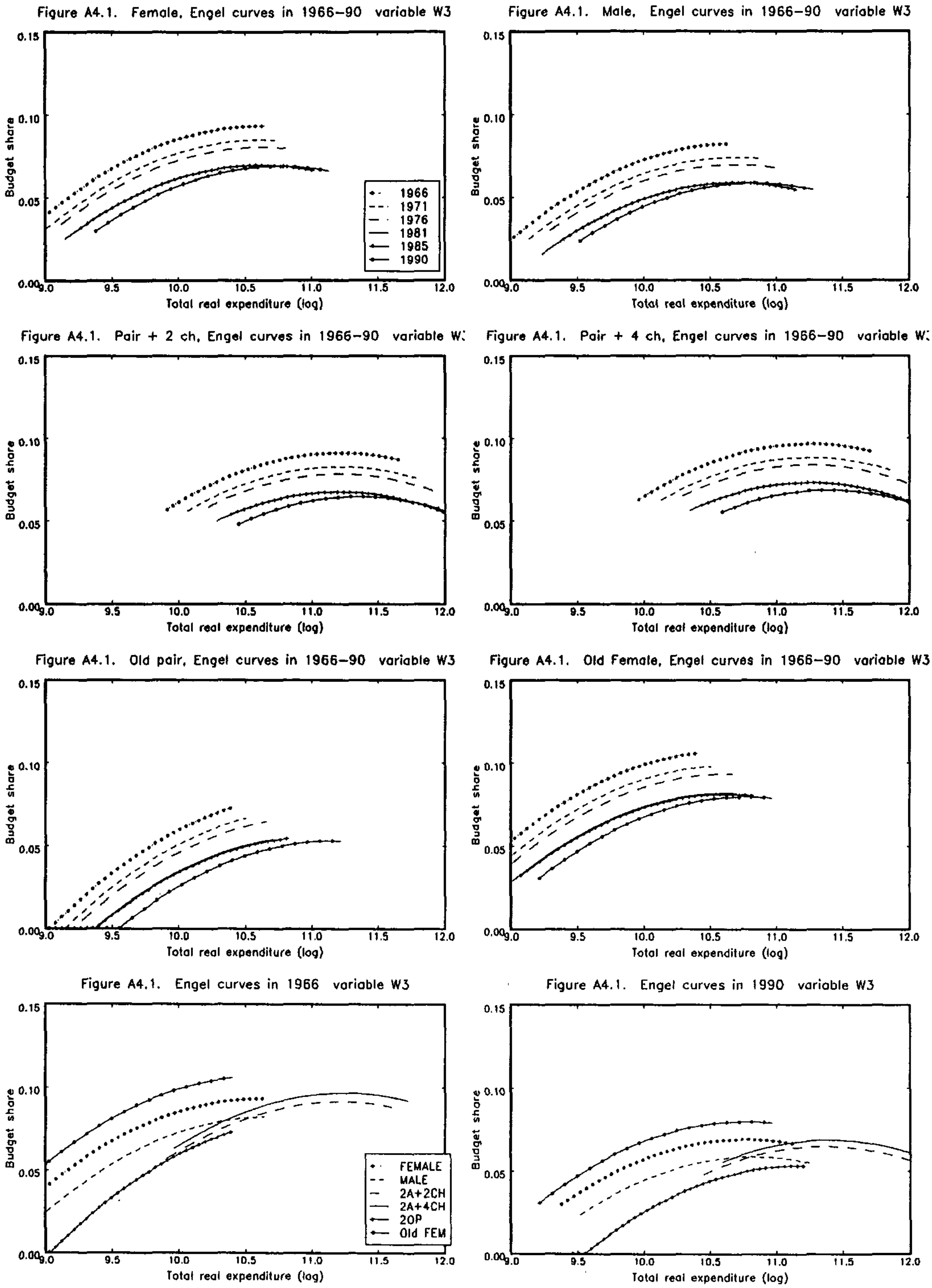


Figure A4.1. Engel curves in consumption and household type.

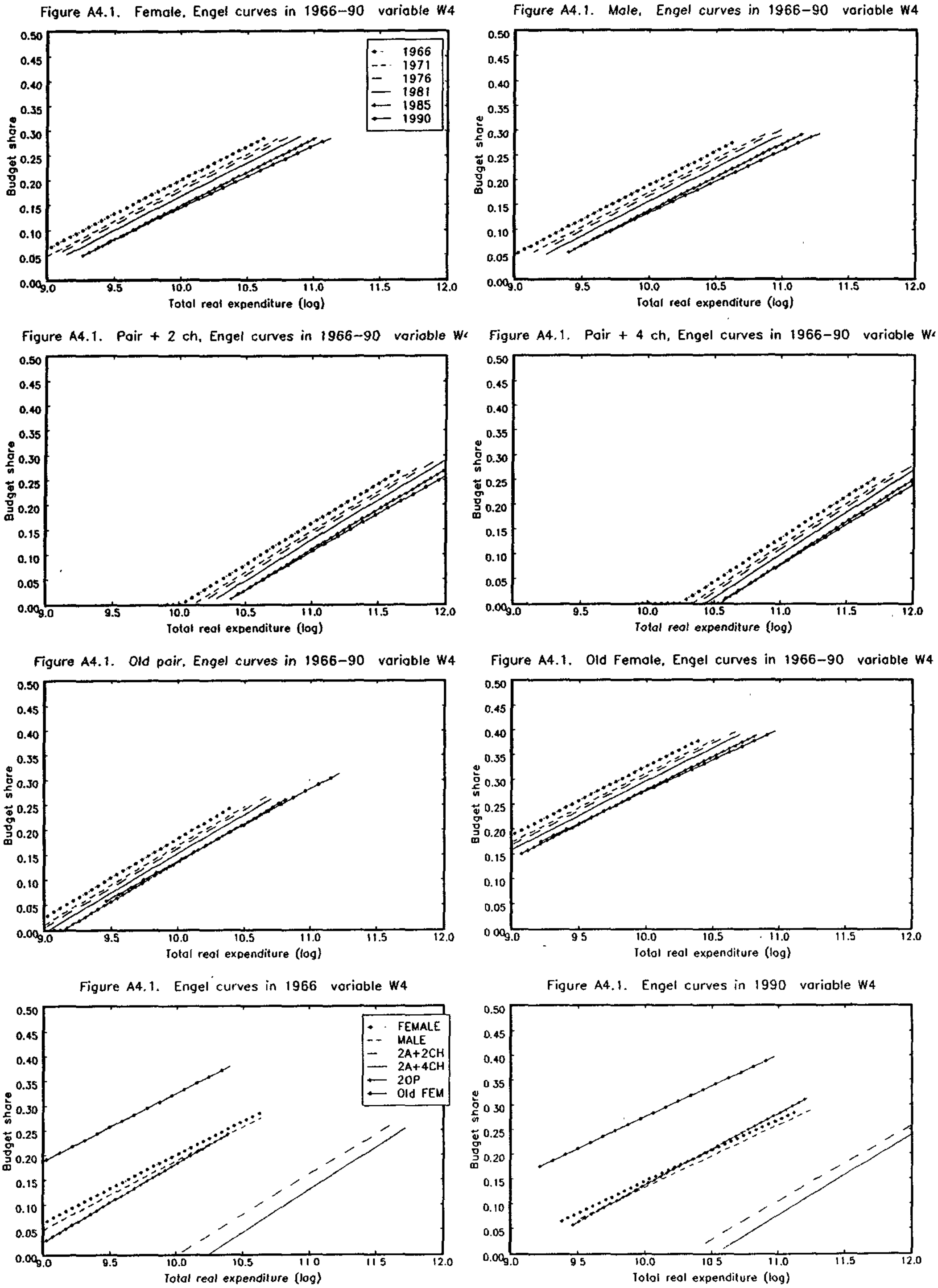


Figure A4.1. Engel curves in consumption and household type.

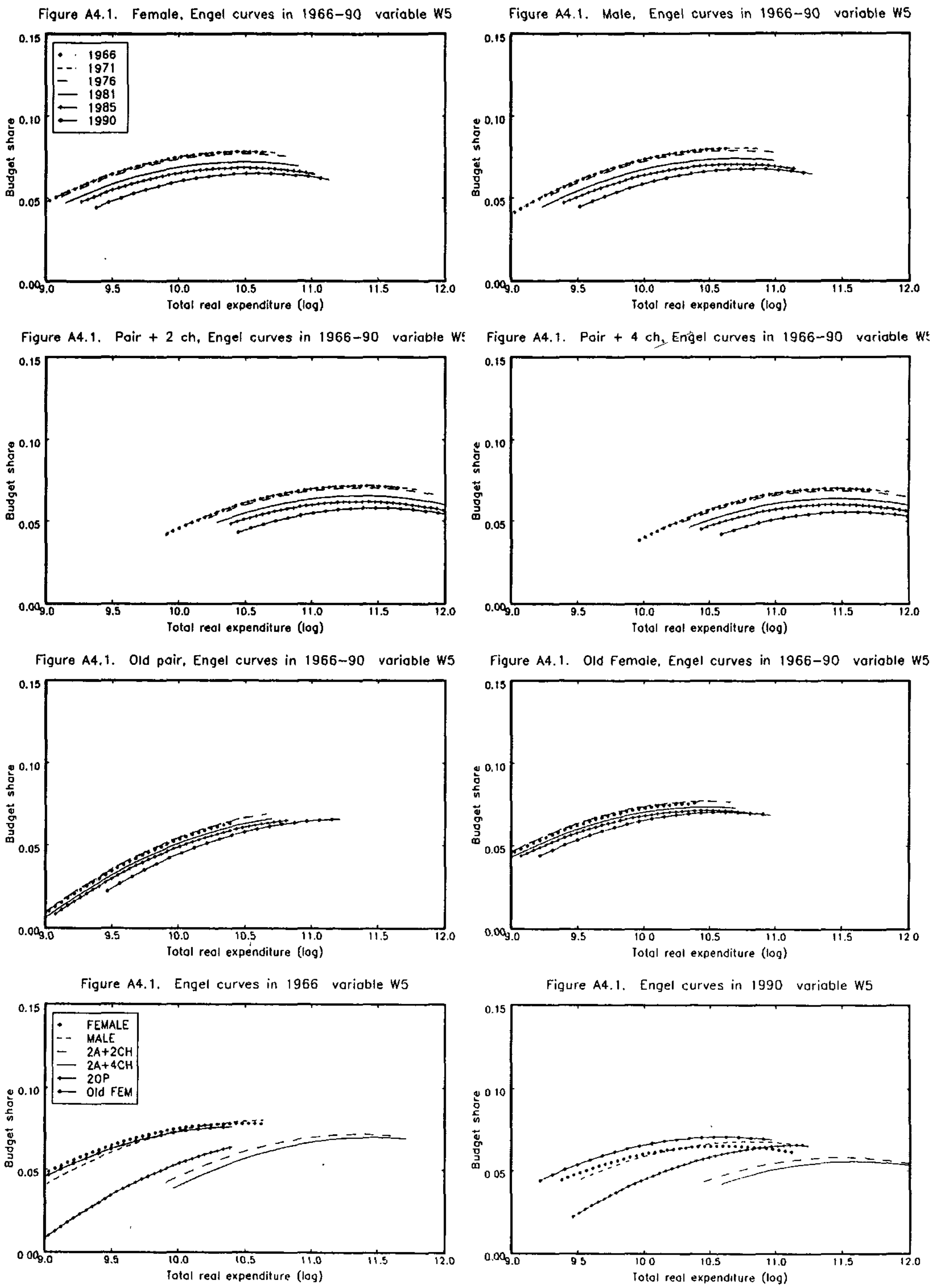


Figure A4.1. Engel curves in consumption and household type.

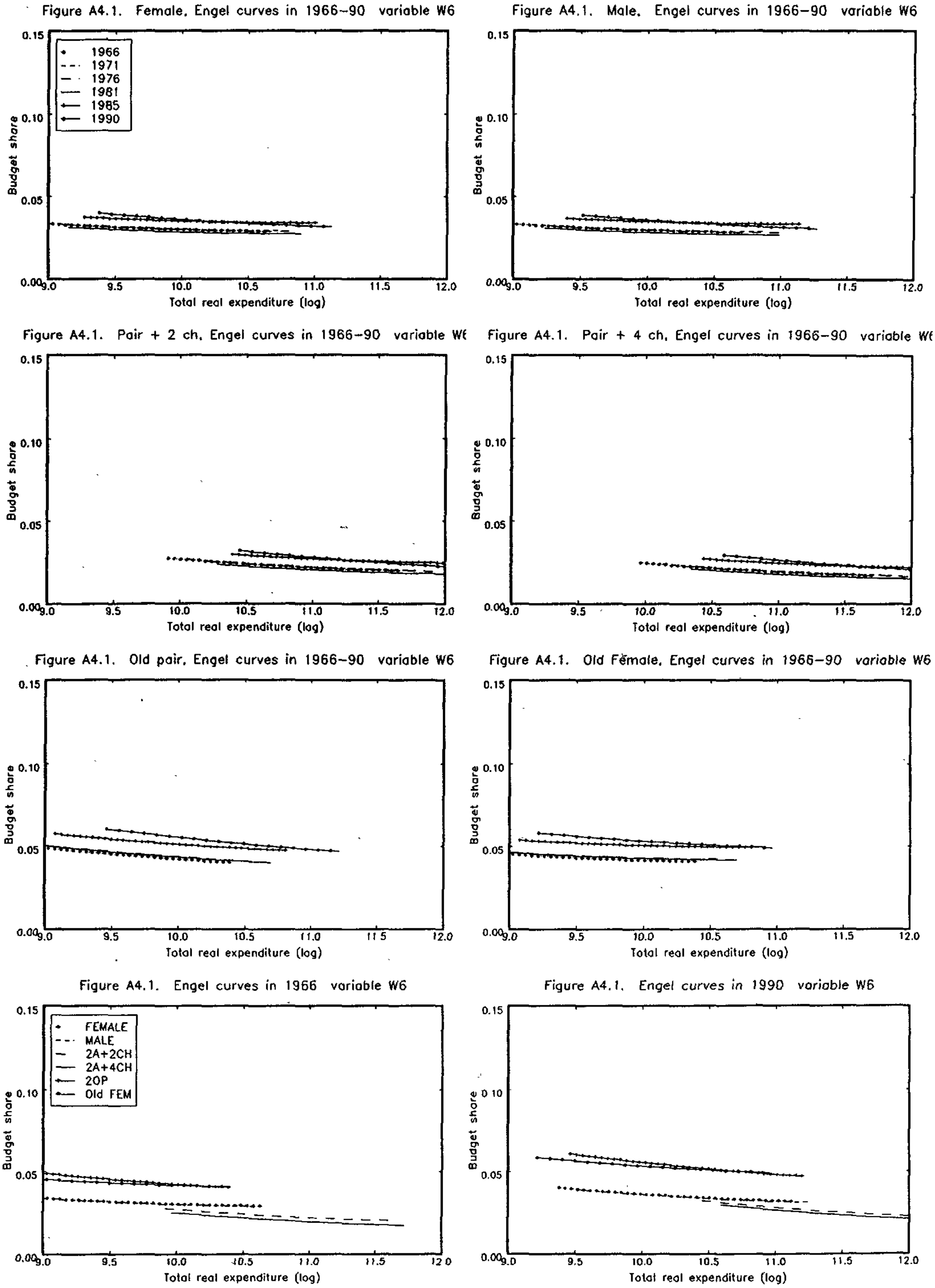


Figure A4.1. Engel curves in consumption and household type.

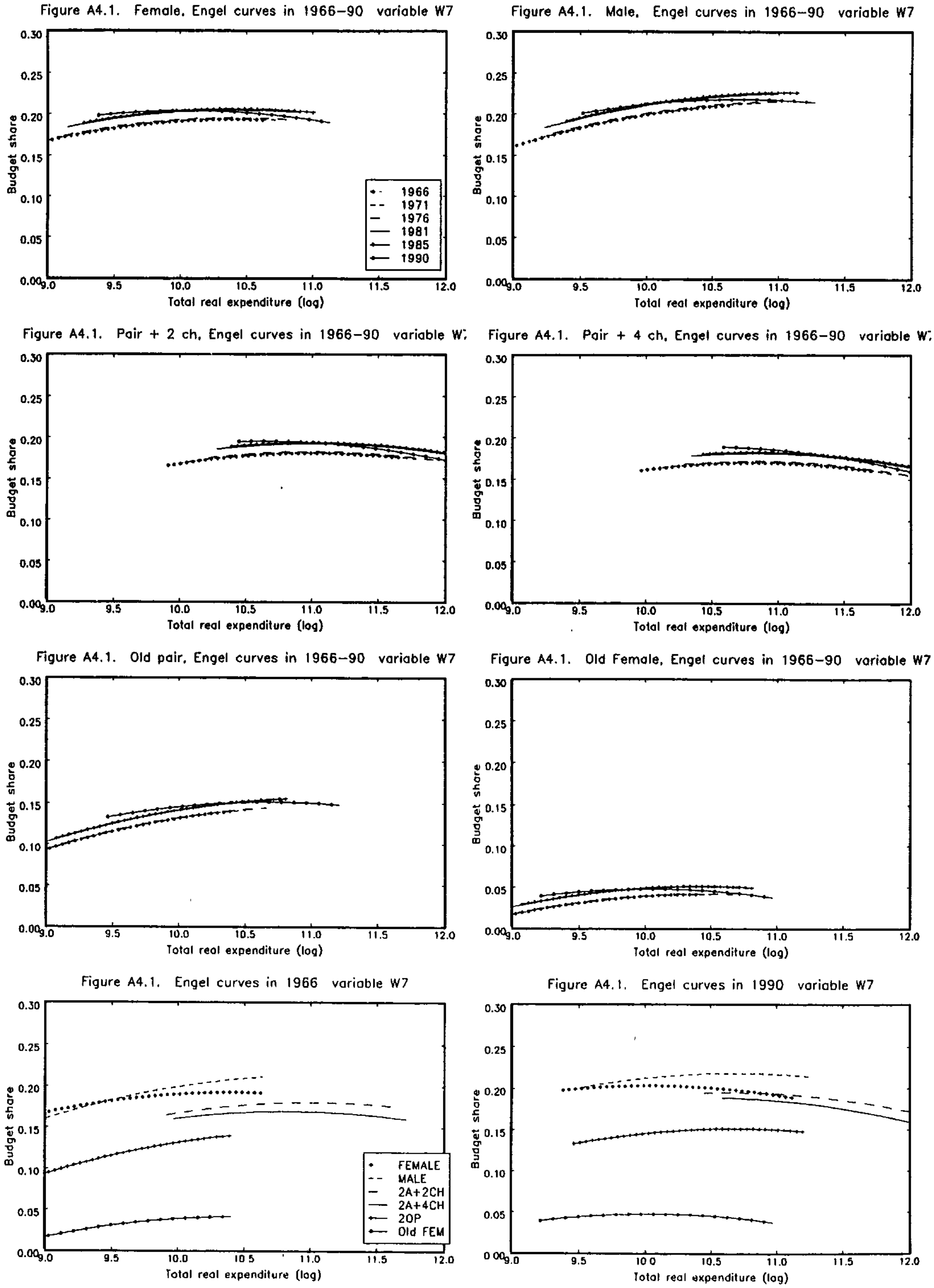


Figure A4.1. Engel curves in consumption and household type.

Figure A4.1. Female, Engel curves in 1966–90 variable W8

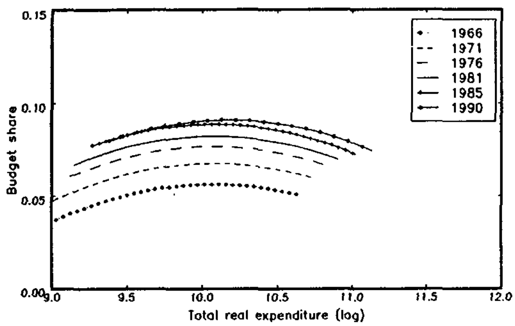


Figure A4.1. Male, Engel curves in 1966–90 variable W8

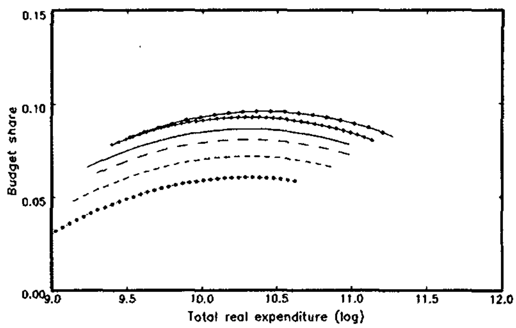


Figure A4.1. Pair + 2 ch, Engel curves in 1966–90 variable W8

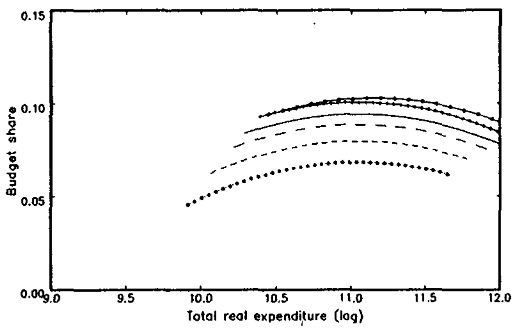


Figure A4.1. Pair + 4 ch, Engel curves in 1966–90 variable W8

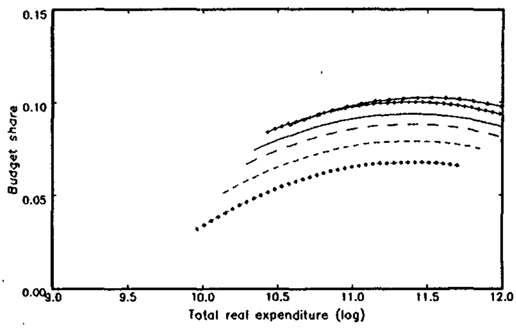


Figure A4.1. Old pair, Engel curves in 1966–90 variable W8

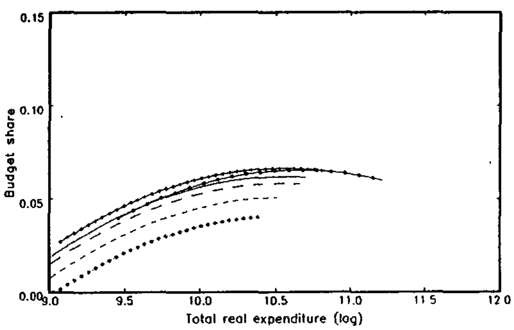


Figure A4.1. Old Female, Engel curves in 1966–90 variable W8

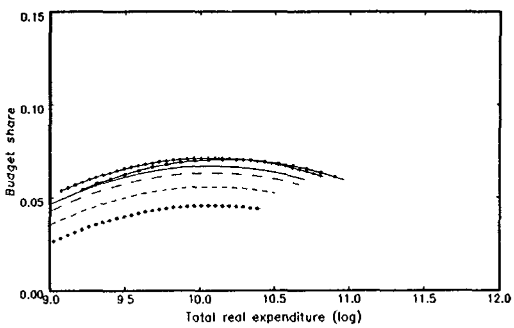


Figure A4.1. Engel curves in 1966 variable W8

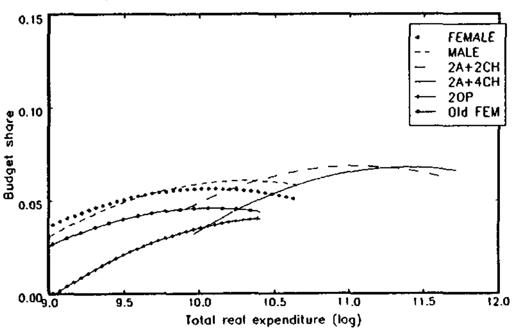


Figure A4.1. Engel curves in 1990 variable W8

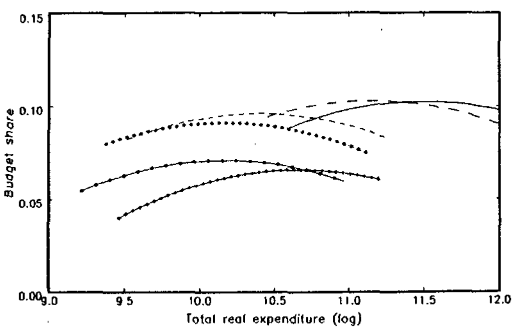


Figure A4.1. Engel curves in consumption and household type.

Figure A4.1. Female, Engel curves in 1966–90 variable W9

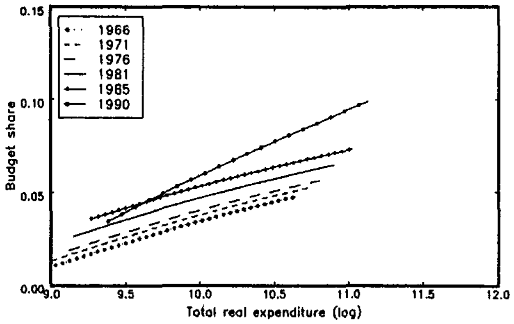


Figure A4.1. Male, Engel curves in 1966–90 variable W9

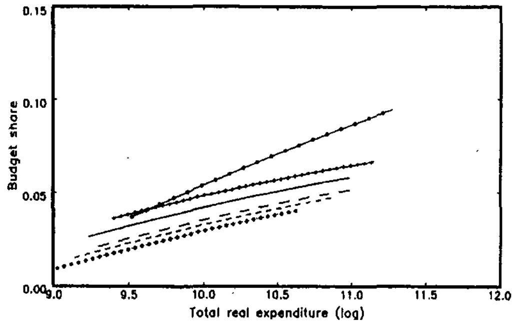


Figure A4.1. Pair + 2 ch, Engel curves in 1966–90 variable W9

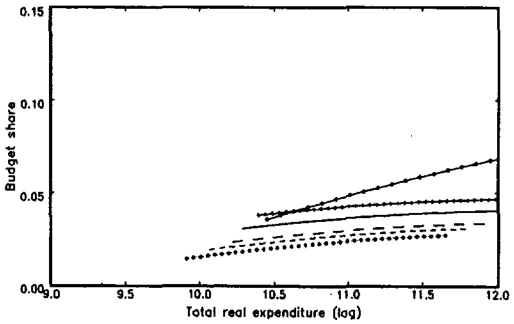


Figure A4.1. Pair + 4 ch, Engel curves in 1966–90 variable W9

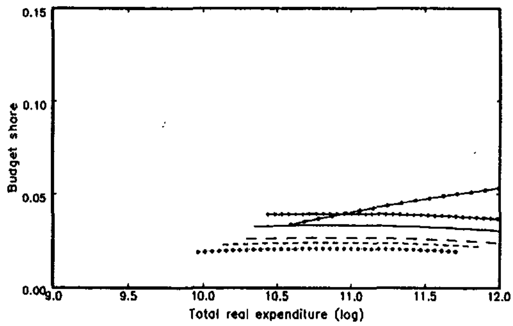


Figure A4.1. Old pair, Engel curves in 1966–90 variable W9

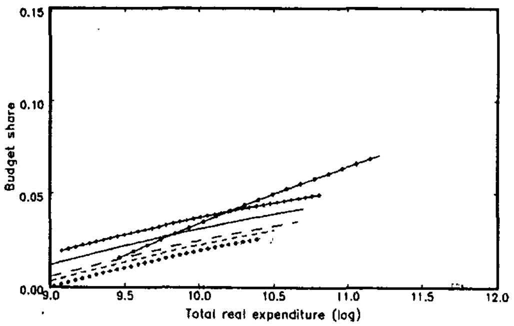


Figure A4.1. Old Female, Engel curves in 1966–90 variable W9

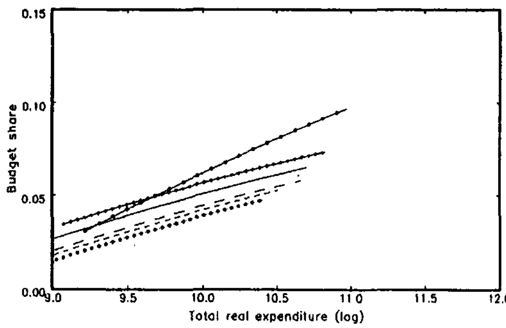


Figure A4.1. Engel curves in 1966 variable W9

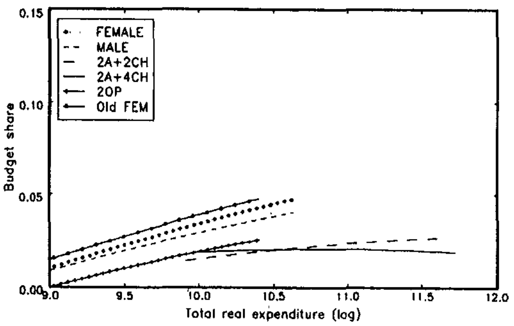


Figure A4.1. Engel curves in 1990 variable W9

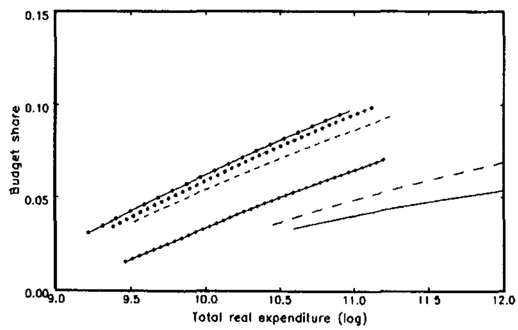


Table A4.1.i Aggregate elasticities of demand, durables included, Year 1966.

Variable	Uncompensated price elasticities LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.485	-0.013	0.129	0.027	-0.014	-0.027	0.022	-0.059	-0.120
W2	-0.304	-0.021	-0.735	0.600	-0.022	-0.701	-0.471	0.078	0.497
W3	0.291	-0.313	-0.947	0.760	-0.520	-0.401	-0.408	0.003	0.409
W4	-0.322	0.086	0.271	-0.902	-0.003	-0.126	-0.228	-0.201	-0.145
W5	-0.281	-0.016	-0.764	0.078	-0.547	0.057	-0.369	1.132	-0.428
W6	-0.476	-1.012	-1.355	-0.915	0.150	0.627	0.053	1.373	0.673
W7	-0.030	-0.138	-0.275	-0.242	-0.166	0.012	-0.496	0.179	0.319
W8	-0.518	0.048	0.007	-0.639	1.154	0.590	0.345	-0.486	-1.588
W9	-1.869	0.618	1.196	-1.187	-0.947	0.575	1.227	-3.334	1.815

	Compensated price elasticities LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.299	0.007	0.178	0.148	0.019	-0.013	0.089	-0.026	-0.104
W2	0.068	0.020	-0.638	0.841	0.045	-0.673	-0.337	0.144	0.529
W3	0.679	-0.270	-0.844	1.011	-0.450	-0.371	-0.268	0.072	0.442
W4	0.218	0.147	0.414	-0.552	0.094	-0.085	-0.032	-0.105	-0.098
W5	0.111	0.028	-0.661	0.332	-0.476	0.087	-0.227	1.201	-0.394
W6	-0.172	-0.978	-1.275	-0.718	0.205	0.650	0.163	1.426	0.699
W7	0.259	-0.106	-0.199	-0.055	-0.115	0.035	-0.392	0.230	0.344
W8	-0.143	0.090	0.106	-0.396	1.221	0.619	0.481	-0.420	-1.556
W9	-1.212	0.692	1.369	-0.762	-0.829	0.626	1.464	-3.218	1.871

Variable	Aggregate Share	Expenditure elasticities Direct	Relative
W1	0.345	0.540	-0.000
W2	0.038	1.079	0.000
W3	0.091	1.125	0.001
W4	0.223	1.569	0.054
W5	0.062	1.137	0.101
W6	0.026	0.883	-0.101
W7	0.125	0.837	0.089
W8	0.061	1.088	-0.112
W9	0.029	1.906	-0.676

	Slutsky -matrix LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.103	0.003	0.061	0.051	0.007	-0.005	0.031	-0.009	-0.036
W2	0.003	0.000	-0.024	0.032	0.002	-0.026	-0.013	0.006	0.020
W3	0.062	-0.025	-0.077	0.092	-0.041	-0.034	-0.024	0.007	0.040
W4	0.049	0.033	0.092	-0.123	0.021	-0.019	-0.007	-0.023	-0.022
W5	0.007	0.002	-0.041	0.021	-0.029	0.005	-0.014	0.074	-0.024
W6	-0.005	-0.026	-0.034	-0.019	0.005	0.017	0.004	0.038	0.018
W7	0.032	-0.013	-0.025	-0.007	-0.014	0.004	-0.049	0.029	0.043
W8	-0.009	0.005	0.006	-0.024	0.074	0.038	0.029	-0.026	-0.095
W9	-0.036	0.020	0.040	-0.022	-0.024	0.018	0.043	-0.095	0.055

Table A4.1.ii Aggregate elasticities of demand, durables included, Year 1971.

Variable	Uncompensated price elasticities LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.435	-0.016	0.137	0.007	-0.017	-0.032	0.033	-0.065	-0.137
W2	-0.291	-0.039	-0.719	0.595	-0.020	-0.687	-0.460	0.077	0.488
W3	0.337	-0.350	-0.936	0.863	-0.582	-0.449	-0.457	0.004	0.460
W4	-0.305	0.085	0.275	-0.887	-0.005	-0.125	-0.239	-0.203	-0.144
W5	-0.246	-0.014	-0.694	0.082	-0.584	0.053	-0.337	1.035	-0.390
W6	-0.471	-0.991	-1.329	-0.901	0.147	0.593	0.053	1.345	0.659
W7	-0.025	-0.116	-0.231	-0.204	-0.138	0.011	-0.572	0.152	0.269
W8	-0.409	0.042	0.013	-0.507	0.961	0.491	0.293	-0.570	-1.313
W9	-1.567	0.519	1.012	-0.993	-0.802	0.483	1.008	-2.815	1.365

Variable	Compensated price elasticities LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.277	0.004	0.180	0.126	0.019	-0.018	0.111	-0.026	-0.119
W2	0.028	0.002	-0.633	0.834	0.051	-0.659	-0.303	0.155	0.525
W3	0.672	-0.307	-0.846	1.114	-0.507	-0.419	-0.292	0.086	0.499
W4	0.163	0.146	0.401	-0.537	0.100	-0.083	-0.009	-0.090	-0.089
W5	0.085	0.029	-0.605	0.329	-0.510	0.082	-0.174	1.115	-0.351
W6	-0.200	-0.956	-1.257	-0.699	0.207	0.617	0.186	1.411	0.690
W7	0.233	-0.082	-0.162	-0.011	-0.080	0.034	-0.445	0.215	0.299
W8	-0.107	0.082	0.094	-0.281	1.028	0.518	0.442	-0.496	-1.278
W9	-1.025	0.589	1.157	-0.589	-0.681	0.531	1.274	-2.684	1.427

Variable	Aggregate Share	Expenditure elasticities Direct	Relative
W1	0.303	0.523	-0.000
W2	0.039	1.056	0.000
W3	0.081	1.109	0.001
W4	0.226	1.547	0.053
W5	0.068	1.095	0.092
W6	0.027	0.896	-0.099
W7	0.148	0.854	0.075
W8	0.073	0.999	-0.093
W9	0.035	1.792	-0.569

Variable	Slutsky -matrix LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.084	0.001	0.054	0.038	0.006	-0.005	0.034	-0.008	-0.036
W2	0.001	0.000	-0.025	0.033	0.002	-0.026	-0.012	0.006	0.021
W3	0.054	-0.025	-0.068	0.090	-0.041	-0.034	-0.024	0.007	0.040
W4	0.037	0.033	0.091	-0.121	0.023	-0.019	-0.002	-0.020	-0.020
W5	0.006	0.002	-0.041	0.022	-0.035	0.006	-0.012	0.075	-0.024
W6	-0.005	-0.026	-0.034	-0.019	0.006	0.017	0.005	0.038	0.019
W7	0.035	-0.012	-0.024	-0.002	-0.012	0.005	-0.066	0.032	0.044
W8	-0.008	0.006	0.007	-0.021	0.075	0.038	0.032	-0.036	-0.094
W9	-0.036	0.021	0.040	-0.021	-0.024	0.019	0.045	-0.094	0.050

Table A4.1.iii Aggregate elasticities of demand, durables included, Year 1976.

Variable	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
	Uncompensated price elasticities								
W1	-0.413	-0.021	0.140	-0.014	-0.022	-0.036	0.036	-0.069	-0.147
W2	-0.313	0.054	-0.785	0.659	-0.020	-0.752	-0.502	0.086	0.536
W3	0.357	-0.357	-0.930	0.899	-0.594	-0.459	-0.465	0.007	0.474
W4	-0.305	0.086	0.274	-0.879	-0.004	-0.123	-0.245	-0.205	-0.142
W5	-0.242	-0.012	-0.706	0.095	-0.572	0.055	-0.340	1.060	-0.397
W6	-0.509	-1.066	-1.430	-0.973	0.157	0.711	0.056	1.445	0.707
W7	-0.018	-0.107	-0.213	-0.186	-0.127	0.010	-0.601	0.143	0.249
W8	-0.356	0.041	0.017	-0.446	0.884	0.451	0.277	-0.601	-1.199
W9	-1.414	0.469	0.911	-0.883	-0.720	0.435	0.895	-2.536	1.126

Variable	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
	Compensated price elasticities								
W1	-0.257	-0.002	0.183	0.111	0.014	-0.022	0.124	-0.025	-0.126
W2	-0.016	0.091	-0.704	0.896	0.048	-0.726	-0.335	0.169	0.576
W3	0.662	-0.319	-0.846	1.143	-0.523	-0.432	-0.293	0.093	0.516
W4	0.136	0.141	0.396	-0.527	0.098	-0.084	0.003	-0.081	-0.082
W5	0.061	0.026	-0.623	0.337	-0.502	0.082	-0.170	1.145	-0.356
W6	-0.252	-1.034	-1.359	-0.767	0.216	0.734	0.201	1.517	0.742
W7	0.225	-0.076	-0.146	0.008	-0.071	0.031	-0.464	0.211	0.282
W8	-0.090	0.075	0.091	-0.233	0.946	0.474	0.427	-0.526	-1.163
W9	-0.923	0.530	1.047	-0.491	-0.606	0.478	1.171	-2.398	1.192

Variable	Aggregate Share	Expenditure elasticities Direct	Relative
W1	0.286	0.545	-0.000
W2	0.036	1.038	0.000
W3	0.079	1.068	0.002
W4	0.228	1.542	0.053
W5	0.066	1.060	0.094
W6	0.025	0.902	-0.106
W7	0.161	0.849	0.069
W8	0.080	0.931	-0.085
W9	0.039	1.718	-0.512

Variable	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
	Slutsky -matrix								
W1	-0.073	-0.000	0.052	0.032	0.004	-0.006	0.035	-0.007	-0.036
W2	-0.000	0.003	-0.025	0.032	0.002	-0.026	-0.012	0.006	0.021
W3	0.052	-0.025	-0.067	0.090	-0.041	-0.034	-0.023	0.007	0.041
W4	0.031	0.032	0.090	-0.120	0.022	-0.019	0.000	-0.019	-0.019
W5	0.004	0.002	-0.041	0.022	-0.033	0.005	-0.011	0.076	-0.024
W6	-0.006	-0.026	-0.034	-0.019	0.005	0.018	0.005	0.038	0.019
W7	0.036	-0.012	-0.023	0.001	-0.011	0.005	-0.075	0.034	0.045
W8	-0.007	0.006	0.007	-0.019	0.076	0.038	0.034	-0.042	-0.093
W9	-0.036	0.021	0.041	-0.019	-0.024	0.019	0.046	-0.093	0.046

Table A4.1.iv Aggregate elasticities of demand, durables included, Year 1981.

Variable	Uncompensated price elasticities								
	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.399	-0.023	0.139	-0.022	-0.025	-0.038	0.038	-0.069	-0.150
W2	-0.328	0.093	-0.816	0.680	-0.022	-0.781	-0.522	0.088	0.555
W3	0.410	-0.410	-0.919	1.031	-0.681	-0.527	-0.533	0.008	0.543
W4	-0.295	0.086	0.277	-0.872	-0.002	-0.120	-0.243	-0.205	-0.143
W5	-0.244	-0.012	-0.720	0.100	-0.562	0.057	-0.346	1.083	-0.405
W6	-0.539	-1.125	-1.509	-1.029	0.165	0.804	0.059	1.524	0.746
W7	-0.017	-0.104	-0.208	-0.182	-0.124	0.010	-0.611	0.140	0.243
W8	-0.320	0.038	0.016	-0.403	0.807	0.412	0.256	-0.634	-1.093
W9	-1.169	0.386	0.754	-0.730	-0.593	0.358	0.730	-2.095	0.744

Variable	Compensated price elasticities								
	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.247	-0.004	0.176	0.105	0.011	-0.025	0.129	-0.021	-0.124
W2	-0.037	0.130	-0.744	0.924	0.046	-0.756	-0.348	0.180	0.605
W3	0.708	-0.373	-0.845	1.281	-0.611	-0.501	-0.355	0.102	0.594
W4	0.124	0.139	0.381	-0.521	0.097	-0.084	0.008	-0.072	-0.072
W5	0.046	0.024	-0.648	0.343	-0.494	0.082	-0.173	1.175	-0.355
W6	-0.290	-1.094	-1.447	-0.820	0.223	0.826	0.209	1.604	0.789
W7	0.218	-0.074	-0.150	0.016	-0.068	0.030	-0.470	0.215	0.283
W8	-0.066	0.070	0.080	-0.190	0.867	0.434	0.408	-0.553	-1.049
W9	-0.723	0.441	0.865	-0.356	-0.489	0.396	0.997	-1.953	0.821

Variable	Aggregate Share	Expenditure elasticities Direct	Relative
W1	0.276	0.549	-0.000
W2	0.034	1.053	0.000
W3	0.069	1.078	0.002
W4	0.231	1.514	0.052
W5	0.065	1.048	0.096
W6	0.024	0.903	-0.112
W7	0.165	0.852	0.067
W8	0.088	0.921	-0.077
W9	0.047	1.615	-0.421

Variable	Slutsky -matrix								
	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.068	-0.001	0.049	0.029	0.003	-0.007	0.036	-0.006	-0.034
W2	-0.001	0.004	-0.026	0.032	0.002	-0.026	-0.012	0.006	0.021
W3	0.049	-0.026	-0.058	0.088	-0.042	-0.034	-0.024	0.007	0.041
W4	0.029	0.032	0.088	-0.121	0.022	-0.019	0.002	-0.017	-0.017
W5	0.003	0.002	-0.042	0.022	-0.032	0.005	-0.011	0.076	-0.023
W6	-0.007	-0.026	-0.034	-0.019	0.005	0.020	0.005	0.038	0.019
W7	0.036	-0.012	-0.025	0.003	-0.011	0.005	-0.078	0.036	0.047
W8	-0.006	0.006	0.007	-0.017	0.076	0.038	0.036	-0.049	-0.092
W9	-0.034	0.021	0.041	-0.017	-0.023	0.019	0.047	-0.092	0.039

Table A4.1.v Aggregate elasticities of demand, durables included, Year 1985.

Variable	Uncompensated price elasticities LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.375	-0.027	0.141	-0.038	-0.030	-0.038	0.037	-0.077	-0.158
W2	-0.344	0.173	-0.873	0.735	-0.022	-0.837	-0.556	0.097	0.596
W3	0.456	-0.442	-0.909	1.127	-0.734	-0.570	-0.571	0.012	0.590
W4	-0.289	0.086	0.276	-0.868	-0.000	-0.121	-0.243	-0.202	-0.144
W5	-0.241	-0.011	-0.733	0.110	-0.551	0.059	-0.349	1.110	-0.412
W6	-0.420	-0.871	-1.169	-0.799	0.127	0.396	0.045	1.178	0.577
W7	-0.014	-0.101	-0.203	-0.176	-0.120	0.011	-0.619	0.137	0.238
W8	-0.312	0.040	0.019	-0.398	0.820	0.419	0.268	-0.625	-1.103
W9	-0.966	0.320	0.626	-0.599	-0.490	0.292	0.599	-1.731	0.439

Variable	Compensated price elasticities LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.228	-0.009	0.177	0.095	0.006	-0.021	0.133	-0.028	-0.126
W2	-0.075	0.206	-0.807	0.978	0.043	-0.805	-0.381	0.186	0.655
W3	0.727	-0.408	-0.843	1.372	-0.668	-0.538	-0.394	0.103	0.650
W4	0.104	0.135	0.371	-0.514	0.095	-0.075	0.014	-0.071	-0.058
W5	0.025	0.022	-0.669	0.350	-0.486	0.090	-0.176	1.198	-0.354
W6	-0.176	-0.841	-1.109	-0.579	0.186	0.425	0.204	1.260	0.631
W7	0.206	-0.074	-0.149	0.023	-0.066	0.037	-0.475	0.211	0.286
W8	-0.084	0.068	0.074	-0.193	0.875	0.445	0.416	-0.549	-1.053
W9	-0.572	0.369	0.722	-0.243	-0.394	0.339	0.856	-1.600	0.525

Variable	Aggregate Share	Expenditure elasticities Direct	Relative
W1	0.261	0.564	-0.000
W2	0.032	1.031	0.000
W3	0.063	1.041	0.002
W4	0.235	1.506	0.051
W5	0.063	1.018	0.098
W6	0.031	0.936	-0.087
W7	0.170	0.845	0.065
W8	0.087	0.873	-0.078
W9	0.057	1.510	-0.348

Variable	Slutsky -matrix LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
W1	-0.059	-0.002	0.046	0.025	0.002	-0.005	0.035	-0.007	-0.033
W2	-0.002	0.007	-0.026	0.031	0.001	-0.026	-0.012	0.006	0.021
W3	0.046	-0.026	-0.054	0.087	-0.042	-0.034	-0.025	0.007	0.041
W4	0.024	0.032	0.087	-0.121	0.022	-0.018	0.003	-0.017	-0.014
W5	0.002	0.001	-0.042	0.022	-0.031	0.006	-0.011	0.076	-0.022
W6	-0.005	-0.026	-0.034	-0.018	0.006	0.013	0.006	0.039	0.019
W7	0.035	-0.013	-0.025	0.004	-0.011	0.006	-0.081	0.036	0.049
W8	-0.007	0.006	0.006	-0.017	0.076	0.039	0.036	-0.048	-0.091
W9	-0.033	0.021	0.041	-0.014	-0.023	0.019	0.049	-0.091	0.030

Table A4.1.vi Aggregate elasticities of demand, durables included, all data.

Variable	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
	Uncompensated price elasticities								
W1	-0.360	-0.027	0.147	-0.034	-0.030	-0.040	0.036	-0.079	-0.163
W2	-0.324	0.108	-0.824	0.695	-0.021	-0.790	-0.525	0.092	0.564
W3	0.433	-0.420	-0.914	1.070	-0.697	-0.541	-0.541	0.012	0.561
W4	-0.273	0.083	0.267	-0.872	-0.000	-0.117	-0.231	-0.195	-0.139
W5	-0.230	-0.010	-0.727	0.119	-0.551	0.060	-0.339	1.107	-0.407
W6	-0.462	-0.939	-1.261	-0.869	0.134	0.502	0.041	1.265	0.619
W7	-0.010	-0.101	-0.204	-0.171	-0.120	0.012	-0.607	0.142	0.244
W8	-0.324	0.039	0.017	-0.409	0.821	0.419	0.263	-0.626	-1.109
W9	-0.985	0.312	0.611	-0.629	-0.494	0.287	0.571	-1.730	0.417

Variable	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
	Compensated price elasticities								
W1	-0.221	-0.008	0.184	0.099	0.005	-0.024	0.128	-0.032	-0.131
W2	-0.064	0.143	-0.756	0.943	0.045	-0.761	-0.353	0.181	0.623
W3	0.696	-0.385	-0.845	1.321	-0.631	-0.511	-0.368	0.102	0.621
W4	0.101	0.134	0.366	-0.515	0.094	-0.074	0.016	-0.067	-0.054
W5	0.018	0.024	-0.661	0.355	-0.488	0.087	-0.176	1.192	-0.351
W6	-0.216	-0.906	-1.196	-0.635	0.196	0.530	0.203	1.349	0.675
W7	0.197	-0.074	-0.149	0.026	-0.068	0.035	-0.471	0.213	0.291
W8	-0.093	0.070	0.078	-0.189	0.879	0.445	0.415	-0.548	-1.057
W9	-0.569	0.368	0.721	-0.233	-0.390	0.334	0.845	-1.588	0.512

Variable	Aggregate Share	Expenditure elasticities Direct	Relative
W1	0.254	0.550	-0.000
W2	0.034	1.026	0.000
W3	0.067	1.036	0.002
W4	0.242	1.476	0.050
W5	0.064	0.978	0.098
W6	0.029	0.970	-0.094
W7	0.167	0.815	0.066
W8	0.086	0.908	-0.079
W9	0.058	1.640	-0.345

Variable	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9
	Slutsky -matrix								
W1	-0.056	-0.002	0.047	0.025	0.001	-0.006	0.032	-0.008	-0.033
W2	-0.002	0.005	-0.026	0.032	0.002	-0.026	-0.012	0.006	0.021
W3	0.047	-0.026	-0.056	0.088	-0.042	-0.034	-0.025	0.007	0.042
W4	0.025	0.032	0.088	-0.125	0.023	-0.018	0.004	-0.016	-0.013
W5	0.001	0.002	-0.042	0.023	-0.031	0.006	-0.011	0.076	-0.022
W6	-0.006	-0.026	-0.034	-0.018	0.006	0.015	0.006	0.038	0.019
W7	0.033	-0.012	-0.025	0.004	-0.011	0.006	-0.079	0.036	0.049
W8	-0.008	0.006	0.007	-0.016	0.076	0.038	0.036	-0.047	-0.091
W9	-0.033	0.021	0.042	-0.013	-0.022	0.019	0.049	-0.091	0.029

A.5 Appendix 5

Full estimation results are reported on Model ND, with no parameter constraints imposed, see Chapter 9. The parameter estimates of the (eight) budget share equations have been multiplied by 100 to present the results in percentage points, for ease in exposition. The other parameters correspond to the (logarithmic) variance components and are reproduced as such, having a useful interpretation in percentage points. The row LOGS0 gives the estimate for the (the logarithmic) variance component in 1985. The row YFIT0 gives the heteroskedasticity parameter connecting the (exogenous part of) fit and logarithmic variance of the error in the model.

Table A5.1. Estimation results by quasi maximum likelihood, nondurables.

Variable	Food		Clothing, Footwear		Energy		Household Appliances	
	Param.	T	Param.	T	Param.	T	Param.	T
CONSTANT	-76.6081	-8.12	34.5407	6.14	-1.9048	-0.84	32.7181	14.13
LCOHAGE	-1.4025	-1.46	1.0908	1.95	-1.1994	-5.22	1.1063	5.25
LAGE	55.8081	10.29	-12.9058	-4.03	4.2693	3.28	-15.6968	-11.84
LAGESQ	-6.1773	-8.70	1.3794	3.28	-0.2387	-1.37	1.9451	11.54
HHSIZE	1.4167	8.30	-0.0608	-0.62	-1.0138	-23.02	-0.4004	-11.42
HHSIZESQ	-0.2332	-12.75	0.0267	2.51	0.0288	5.86	0.0093	2.73
CHILDREN	1.2540	11.74	0.2523	4.40	0.5558	21.75	0.2942	12.77
FARMER	0.9696	3.88	0.6009	4.63	1.7309	24.39	0.0700	1.57
SELFEMPL	-0.1625	-0.52	1.1778	6.78	0.6852	8.61	-0.0053	-0.09
WHCOLLAR	-2.0636	-10.74	0.7309	6.74	-0.1869	-4.46	0.0508	1.43
RETIRED	-1.0468	-4.01	0.0946	0.67	0.5484	8.34	0.1308	2.65
EDUCM	-1.8229	-11.01	-0.0325	-0.36	-0.2214	-5.85	0.2423	7.39
EDUCH	-2.6877	-9.71	-0.3593	-2.35	-0.6628	-11.10	0.4751	8.68
FEMALE	-1.7586	-9.58	1.6767	14.98	-0.2457	-5.64	0.1063	2.98
OLDAGE	1.1451	7.25	-0.5176	-6.43	0.3000	7.23	0.1766	6.02
SMHOUSE	0.4551	2.54	-0.7756	-7.83	4.0634	79.57	0.2068	5.92
SDHOUSE	-0.8476	-1.98	0.4403	1.67	2.2929	18.95	0.3339	3.90
TENURENT	0.6047	3.18	0.4378	3.93	-0.9384	-22.07	-0.2901	-7.51
TENURKIN	0.4453	1.51	1.4476	8.13	-1.0690	-16.82	-0.2150	-3.65
CENTHEAT	-0.7361	-3.67	-0.2678	-2.49	-0.0704	-1.38	0.1603	4.32
WEHOUSE	-0.1431	-0.85	-0.0661	-0.72	0.3663	9.28	0.1428	4.37
BATHROOM	-1.4675	-6.79	0.8725	7.67	0.1023	1.93	0.4147	9.70
MIDDLE	0.6293	4.17	0.3012	3.64	0.4807	13.42	-0.0382	-1.35
NORTH	0.4271	2.13	0.7679	6.75	0.5023	10.25	0.0146	0.38
RURAL	-0.0769	-0.50	-0.1111	-1.34	0.7057	18.85	-0.0680	-2.32
SPOUSENW	1.1823	7.33	-0.7748	-8.45	0.5052	14.02	-0.0993	-3.29
CAR	-3.0279	-16.28	-1.4409	-13.62	-0.2049	-4.94	-0.1380	-3.98
WINTER	-0.6641	-3.66	-0.0380	-0.37	0.6588	14.81	-0.6171	-13.39
SUMMER	3.4106	16.82	-1.1368	-10.65	-0.1345	-2.96	-0.6617	-13.37
AUTUMN	-0.0203	-0.11	0.8394	7.78	0.0142	0.32	-0.5611	-12.67
LNP1	23.2243	8.79	4.0171	2.58	1.6533	2.44	-2.5731	-3.97
LNP3	-1.4233	-0.51	-0.8026	-0.50	3.6304	5.04	1.7067	2.67
LNP4	1.7685	0.78	3.5338	2.60	0.6952	1.14	1.9722	3.61
LNP5	-11.6000	-3.04	-11.0780	-5.13	0.9923	1.07	2.5850	3.09
LNP6	-3.6092	-1.41	-1.5584	-1.06	-2.0118	-2.97	-0.1129	-0.21
LNP7	-0.7483	-0.15	-0.3701	-0.13	-2.0474	-1.70	-8.5791	-8.01
LNP8	-9.4034	-1.68	-0.1821	-0.06	-5.2912	-3.64	3.8811	3.39
ILNXR	-20.0574	-21.58	5.1471	9.36	-2.5657	-9.10	0.6959	2.00
ILNXCH	-1.5042	-4.77	0.4348	2.07	-0.5949	-6.04	-0.0645	-0.55
ILNXFEM	2.0207	3.83	-1.5528	-4.40	0.0800	0.52	-0.6876	-3.11
ILNXSIZE	1.6727	6.22	-0.1101	-0.65	0.8848	10.75	0.1661	1.74
ILNXSQ	2.8979	4.33	-2.1182	-5.10	1.0795	5.02	-0.6121	-2.31
LNRELX	-2.1217	-3.23	-1.1979	-2.92	0.0123	0.07	0.2432	0.87
LNP9	1.7913	0.34	6.4402	2.15	2.3792	1.80	1.1202	0.92

LOGSO	-5.3531	-6.1074	-8.4749	-8.4998
D6676	-0.1511	-0.3661	-0.0370	-0.4449
D66	-0.0914	-0.1498	0.2368	-0.3396
D76	-0.0707	0.2190	0.1460	0.1970
D81	-0.0130	-0.2903	0.1996	-0.1590
D90	-0.0101	-0.1579	0.0951	-0.2569
YFITO	3.0757	12.6029	30.9773	57.2260

Table A5.1. Estimation results by quasi maximum likelihood, nondurables.

Variable	Health Care, Param.	T	Transport, Communication Param.	T	Education, Entertainm. Param.	T	Other Services Param.	T
CONSTANT	-3.6817	-2.37	55.0012	7.66	7.2873	1.86	18.7124	3.83
LCOHAGE	2.5340	12.92	-3.6943	-4.83	-0.5420	-1.24	2.4356	4.61
LAGE	0.9832	1.09	-16.0175	-3.94	4.8952	2.20	-1.7407	-0.62
LAGESQ	-0.3771	-3.23	2.2501	4.22	-0.9429	-3.28	-0.4131	-1.15
HHSIZE	-0.3273	-11.44	-0.6869	-5.73	-0.2037	-3.35	-1.9359	-20.33
HHSIZESQ	0.0137	4.71	0.1521	10.88	-0.0124	-1.84	0.2547	21.29
CHILDREN	-0.0275	-1.66	-1.8606	-23.46	0.6042	15.14	-1.0308	-19.65
FARMER	0.4331	10.28	-0.9288	-5.43	-0.3462	-3.93	-1.8081	-16.33
SELFEMPL	0.1903	3.62	-1.2310	-5.39	0.2576	2.13	0.7572	4.72
WHCOLLAR	-0.0337	-1.05	-0.2992	-2.07	0.4378	5.68	0.4198	4.22
RETIRED	0.7568	15.19	0.1631	0.89	0.5414	5.41	-1.1069	-8.61
EDUCM	-0.0465	-1.70	0.4528	3.69	0.4154	6.27	0.6922	8.13
EDUCH	-0.3853	-8.70	1.1529	5.51	1.0445	9.21	1.0566	7.61
FEMALE	0.0622	1.90	-0.1125	-0.90	-0.1315	-1.98	-0.3820	-4.39
OLDAGE	0.4068	14.44	-1.2323	-11.45	-0.2241	-4.07	-0.9962	-13.54
SMHOUSE	-0.4234	-13.02	-0.8168	-6.07	-1.0381	-14.19	-1.4675	-14.34
SDHOUSE	-0.0694	-0.92	-0.3799	-1.18	0.2053	1.12	-0.1234	-0.53
TENURENT	0.0745	2.24	0.7684	5.51	0.2217	2.87	0.7700	7.45
TENURKIN	0.1843	3.54	0.6125	2.68	0.2253	1.84	0.9443	5.72
CENTHEAT	0.1079	3.16	0.0764	0.55	0.4417	6.18	0.0907	0.90
WEHOUSE	0.0045	0.16	0.2059	1.62	-0.1988	-3.06	-0.1615	-1.88
BATHROOM	0.0553	1.53	-0.9863	-6.46	-0.1808	-2.33	0.3450	3.23
MIDDLE	-0.0994	-3.91	-0.4271	-3.97	-0.0424	-0.75	-0.5816	-7.88
NORTH	-0.1520	-4.47	-0.0165	-0.11	-0.2372	-3.11	-0.5298	-5.35
RURAL	-0.2578	-9.61	0.9660	8.53	-0.1586	-2.68	-0.7457	-9.33
SPOUSENW	0.2626	9.57	1.0534	8.73	-0.7514	-11.58	0.4120	4.98
CAR	-0.2740	-8.52	7.7374	53.65	-0.5160	-7.67	-1.3680	-14.72
WINTER	0.0990	3.04	-0.3696	-2.83	0.8923	12.71	0.3462	3.86
SUMMER	-0.4594	-13.11	-0.2603	-1.84	0.3629	4.88	0.0481	0.49
AUTUMN	-0.3261	-9.53	-0.1977	-1.45	0.4825	6.71	0.0675	0.72
LNP1	1.6536	2.87	-11.1391	-5.86	-1.6939	-1.58	-2.5314	-1.80
LNP3	-2.2928	-3.90	6.4521	3.11	-4.7582	-4.19	11.9123	8.04
LNP4	1.2639	2.51	-9.3937	-5.32	-1.4432	-1.48	-10.1010	-7.85
LNP5	2.9228	3.82	-7.0295	-2.46	3.9168	2.55	1.6540	0.82
LNP6	6.0640	11.23	-5.9326	-2.89	-0.2967	-0.28	3.2160	2.23
LNP7	-4.1307	-4.13	16.3768	4.41	0.3061	0.15	9.5337	3.62
LNP8	-4.0071	-3.39	3.5893	0.81	6.0442	2.63	-11.3301	-3.67
ILNXR	-0.4228	-1.27	6.8845	9.83	2.6048	6.18	8.9213	14.43
ILNXCH	-0.1003	-1.13	-1.0414	-4.44	1.9293	13.45	0.1976	1.05
ILNXFEM	0.1879	1.01	1.1012	2.70	-0.3793	-1.50	-0.0979	-0.27
ILNXSIZE	0.0848	1.07	-0.4636	-2.26	-0.9472	-8.30	-0.5409	-3.30
ILNXSQ	0.3767	1.78	-1.8984	-3.91	-1.9819	-6.84	3.4071	8.48
LNRELX	0.3626	1.41	-0.6462	-1.19	0.5346	1.55	-0.3199	-0.63
LNP9	-1.4737	-1.33	7.0767	1.76	-2.0750	-0.92	-2.3535	-0.81

LOGSO	-8.0830	-5.7921	-7.5103	-6.4813
D6676	0.1970	-0.1744	-0.1089	-0.2913
D66	-0.5413	-0.0959	-0.0968	-0.1361
D76	-1.1486	0.0218	0.1477	-0.0244
D81	-0.8920	-0.0356	-0.0862	-0.1358
D90	-0.3625	-0.0015	-0.1141	0.1611
YFITO	60.0142	7.7931	21.0842	16.8595

Table A5.1. Estimation results by weighted LS, nondurables.

Variable	Food Param.	T	Clothing, Footwear Param.	T	Energy Param.	T	Household Appliances Param.	T
CONSTANT	-89.8973	-9.21	23.3982	3.48	-2.8780	-1.00	31.3332	6.89
LCOHAGE	-3.7371	-3.84	1.0114	1.41	-1.1694	-4.41	2.5905	5.50
LAGE	63.9471	11.41	-7.8239	-2.04	4.4283	2.66	-16.9138	-6.45
LAGESQ	-6.8817	-9.32	0.6963	1.40	-0.2800	-1.25	1.9088	5.66
HHSIZE	2.1615	12.49	0.7771	6.47	-0.4357	-7.53	-0.0997	-1.40
HHSIZESQ	-0.3131	-16.42	-0.0224	-1.60	-0.0279	-4.25	-0.0097	-1.26
CHILDREN	1.1383	10.15	0.2156	2.93	0.4836	14.03	0.3601	8.66
FARMER	0.4403	1.69	0.4372	2.68	1.8873	16.54	-0.1286	-1.30
SELFEMPL	-0.0157	-0.05	0.9308	4.32	0.6331	6.15	0.0250	0.20
WHCOLLAR	-1.4344	-7.24	0.7346	5.41	0.0511	1.00	-0.0098	-0.12
RETIRED	-1.2073	-4.49	0.1525	0.90	0.2178	2.60	0.2478	2.21
EDUCM	-1.5458	-9.02	-0.0652	-0.58	-0.2238	-4.70	0.1930	2.70
EDUCH	-1.6717	-5.76	-0.5934	-3.02	-0.3953	-5.25	0.5100	3.86
FEMALE	-1.6653	-8.77	1.5385	12.18	-0.1873	-3.24	0.2776	3.46
OLDAGE	1.1070	6.66	-0.5409	-5.53	0.3306	5.56	0.2712	4.11
SMHOUSE	0.7362	3.97	-0.9185	-7.56	4.1796	72.36	0.2051	2.59
SDHOUSE	-1.3183	-3.03	0.2536	0.78	0.8251	6.55	0.3376	1.75
TENURENT	0.1585	0.81	0.3225	2.38	-1.3560	-28.43	-0.2334	-2.80
TENURKIN	-0.1946	-0.65	1.1889	5.50	-1.3412	-18.34	-0.2231	-1.73
CENTHEAT	-0.6894	-3.29	-0.0406	-0.32	-0.2318	-2.90	0.2309	2.79
WEHOUSE	0.0482	0.28	-0.0124	-0.11	0.4652	9.46	0.1672	2.28
BATHROOM	-1.1550	-5.16	0.7525	5.42	0.2973	4.04	0.4657	5.22
MIDDLE	0.3507	2.24	0.4370	4.33	0.4656	10.00	0.1163	1.82
NORTH	0.2680	1.29	0.9102	6.58	0.4802	7.62	0.0747	0.88
RURAL	-0.2603	-1.65	-0.1609	-1.59	0.6280	12.98	-0.0315	-0.48
SPOUSENW	0.5478	3.24	-0.8162	-7.31	0.2598	5.55	-0.0515	-0.75
CAR	-2.2389	-11.47	-1.2862	-9.94	0.0617	1.14	-0.1801	-2.20
WINTER	-0.9954	-5.34	0.0065	0.05	0.3707	6.74	-0.9998	-12.09
SUMMER	3.5134	16.86	-0.9750	-7.55	-0.1130	-2.02	-1.0021	-11.63
AUTUMN	-0.0998	-0.52	0.8732	6.75	-0.0337	-0.64	-0.7246	-8.42
LNP1	21.5753	8.08	2.0654	1.17	-0.1210	-0.16	-5.2761	-4.76
LNP3	-4.2923	-1.51	-1.6296	-0.87	2.6334	3.14	-2.7476	-2.34
LNP4	3.3451	1.46	4.1856	2.71	1.2723	1.91	5.1499	5.31
LNP5	-12.0829	-3.12	-7.8632	-3.00	2.0931	1.93	6.0978	3.65
LNP6	-4.5978	-1.75	-0.6638	-0.38	-1.8728	-2.48	2.3694	2.12
LNP7	-0.6879	-0.14	-1.1840	-0.36	-3.3760	-2.47	-9.6441	-4.62
LNP8	-4.4249	-0.76	1.9902	0.53	-4.4515	-2.69	6.3977	2.64
ILNXR	-20.5135	-22.14	4.4504	7.66	-2.6335	-8.76	1.0292	2.64
ILNXCH	-1.2383	-3.89	0.7007	3.29	-0.4325	-4.26	0.0865	0.72
ILNXFEM	2.0345	3.85	-1.2759	-3.56	0.0929	0.58	-0.7506	-3.21
ILNXSIZE	0.8458	3.14	-0.2339	-1.33	0.3763	4.30	0.0803	0.78
ILNXSQ	1.4828	2.24	-0.9922	-2.33	0.7668	3.57	-0.3184	-1.10
LNRELX	-1.9007	-2.90	-0.7141	-1.71	0.4818	2.64	0.3299	1.14
LNP9	1.1654	0.22	3.0995	0.87	3.8225	2.52	-2.3469	-1.02
S.E.E		0.1201		0.0783		0.0338		0.0496
R**2		0.3936		0.0808		0.3659		0.0273
RESET(3)		46.9757		30.1403		887.7166		51.6010

Table A5.1. Estimation results by weighted LS, nondurables.

Variable	Health Care, Param.	Health Care, T	Transport, Communication Param.	Transport, Communication T	Education, Entertainm. Param.	Education, Entertainm. T	Other Services Param.	Other Services T
CONSTANT	16.2122	4.75	64.4049	8.02	16.5143	3.26	52.6584	7.38
LCOHAGE	4.5987	11.76	-2.9326	-3.37	-1.5135	-2.68	-3.3283	-4.21
LAGE	-12.7014	-6.35	-23.4615	-5.19	-0.2701	-0.09	-14.1218	-3.50
LAGESQ	1.2253	4.72	3.2031	5.38	-0.0290	-0.08	1.8542	3.56
HHSIZE	0.1162	2.15	0.3108	2.39	0.1693	2.10	-0.5086	-4.24
HHSIZESQ	-0.0168	-3.04	0.0760	5.25	-0.0343	-3.84	0.1596	11.76
CHILDREN	-0.0070	-0.22	-1.9174	-21.72	0.7326	13.99	-1.1769	-17.14
FARMER	0.3285	4.35	-0.9888	-5.16	-0.4325	-3.83	-1.6843	-11.91
SELFEMPL	0.0402	0.42	-2.1406	-8.52	0.0973	0.59	0.6637	2.95
WHCOLLAR	-0.1321	-2.18	-0.4572	-2.73	0.4809	4.36	1.2628	8.47
RETIRED	0.8332	8.39	0.4869	2.34	0.1815	1.43	-1.1012	-6.32
EDUCM	0.0293	0.54	0.4115	2.92	0.4856	5.34	0.7365	6.16
EDUCH	-0.3633	-4.06	0.6674	2.64	1.1987	6.95	1.1251	4.98
FEMALE	0.1303	1.96	0.0835	0.59	0.1846	2.07	-0.0351	-0.28
OLDAGE	0.8997	15.42	-1.0834	-9.01	-0.2218	-3.22	-0.9566	-10.50
SMHOUSE	-0.5439	-9.09	-0.9103	-5.96	-1.0951	-11.07	-2.5339	-18.64
SDHOUSE	-0.1540	-1.10	-0.6011	-1.70	-0.3322	-1.34	-1.3007	-3.95
TENURENT	-0.0230	-0.36	0.6217	3.95	0.1803	1.69	0.8799	5.86
TENURKIN	0.0260	0.26	0.3040	1.19	0.0808	0.48	0.6973	2.95
CENTHEAT	0.0759	1.20	0.0035	0.02	0.3099	3.28	0.0079	0.06
WEHOUSE	-0.0433	-0.79	0.1379	0.95	-0.1791	-2.00	-0.4221	-3.52
BATHROOM	-0.0265	-0.39	-0.9020	-5.19	-0.0686	-0.65	0.2532	1.83
MIDDLE	-0.0876	-1.81	-0.2996	-2.47	-0.1200	-1.58	-0.5812	-5.87
NORTH	-0.1573	-2.54	-0.2141	-1.31	-0.2828	-2.82	-0.7165	-5.48
RURAL	-0.3241	-6.72	1.1908	9.37	-0.2899	-3.65	-0.8322	-7.86
SPOUSENW	0.2595	5.12	0.9028	6.57	-0.8674	-10.24	-0.1589	-1.42
CAR	-0.3938	-6.18	7.7931	53.16	-0.4064	-4.33	-1.5850	-12.56
WINTER	0.2808	4.52	-0.3003	-2.04	0.9695	10.53	0.4282	3.49
SUMMER	-0.4083	-6.42	-0.2960	-1.86	0.0836	0.86	-0.2417	-1.85
AUTUMN	-0.3358	-5.22	-0.4068	-2.67	0.4257	4.52	0.0440	0.35
LNP1	-0.3627	-0.42	-10.6659	-5.18	-1.7386	-1.31	-4.9254	-2.91
LNP3	-4.2842	-4.33	5.4194	2.38	-5.0083	-3.37	11.9153	6.17
LNP4	0.2120	0.26	-7.8935	-4.20	0.7324	0.59	-8.4452	-5.22
LNP5	3.8945	2.78	-3.6772	-1.16	6.3791	3.08	1.5498	0.57
LNP6	5.1785	5.28	-4.9649	-2.25	1.0556	0.72	2.2012	1.14
LNP7	-3.4443	-1.88	11.6900	2.91	-3.8913	-1.51	10.9387	3.24
LNP8	-0.4860	-0.21	5.2776	1.07	6.1482	1.91	-7.0796	-1.63
ILNXR	0.6800	1.85	7.3131	10.23	1.7501	3.99	5.5429	8.59
ILNXCH	-0.1380	-1.50	-1.1743	-4.95	1.9895	13.80	-0.2711	-1.42
ILNXFEM	0.1574	0.79	1.1650	2.86	-0.4043	-1.59	-0.4226	-1.18
ILNXSIZE	-0.0111	-0.13	-0.3431	-1.65	-0.8037	-6.86	0.1855	1.11
ILNXSQ	0.1050	0.45	-1.3869	-2.81	-1.8490	-6.04	3.9530	9.32
LNRELX	0.4821	1.79	-0.4228	-0.78	0.8478	2.41	0.6192	1.21
LNP9	-0.7079	-0.36	4.8146	1.08	-3.6771	-1.26	-6.1547	-1.61
S.E.E		0.0374		0.0941		0.0591		0.0779
R**2		0.0640		0.2508		0.1530		0.2561
RESET(3)		135.4811		107.2809		128.5726		269.0854

A.6 Appendix 6

For the allocation of non-durable consumption full estimation results are reported on the price and expenditure elasticities of household demand which have been calculated at the aggregate level. The results are based on Model ND with both symmetry and adding-up constraints imposed, see Chapter 9.

The 'Slutsky-matrix' is calculated as $D(w)\Xi$, where $D(w)$ is a diagonal matrix with the vector of budget shares on the diagonal, and Ξ is the matrix having the compensated price elasticities as elements.

Table A6.1.i Aggregate elasticities of demand, nondurables, Year 1966.

	Uncompensated price elasticities							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.464	-0.015	0.087	-0.028	0.008	-0.073	-0.077	-0.045
NW3	-0.419	-0.696	0.248	-0.221	-0.052	-0.394	-0.171	0.307
NW4	0.469	0.562	-0.748	0.697	0.002	-0.563	-0.545	-0.872
NW5	-0.489	-0.491	0.792	-0.392	0.173	-1.811	0.915	0.159
NW6	-0.141	-0.152	-0.007	0.256	0.028	-0.834	-0.610	0.318
NW7	-0.571	-0.410	-0.313	-0.838	-0.264	0.455	0.164	0.525
NW8	-0.855	-0.302	-0.495	0.675	-0.317	0.263	0.346	-0.687
NW9	-0.734	0.419	-0.682	0.067	0.116	0.671	-0.620	-0.960

	Compensated price elasticities							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.189	0.061	0.125	0.004	0.030	-0.002	-0.034	0.005
NW3	0.215	-0.521	0.334	-0.147	-0.002	-0.231	-0.072	0.423
NW4	0.921	0.687	-0.687	0.750	0.038	-0.447	-0.474	-0.789
NW5	0.031	-0.347	0.862	-0.331	0.214	-1.678	0.996	0.254
NW6	0.377	-0.009	0.063	0.317	0.069	-0.702	-0.529	0.413
NW7	-0.004	-0.253	-0.236	-0.771	-0.219	0.600	0.253	0.629
NW8	-0.233	-0.129	-0.411	0.748	-0.267	0.422	0.443	-0.573
NW9	0.047	0.636	-0.577	0.159	0.178	0.871	-0.497	-0.817

	Aggregate	Expenditure elasticities	
Variable	Share	Direct	Relative
NW1	0.453	0.606	-0.013
NW3	0.126	1.398	-0.035
NW4	0.061	0.996	-0.009
NW5	0.053	1.145	0.161
NW6	0.036	1.142	-0.080
NW7	0.116	1.251	0.028
NW8	0.071	1.373	0.041
NW9	0.083	1.722	-0.008

	Slutsky -matrix							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.086	0.028	0.056	0.002	0.014	-0.001	-0.015	0.002
NW3	0.027	-0.065	0.042	-0.018	-0.000	-0.029	-0.009	0.053
NW4	0.056	0.042	-0.042	0.046	0.002	-0.027	-0.029	-0.048
NW5	0.002	-0.019	0.046	-0.018	0.011	-0.089	0.053	0.014
NW6	0.014	-0.000	0.002	0.011	0.002	-0.025	-0.019	0.015
NW7	-0.000	-0.029	-0.027	-0.090	-0.025	0.070	0.029	0.073
NW8	-0.017	-0.009	-0.029	0.053	-0.019	0.030	0.031	-0.041
NW9	0.004	0.053	-0.048	0.013	0.015	0.072	-0.041	-0.068

Table A6.1.ii Aggregate elasticities of demand, nondurables, Year 1971.

Variable	Uncompensated price elasticities LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.416	-0.024	0.096	-0.032	0.008	-0.071	-0.082	-0.050
NW3	-0.416	-0.665	0.268	-0.233	-0.053	-0.424	-0.183	0.329
NW4	0.482	0.583	-0.739	0.725	0.002	-0.587	-0.567	-0.908
NW5	-0.452	-0.465	0.762	-0.415	0.168	-1.737	0.879	0.155
NW6	-0.141	-0.156	-0.006	0.267	0.073	-0.873	-0.637	0.331
NW7	-0.451	-0.325	-0.248	-0.667	-0.210	0.152	0.127	0.416
NW8	-0.652	-0.229	-0.398	0.557	-0.256	0.220	0.108	-0.555
NW9	-0.670	0.363	-0.603	0.053	0.100	0.556	-0.560	-0.978

Variable	Compensated price elasticities LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.184	0.043	0.130	-0.000	0.028	0.013	-0.033	0.004
NW3	0.142	-0.502	0.349	-0.157	-0.006	-0.223	-0.063	0.460
NW4	0.891	0.703	-0.679	0.781	0.037	-0.440	-0.480	-0.812
NW5	-0.004	-0.334	0.827	-0.354	0.206	-1.576	0.975	0.260
NW6	0.322	-0.021	0.061	0.330	0.112	-0.706	-0.538	0.440
NW7	0.037	-0.182	-0.177	-0.600	-0.168	0.328	0.232	0.530
NW8	-0.164	-0.087	-0.327	0.624	-0.214	0.396	0.212	-0.440
NW9	0.035	0.568	-0.500	0.149	0.160	0.810	-0.409	-0.813

Variable	Aggregate Share	Expenditure elasticities Direct	Relative
NW1	0.405	0.571	-0.015
NW3	0.118	1.378	-0.038
NW4	0.059	1.010	-0.010
NW5	0.056	1.106	0.154
NW6	0.035	1.143	-0.084
NW7	0.146	1.206	0.022
NW8	0.087	1.204	0.034
NW9	0.095	1.738	-0.007

Variable	Slutsky -matrix LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.075	0.017	0.052	-0.000	0.011	0.005	-0.013	0.002
NW3	0.017	-0.059	0.041	-0.019	-0.000	-0.026	-0.007	0.054
NW4	0.052	0.041	-0.040	0.046	0.002	-0.026	-0.028	-0.048
NW5	-0.000	-0.019	0.046	-0.020	0.011	-0.087	0.054	0.014
NW6	0.011	-0.000	0.002	0.011	0.004	-0.024	-0.019	0.015
NW7	0.005	-0.027	-0.026	-0.088	-0.025	0.048	0.034	0.077
NW8	-0.014	-0.008	-0.028	0.054	-0.019	0.034	0.018	-0.038
NW9	0.003	0.054	-0.048	0.014	0.015	0.077	-0.039	-0.077

Table A6.1.iii Aggregate elasticities of demand, nondurables, Year 1976.

	Uncompensated price elasticities							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.392	-0.031	0.101	-0.036	0.007	-0.073	-0.086	-0.052
NW3	-0.413	-0.644	0.280	-0.238	-0.053	-0.437	-0.187	0.343
NW4	0.457	0.562	-0.749	0.700	0.001	-0.571	-0.551	-0.881
NW5	-0.465	-0.487	0.808	-0.379	0.178	-1.834	0.932	0.166
NW6	-0.144	-0.160	-0.006	0.277	0.111	-0.905	-0.660	0.343
NW7	-0.420	-0.301	-0.232	-0.623	-0.196	0.077	0.119	0.389
NW8	-0.582	-0.206	-0.368	0.527	-0.237	0.213	0.045	-0.516
NW9	-0.642	0.329	-0.556	0.047	0.090	0.492	-0.518	-0.987

	Compensated price elasticities							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.175	0.033	0.135	-0.006	0.026	0.015	-0.034	0.007
NW3	0.108	-0.490	0.362	-0.167	-0.008	-0.227	-0.062	0.484
NW4	0.855	0.680	-0.686	0.754	0.036	-0.410	-0.456	-0.773
NW5	-0.047	-0.364	0.873	-0.323	0.214	-1.665	1.032	0.279
NW6	0.298	-0.029	0.063	0.337	0.149	-0.726	-0.554	0.463
NW7	0.039	-0.166	-0.160	-0.560	-0.156	0.262	0.229	0.513
NW8	-0.147	-0.078	-0.300	0.586	-0.200	0.388	0.149	-0.398
NW9	0.033	0.528	-0.450	0.139	0.148	0.765	-0.357	-0.805

	Aggregate	Expenditure elasticities	
Variable	Share	Direct	Relative
NW1	0.386	0.562	-0.016
NW3	0.114	1.350	-0.039
NW4	0.061	1.031	-0.009
NW5	0.052	1.082	0.163
NW6	0.033	1.144	-0.087
NW7	0.156	1.186	0.020
NW8	0.092	1.126	0.032
NW9	0.104	1.746	-0.007

	Slutsky -matrix							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.068	0.013	0.052	-0.002	0.010	0.006	-0.013	0.003
NW3	0.012	-0.056	0.041	-0.019	-0.001	-0.026	-0.007	0.055
NW4	0.052	0.041	-0.042	0.046	0.002	-0.025	-0.028	-0.047
NW5	-0.002	-0.019	0.046	-0.017	0.011	-0.087	0.054	0.015
NW6	0.010	-0.001	0.002	0.011	0.005	-0.024	-0.018	0.015
NW7	0.006	-0.026	-0.025	-0.087	-0.024	0.041	0.036	0.080
NW8	-0.014	-0.007	-0.028	0.054	-0.018	0.036	0.014	-0.037
NW9	0.003	0.055	-0.047	0.014	0.015	0.080	-0.037	-0.084

Table A6.1.iv Aggregate elasticities of demand, nondurables, Year 1981.

	Uncompensated price elasticities							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.361	-0.037	0.109	-0.039	0.006	-0.074	-0.088	-0.052
NW3	-0.420	-0.619	0.296	-0.249	-0.055	-0.460	-0.198	0.362
NW4	0.433	0.529	-0.764	0.657	0.002	-0.533	-0.515	-0.824
NW5	-0.478	-0.509	0.851	-0.345	0.189	-1.927	0.983	0.176
NW6	-0.151	-0.170	-0.007	0.299	0.196	-0.974	-0.711	0.368
NW7	-0.399	-0.285	-0.221	-0.589	-0.185	0.016	0.110	0.365
NW8	-0.518	-0.184	-0.335	0.482	-0.216	0.198	-0.045	-0.468
NW9	-0.578	0.293	-0.500	0.042	0.080	0.427	-0.471	-0.998

	Compensated price elasticities							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.166	0.021	0.144	-0.013	0.023	0.014	-0.034	0.011
NW3	0.067	-0.474	0.383	-0.182	-0.013	-0.239	-0.062	0.519
NW4	0.802	0.638	-0.698	0.707	0.033	-0.366	-0.412	-0.705
NW5	-0.093	-0.395	0.920	-0.293	0.222	-1.752	1.090	0.301
NW6	0.266	-0.046	0.068	0.356	0.232	-0.784	-0.595	0.503
NW7	0.032	-0.157	-0.144	-0.530	-0.148	0.212	0.230	0.504
NW8	-0.124	-0.066	-0.264	0.536	-0.182	0.376	0.065	-0.341
NW9	0.040	0.478	-0.390	0.127	0.133	0.708	-0.298	-0.799

	Aggregate	Expenditure elasticities	
Variable	Share	Direct	Relative
NW1	0.363	0.536	-0.017
NW3	0.108	1.344	-0.041
NW4	0.065	1.016	-0.009
NW5	0.050	1.061	0.171
NW6	0.031	1.150	-0.093
NW7	0.165	1.188	0.019
NW8	0.101	1.085	0.029
NW9	0.117	1.705	-0.006

	Slutsky -matrix							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.060	0.008	0.052	-0.005	0.008	0.005	-0.012	0.004
NW3	0.007	-0.051	0.041	-0.020	-0.001	-0.026	-0.007	0.056
NW4	0.052	0.041	-0.045	0.046	0.002	-0.024	-0.027	-0.046
NW5	-0.005	-0.020	0.046	-0.015	0.011	-0.087	0.054	0.015
NW6	0.008	-0.001	0.002	0.011	0.007	-0.024	-0.018	0.016
NW7	0.005	-0.026	-0.024	-0.087	-0.024	0.035	0.038	0.083
NW8	-0.013	-0.007	-0.027	0.054	-0.018	0.038	0.007	-0.035
NW9	0.005	0.056	-0.046	0.015	0.016	0.083	-0.035	-0.094

Table A6.1.v Aggregate elasticities of demand, nondurables, Year 1985.

Variable	Uncompensated price elasticities LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.332	-0.047	0.113	-0.043	0.010	-0.075	-0.092	-0.052
NW3	-0.454	-0.568	0.332	-0.274	-0.062	-0.511	-0.218	0.404
NW4	0.452	0.557	-0.752	0.693	0.001	-0.566	-0.546	-0.871
NW5	-0.503	-0.542	0.912	-0.299	0.202	-2.058	1.053	0.191
NW6	-0.121	-0.137	-0.005	0.245	-0.024	-0.796	-0.581	0.301
NW7	-0.367	-0.263	-0.204	-0.548	-0.173	-0.055	0.103	0.340
NW8	-0.484	-0.172	-0.320	0.466	-0.207	0.196	-0.078	-0.447
NW9	-0.532	0.268	-0.450	0.038	0.066	0.370	-0.430	-1.008

Variable	Compensated price elasticities LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.153	0.004	0.144	-0.019	0.029	0.017	-0.037	0.015
NW3	0.010	-0.436	0.416	-0.211	-0.011	-0.272	-0.076	0.580
NW4	0.807	0.657	-0.688	0.741	0.040	-0.383	-0.437	-0.737
NW5	-0.144	-0.441	0.976	-0.250	0.242	-1.873	1.163	0.327
NW6	0.264	-0.028	0.064	0.297	0.019	-0.598	-0.463	0.447
NW7	0.034	-0.149	-0.133	-0.493	-0.129	0.152	0.226	0.492
NW8	-0.124	-0.071	-0.255	0.515	-0.167	0.381	0.033	-0.311
NW9	0.045	0.431	-0.347	0.116	0.130	0.667	-0.253	-0.789

Variable	Aggregate Share	Expenditure elasticities Direct	Relative
NW1	0.344	0.519	-0.018
NW3	0.097	1.351	-0.046
NW4	0.061	1.032	-0.009
NW5	0.047	1.043	0.183
NW6	0.038	1.119	-0.076
NW7	0.177	1.168	0.018
NW8	0.105	1.045	0.028
NW9	0.130	1.677	-0.005

Variable	Slutsky -matrix LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.053	0.001	0.050	-0.007	0.010	0.006	-0.013	0.005
NW3	0.001	-0.042	0.040	-0.021	-0.001	-0.026	-0.007	0.056
NW4	0.050	0.040	-0.042	0.046	0.002	-0.024	-0.027	-0.045
NW5	-0.007	-0.021	0.046	-0.012	0.011	-0.087	0.054	0.015
NW6	0.010	-0.001	0.002	0.011	0.000	-0.023	-0.018	0.017
NW7	0.006	-0.026	-0.023	-0.087	-0.023	0.027	0.040	0.087
NW8	-0.013	-0.007	-0.027	0.054	-0.018	0.040	0.003	-0.033
NW9	0.006	0.056	-0.045	0.015	0.017	0.087	-0.033	-0.103

Table A6.1.vi Aggregate elasticities of demand, nondurables, all data.

	Uncompensated price elasticities							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.325	-0.045	0.113	-0.043	0.009	-0.078	-0.095	-0.056
NW3	-0.432	-0.598	0.312	-0.260	-0.059	-0.482	-0.207	0.379
NW4	0.466	0.578	-0.742	0.720	0.000	-0.591	-0.569	-0.908
NW5	-0.444	-0.498	0.851	-0.345	0.191	-1.899	0.986	0.185
NW6	-0.130	-0.139	-0.006	0.240	-0.034	-0.794	-0.579	0.295
NW7	-0.361	-0.262	-0.203	-0.548	-0.173	-0.051	0.105	0.342
NW8	-0.483	-0.173	-0.320	0.467	-0.206	0.199	-0.074	-0.446
NW9	-0.536	0.267	-0.454	0.035	0.066	0.372	-0.437	-1.006

	Compensated price elasticities							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.149	0.009	0.144	-0.017	0.029	0.014	-0.040	0.011
NW3	0.023	-0.459	0.392	-0.192	-0.007	-0.244	-0.065	0.553
NW4	0.820	0.686	-0.681	0.772	0.041	-0.406	-0.459	-0.773
NW5	-0.115	-0.398	0.908	-0.296	0.228	-1.727	1.089	0.310
NW6	0.258	-0.020	0.062	0.298	0.010	-0.591	-0.458	0.443
NW7	0.028	-0.143	-0.135	-0.490	-0.129	0.153	0.226	0.491
NW8	-0.133	-0.066	-0.259	0.519	-0.167	0.382	0.035	-0.313
NW9	0.035	0.442	-0.354	0.120	0.131	0.672	-0.259	-0.788

	Aggregate	Expenditure elasticities	
Variable	Share	Direct	Relative
NW1	0.338	0.519	-0.018
NW3	0.103	1.347	-0.043
NW4	0.059	1.046	-0.010
NW5	0.050	0.974	0.170
NW6	0.038	1.147	-0.076
NW7	0.177	1.151	0.018
NW8	0.105	1.036	0.028
NW9	0.129	1.692	-0.005

	Slutsky -matrix							
Variable	LNP1	LNP3	LNP4	LNP5	LNP6	LNP7	LNP8	LNP9
NW1	-0.050	0.003	0.049	-0.006	0.010	0.005	-0.013	0.004
NW3	0.002	-0.047	0.040	-0.020	-0.000	-0.025	-0.007	0.057
NW4	0.048	0.041	-0.040	0.046	0.002	-0.024	-0.027	-0.046
NW5	-0.006	-0.020	0.046	-0.015	0.011	-0.087	0.055	0.016
NW6	0.010	-0.000	0.002	0.011	0.000	-0.023	-0.018	0.017
NW7	0.005	-0.025	-0.024	-0.087	-0.023	0.027	0.040	0.087
NW8	-0.014	-0.007	-0.027	0.055	-0.018	0.040	0.004	-0.033
NW9	0.005	0.057	-0.046	0.015	0.017	0.087	-0.033	-0.102

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