Effects of the Changing Structure of Population on the Italian Economy[a]

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Introduction

The evolution of the structure of Italian population is well known in its characteristic features: zero growth, population ageing and high immigration. Several models exist to estimate the impact of these features on different areas of the economy. The work presented in this paper focuses mainly on the effect of population ageing on consumer spending, although future work will address to other possible economic influences of demographic evolution, such as effects on labour markets and on the government budget.

The approach adopted here consists of different modules which are integrated to study household consumption, income distribution, and demographics. All these modules are designed to be included in a macroeconomic interindustry model of Italy.[1] This framework imposes some constraints and implies some assumptions that will be outlined in this study. However, the linkage to this interindustry model allows us to study the impact of demographic changes on the economy in a very detailed and integrated manner. We are aware that the "Perfect Model" cannot exist: we are forced to use models which are appropriate for a certain purpose, tools which are meant to answer a specific question but that are not correct in a different context and for a different purpose. Here the main scope is to analyse the long-term economic consequences of population ageing and, therefore, a long-term forecasting model is needed. Another purpose of our research is to study household consumption with a detailed disaggregation of expenditures: our model is designed to estimate a demand system with a 40-item classification scheme.

The approach proposed here is characterised by three different modules. The consumption model is divided into two stages: cross-section analysis and a time-series demand system. Then, a demographic model allows us to go from the historical simulation to the forecast of personal consumption expenditures. Finally, this analysis is integrated into the macroeconomic interindustry model of Italian economy with prices and quantities simultaneously estimated. These modules follow a precise hierarchy, that is each module produces some variables which are included in the following module. First, the cross-section analysis of household expenditures, then the demographic model allows the linkage with the

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[1] This is Intimo (Interindustry Italian Model) which is part of the INFORUM system (Interindustry Forecasting Project University of Maryland). Its fundamental features are described in a recent paper by the builder (Grassini, 1998). At present, the forecasting horizon of the model is the year 2010, but it will be useful to extend it to 2050. In fact, the actual date is before the period when the baby boom generation will reach the retirement age and therefore the study of the impact of this event is inhibited. This change in the forecasting horizon will require the revision of all equations in the model. This stage of the work has not been undertaken yet.

time-series demand system. Finally, the last step, the estimate of demand system inside the macroeconomic Italian model, is performed simultaneously with all the other economic variables included into the model. Obviously, the use of a demographic model is required only for forecasting purposes.

In the paper all these modules will be presented and some preliminary results will be produced to show the main features and capacities of our approach. We will also point out the areas where our research is not completed yet and the direction for future work.

The model of personal consumption expenditure: a two-stage approach

The personal consumption expenditure model presented in this work has been already studied in previous work by the author and other researchers.[2] It is a two-stage approach (cross-section and time-series analyses) already successfully implemented in long-run multisectoral models for which it has been specifically designed by Almon (1979, 1996) and Chao(1991). The system is described in detail in the Appendix. Here we present its fundamental features with particular attention devoted to the linkage between the demand system and the demographic model. For each commodity i, the cross-section function can be summarized as follows:

$$c_{ht} = \left(\sum_{j=1}^{k} x_{hjt} \beta_{jt} + \sum_{j=1}^{m} d_{hjt} \delta_{jt} \right) \sum_{j=1}^{g} n_{hjt} w_{jt} \qquad h=1,\ldots,N \qquad (1)$$

where

c_{ht} : consumption of household h at time t;

x_{hjt} : per capita income within household h divided in k=10 brackets; j is the bracket index and t is the time index;

d_{hjt} : dummy variable j used to show inclusion of household h in m=15 demographic groups at time t;

n_{hjt} : number of members of household h for g=8 age groups at time t;

$\beta_{jt}, \delta_{jt}, w_{jt}$: parameters to be estimated for each commodity at time t;

N : number of households in the sample.

This functional form assumes that the household expenditure for each of the 40 items considered in our classification depends upon per-capita income within the family, demographic characteristics and family size measured as a weighted sum of the household members grouped by age: a set of weights is estimated to express the importance of the household members in contributing to the consumption of a specific item. The per-capita income within the family is divided in brackets and different propensities to consume for each bracket are estimated. The non-age demographic household characteristics are the region of

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residence, the family size, the age of the householder , his/her education and occupation, and the number of workers within the family beside the householder.

The cross-section function is estimated using the data produced by the Italian Institute of Statistics (Istat) with the Household Budgets Surveys for the period 1985-1996. Special treatment is devoted to those items which show a high percentage of zero expenditures. In a previous study, we indicated that the main explanations of the zeroes in the data were infrequency of purchase, conscientious abstention and misreporting. Special techniques were adopted to handle these zeroes. .[3]

The time-series demand system has been estimated with National Accounts data from Istat. This system has been designed by Almon (1979, 1996) and it is particularly suited for long-run forecasting models. In the long-run real income can show a significant growth and therefore it is necessary to pay attention to price effects on the marginal propensity to consume for each commodity when income rises.[4] Moreover, both complementarity and substitutability should be allowed among different goods. These and other theoretical requirements led Almon to design the system described in the Appendix. The analytical form of this demand system may be simplified as follows:

$$\frac{q_{it}}{Pop_t} = (a_i + b_i y_t + c_i) y_t + d_i time) G(p, \mathbf{1}) \tag{2}$$

where:
q_{it}/Pop_t is consumption per capita in constant prices of product i;
y_t is income (total expenditure) per capita in constant prices; (Δy_t is equal to ($y_t - y_{t-1}$));
time is time trend;
$G(p_t, \Theta)$ express the price effects.

The main advantage of this functional form derives from the way price effects on disaggregated expenditures are considered. The non-linear form is very useful in forecasting because it allows plausible price effects for different income effects. The consumption items are combined in economically relevant groups and subgroups: complementarity and substitutability between items in these groups is considered through specific price parameters, as described in the Appendix. The description of the demand system here has been

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[3] See Bardazzi *et al*. (1998a) where the Tobit model, the Cragg model and the *non-linear probability model* have been used.

[4] The most popular demand system, the Almost Ideal Demand System (AIDS), requires that income parameters sum to zero and therefore may have undesirable implications in the long run. In fact, when income rises some expenditures go to zero and may even become negative. This asymptotic characteristic is not empirically derived but is required *a priori* due to the inherent form of the model. Moreover, the derivative of the budget share with respect to income does not depend upon relative prices. These features make the AIDS demand system unsuitable for use in a long-term forecasting model and therefore it has not been considered for this work. Recently, a modified version of AIDS model has been proposed by Banks *et al*. (1997) including a quadratic lerm of the logarithm of income: this version could overcome the problem described above and will be considered in future work.

intentionally kept simple in order to sketch the whole structure of the model and, most of all, the linkage between the consumption model and the demographic model. As one can clearly deduce from equation (2), the demographic variables do not enter directly in the time-series demand system. The main choice of the model builder here has been to design a system in order to evaluate the economic impact on personal expenditure of prices - which are included in a very complex and detailed way in the equation - and of income: both these variables are specifically included in equation (2). The demographic variables are included in the time-series demand system in a more indirect way, that is to say through some parameters estimated with the cross-section analysis.[5] This linkage is the key step where it is also necessary to forecast the demographic variables and therefore to use a demographic model. From the cross-section analysis come the marginal propensities to consume for each income bracket, the coefficients of non-age demographic characteristics and the adult equivalency weights that estimate the effect of the household age structure on consumption. All these parameters are available for each consumption item and through them it is possible to construct two variables, as described below. to be introduced in the demand system: these variables will pass useful information obtained from the sectional data to the time-series demand system.

The income effect, the change in income distribution and the effect of non-age demographic characteristic are summarized in the C_i^* variable, which is built with the $\hat{\beta}_{jt}$ and $\hat{\delta}_{jt}$ parameters of equation (1) specific for every ith commodity as follows:

$$C_{it}^* = \sum_{h=1}^{N} \left(\sum_{j=1}^{k} x_{hjt} \hat{\beta}_{jt} + \sum_{j=1}^{m} d_{hjt} \hat{\delta}_{jt} \right) \tag{3}$$

Equation (3) may be viewed as the result of evaluating equation (1) for each individual in the population and then averaging the results, it express what expenditure per adult equivalent would be - all individual have weight one - by assuming no variation of relative prices and preferences. C* represents the value of expenditure as determined only from income, its distribution and demographic variables. The following aggregated variables contained in (3)

$$\sum_{h=1}^{N} x_{hjt} = X_{jt} \qquad \sum_{h=1}^{N} d_{hjt} = D_{jt}$$

respectively represent the population total expenditure divided in brackets and the population shares in each demographic category considered here. By assuming that the time-series consumption reacts to variation of income and its distribution as estimated in the cross-section analysis, C* may be considered a measure of total expenditure corrected by non-age demographic effects: this variable may be used instead of the real income variable y_t in equation (2). Therefore, we will have an income-based indicator specific for each consumption item by including the information of β and δ parameters of equation (1).

How may we take into account the age structure of the population? The w weights of equation

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[5] The household characteristics have not been directly included in the function because the population proportions in each category vary very slowly in time. Moreover, the number of parameters would rise sharply and managing the demand system would become very cumbersome.

(1) summarize how the consumption of each item varies as the household age composition changes. We may pass this information to the aggregate if we apply these coomodity specific weights to the population divided in *g* age groups as those used in the cross-section analysis:

$$WPOP_{it} = \sum_{h=1}^{N} \sum_{j=1}^{g} n_{hjt} \, \hat{w}_{jt} \tag{4}$$

This variable, *WPOP*, represents the commodity specific weighted population built with weights estimated in (1). The aggregated variable included in (4)

$$\sum_{h=1}^{N} n_{hjt} = N_{jt}$$

represents the total population divided in age groups. The weighted populations may be used in the demand system to compute the per-capita consumption with the main advantage of considering the effect of the commodity specific age structure in the estimate of personal consumption expenditure.

The aggregated data used to build the variables in equations (3) and (4), namely X_j, D_j and N_j may be either found in official time-series statistics or built with available data. However, in order to forecast the personal consumption expenditure, it is not desirable to keep these variables fixed in the future: the age structure of the population is undergoing such a substantial change that it is necessary to allow for this effect in estimating the evolution of consumption.

In order to get the forecast of total income (expenditure) in brackets, X_j, it is either necessary to forecast the income distribution or to assume it constant over the future. The latter is not the best hypothesis because it does not allow to use one of the features of this approach, that is the capacity of modelling the effects of changing income distribution through the marginal propensities to consume for each income bracket, $\hat{\beta}_j$. In order to forecast the income distribution it is necessary to forecast a Lorenz curve: we must choose a functional form that fits the historical data, then forecast the parameters of this function with an appropriate set of variables. At present we have studied different functional forms of Lorenz curves and we are testing them with Italian data: up to now the function by Rasche *et al.* (1980) is the one with the best performance.[6] The forecast of the function parameters is being studied and therefore, in the present work, the income distribution is assumed constant for the future even thought we are fully aware of this limitation.

The other two aggregated variables, D_j and N_j, pertain to the evolution of the non-age demographic characteristics and the age structure of the population. Forecasts of the population divided by age group are produced by several models by assuming specific scenarios of some exogenous variables but projections of demographic characteristics are not

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[6] Among the functional forms tested on Italian data we have those of Ortega , Kakwani and Podder, Gupta, Chotikapanich.

so easily available. For this and also other reasons, among which the possibility of changing the scenarios to forecast the population, we have built a demographic projections model for Italy.

Some remarks about the data

This two-stage approach for the study of personal consumption expenditures requires the use of two types of data: the cross-section data from the *Household Budgets Survey* - BF, which stands for *bilanci di famiglia* - and the household final consumption data estimated for the National Accounts - CN, *Contabilità Nazionale* -. The available BF data cover the period 1985-1996: these are sample data but Istat also publishes for each record in the file an inflation factor which allows one to expand the data for the entire population. However, for the purpose of this study it is not possible to estimate the time-series demand system directly with the BF data instead of using the National Accounts data. Although this matter may seem a marginal one, we prefer to make clear this subject with brief but necessary considerations in order to prevent and eliminate this remark that is often done to our approach.

These two data-sets differ sharply. The first difference concerns the computational method: while the BF data are computed with the so-called "expenditure method" and represent a direct measure of consumption because they are based on a survey, the CN data are based upon the "availability method" that consists of an indirect estimate of households expenditures obtained as a residual from an accounting equation without a direct survey.[7] Moreover, the two data-sets differ for the reference unit, the definitions and the classifications criteria.[8] For the CN data, beside the indirect estimate, additional data sources are utilized in order to improve the results: among others, the BF data, but also more specific information from the electric power consumption recording from ENEL (Italian Electric Power Company), the registration of motor vehicles in the PRA (Public Register of Motor Vehicles) and some others.[9]

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[7] The "availability method" consists in computing the quantity of goods and services supplied for households consumption as follows: the quantities of goods and services for other uses are subtracted from the total resources according to the equation $C=(X+M)-(N+I+G+E)$ where C is households consumption, X is total production, N is intermediate consumption, I is investment, G is inventory changes, and E is exports. For a detailed analysis of the differences between the two statistical methods in Italian accounts see Siesto (1973), p.323 .

[8] The main differences are:
- while the BF concerns residing households, the CN data refer to final consumption over the territory, that is including the consumption of non-residing units;
- the household medical expenses considered in the BF data are limited to the effective expenditure of the family (net of refunds), while in CN data the whole amount of these expenses is ascribed to households;
- as for the car insurance, in the BF the premia payed by the households are included, while for the CN data the eventual compensations for damages from insurance companies are subtracted.

[9] With the adoption of SEC '95 this picture is going to change. As explained by Corea *et al.* (1999), first of all the detail of consumption categories will be different, and, furthermore, beside the definition of final consumption the effective consumption will be considered. This aggregate of consumption will include all goods and services directly used by the households, including those from the market and those acquired

It is clear that the two data sets differ. We now want to explain why we decide to use both of them.[10] The BF data are essential because of the wide variety of households characteristics in the sample tied to household expenditures. Could we have used these data to estimate not only the cross-section equation but also the time-series demand system? The answer to this question is negative. This procedure is not inherently wrong, but it becomes so for the context of the present study, which is to estimate a demand system in a multisectoral model built upon the National Accounts. This purpose necessitates an accounting consistency which is guarantee by the CN household consumption, not by the BF data. On the other hand, if we have decided to use only the CN data we would have excluded from the analysis many demographic characteristics because of missing time-series information of the joint distribution of expenditure and demographic characteristics. This line of reasoning is the explanation of our choice to use both data-sets with a linkage between the cross-section and the time-series analyses.

The demographic model: description and hypotheses

The demographic projections model (DPM) used in this study is based upon the *"cohort component method"* to obtain a population at time t+1 from a base year population and some additional information about the mortality rates from one age to the next, net immigration by age and fertility rates by age.[11] In the long run, it is clear that overall population may be increased by any or all of the following means : a decrease in the mortality rates, an increase in net immigration and in fertility. However, the age composition of the population depends heavily on which of these factors changes and how they change. If we consider a population increase due to an increase of fertility rates and another one explained by a reduction of mortality among the elderly, the age composition of the resulting population would be very different.
With the information about the variables mentioned above, the base year population is aged one year by adding in net immigration for each age and gender, and applying age and gender specific survival rates to the resulting population. For example, the equation used to predict the number of males aged 30 is the following:

$$\text{male30}_{t+1} = \text{male29}_{t} * \text{srtm30}_{t+1} + 0.5\,(\text{immm29}_{t+1} + \text{immm30}_{t+1})*(1+\text{srtm30}_{t+1})*0.5$$

where male29 is the number of males aged 29, srtm30 is the survival rate for 30 year old males, immm29 and immm30 are the numbers of net immigrants aged 29 and 30. The first term on the right hand side of the equation is straightforward but the second term deserves

through the Public Administration and the Non-profit Private Institutions.

[10] These differences are well known to researchers who have worked on Italian data such as Patrizii *et al.* (1990): in their study both data sources have been utilized.

[11] Several forecasts of Italian population are available. Among them, there are those produced by demographic models designed by Istat, by the Institute for Population Research at CNR (IRP) and by the Ragioneria Generale dello Stato (see Istat (1997), Golini *et al.* (1995), Ministero del Tesoro-RGS (1995), respectively). These models differ for their general characteristics and for the scenario hypotheses.

some further explanation.

We assume that immigrant entry into the country is evenly distributed over the year and that some immigrants (emigrants) are 29 year old when they arrive but will be 30 during the year while others are listed as 30 years old and will still be 30 at the end of the year. Therefore we consider the average of the two years to get effective immigrants of 30 year-olds. Furthermore, since immigrants (emigrants) enter the country having lived at least part of the year already, we have to reduce their exposure to mortality for the year: the term (1+srtm20)*0.5 may be interpreted as the effective survival rate of immigrants, who, on average, enter the country at mid-year.

Finally, we need to obtain a projection of the population of infants by applying the fertility rates by age to each female age group. Summing the births from each age group yields the total number of births. It is necessary to split total births in to male and female. This is done by using the ratio of females to males in the last year available for Italian population. We also calculate life expectancy for age and gender by using the stationary population along with standard demographic techniques. The demographic model also includes a set of equation to estimate the demographic proportions D_j as functions of variables produced by the model and other exogenous variables.

To apply this demographic projections model, it is necessary to make hypotheses about mortality rates, fertility rates and net immigration. At this stage of the study, we have assumed the middle series assumptions - therefore the most likely - expressed and used by Istat for its demographic forecasts (Istat, 1997). As for the mortality rates, Istat has produced estimates with a parametric model: these results indicate that for the future decades the survival of Italians is going to increase along the actual trend. The fertility rates for the future have been produced by assuming a further reduction of fertility by cohort as projected from the recent trend. Migrations have been studied with extrapolative models: the central hypothesis forecasts an influx of about one hundred thousand immigrants until 2000 then a constant entry for the rest of the forecast horizon. Emigrants are supposed to decrease until 2020 and then to remain constant. The hypothesis about the net immigration is the most unpredictable of the components of population projections. The assumption by Istat is based upon the past behaviour but cannot take into account further possible factors that could heavily influence future migrations. The hypotheses summarized above cover the period 1996-2020. For the remaining period to 2050 every demographic component is assumed fixed to its 2020 value.

The demographic projections model permits changing the hypotheses about mortality rates, fertility and net immigration in response to specific policies concerning, for instance, economic incentives for stimulating an increase of births or the variation of the maximum number of immigrants allowed into the country each year. At this stage, in order to test our tool, we did not change these assumption: our scenarios were designed to be as close as possible to those adopted by our National Institute of Statistics.

Recent evolution of Italian population

The main characteristics of Italian population evolution are widely known: zero

growth, population ageing and high immigration to compensate the decrease of national population.[12] Obviously, these facts are reproduced also by our demographic model. Table 1 briefly summarizes these results and presents some assumptions of our scenario. The computation of population by gender, births and life expectancy is part of DPM, while the total fertility rate (TFT) and the net immigration are some of our assumptions.

During the period 1956-1968 a relevant increase of births was registered, as shown by the graph below.

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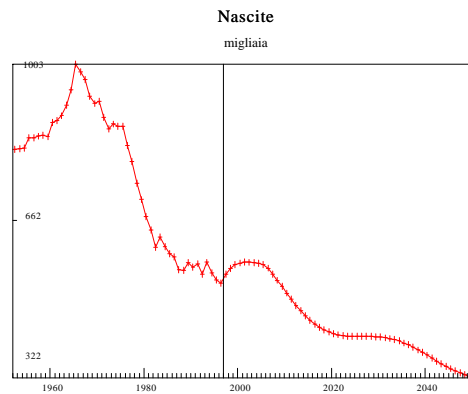
This baby boom was explained by a high fertility rate while the increase in the increase of births during the period 1996-2000 is due to the entry of the baby boom generation in the most fertile age.[13] These two events characterize the age composition of the population as a two-peak distribution. Then, a negative trend is estimated until the end of the forecast horizon with a slowdown during the decade 2020-2030 due to the birth of grandchildren of the same generation. We point out that the increase in the total fertility rate does not contradict the hypothesis of a decrease of fertility: here we are talking about the per period TFT and not the cohort fertility rate. This rate shows an increase because of the partial recovery, for 30 year-olds, of fertility not realized in their youth.

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[12] Many works regarding the quantitative analysis of these demographic trends have been published. See, among others, Golini (1994), Golini *et al.* (1995), IRP (1999).

[13] We remind here that the beginning of fecund age has been moved forward in women lifetime, therefore the births increase is at present in progress.

Table 1

Population: DPM Projections and Demographic Assumptions

	1996	2000	2010	2020	2030	2040	2050	00-10	10-20	20-30	30-40	40-50
Total Population (Millions)	57.3	57.6	57.9	56.5	54.0	50.8	46.7	0.0	-0.3	-0.4	-0.6	-0.8
Males	28	28	28	27	26	25	23	0.1	-0.2	-0.4	-0.6	-0.9
Females	30	30	30	29	28	26	24	0.0	-0.3	-0.4	-0.6	-0.8
Total Births (Thousands)	527.3	571.7	506.0	417.8	410.0	370.5	322.2	-1.2	-1.9	-0.2	-1.0	-1.4
Births per 1000 women aged 15-50	35.9	40.1	38.3	36.2	41.0	40.2	37.8	-0.4	-0.6	1.2	-0.2	-0.6
Total fertility rate (per 1000 women)	1184.7	1311.0	1462.1	1449.5	1449.5	1449.5	1449.5	1.1	-0.1	0.0	0.0	0.0
Total immigration (Thousands)	50.1	50.3	52.7	56.4	59.6	62.9	66.2	0.5	0.7	0.5	0.5	0.5
Males	28.6	28.5	29.7	31.8	33.6	35.5	37.4	0.4	0.7	0.6	0.5	0.5
Females	21.5	21.8	23.0	24.6	26.0	27.4	28.8	0.6	0.7	0.5	0.5	0.5
Life Expectancy at Birth (Years)												
Male	75.6	76.2	77.3	78.4	78.4	78.4	78.4	0.1	0.1	0.0	0.0	0.0
Female	81.4	81.9	82.9	83.8	83.8	83.8	83.8	0.1	0.1	0.0	0.0	0.0

*Sourc*e: authors' calculations and ISTAT demographic assumptions

The analysis of the age composition of the Italian population presents some relevant changes that could deeply influence the Italian economy in several ways. Table 2 shows the impact of the baby boom cohort from the 1960s on the population age composition: the increase of 0-9 cohort in 1960 and 1970 runs progressively down the diagonal of the table,[14] this generation is currently part of the 30-39 and 40-49 age groups and will begin to enlarge the rows of over 60 by 2030, to enter the group of over 75 at the end of our forecast horizon.

The age composition of the population influences the labour force growth: in 1960, 54 percent of the population was aged between 20 and 60 (working age), then as the baby boom cohort ages, this share at first diminishes then rises between the years 1990 and 2000. From the beginning of the new century the percentage of population between 20 and 60 years old decreases to reach the 45 percent of the population by 2050 (assuming fixed labour force participation rates).

Table 2 - Age Structure of the Population 1960-2050

Year	Shares of population in age groups (%)								
	36781	36817	20-29	30-39	40-49	50-59	>60	>75	20-60
1960	16.3	16.1	15.8	15.3	11.9	11.2	13.5	3.1	54.1
1970	17.1	14.7	14.2	14.1	13.6	10.3	15.9	3.7	52.2
1980	14.3	16.3	13.8	13.3	13.1	12.3	16.8	4.5	52.6
1990	10.3	14.2	16	13.6	13	12.4	20.4	6.5	55
2000	9.6	10.2	14.2	16	13.4	12.5	24	8	56.2
2010	9.5	9.7	10.3	14.4	15.9	13	27.1	10.4	53.7
2020	7.9	9.9	10.1	10.9	14.8	16	30.4	12.1	51.8
2030	7.6	8.4	10.5	10.9	11.5	15.1	35.9	14	48.1
2040	7.8	8.2	9.2	11.6	11.7	12	39.5	16.6	44.5
2050	7.3	8.6	9.3	10.5	12.7	12.5	39.1	19.9	45

Source: 1960, Istat; other years, authors' calculations.

The age structure of the population has other impacts, which are the main interest for this study: the composition of consumer spending. People of different ages tend to consume different goods and services; therefore, the population ageing will change the structure of demand. This may affect productive sectors differently, with winners and losers. This in turn will change the output composition and the employment patterns. Using the approach adopted here, we are able to assess these economic effects. The cross-section function permits the estimation of the adult equivalency weights: these parameters show the importance of the household members in different age groups relative to an adult aged 30-39 - whose weight is

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[14] The births increase was from 1956 to 1968, when the total fertility rate rised from 2.38 to 2.7 in the period 1959-64.

equal to one - in contributing to the consumption of a specific item. These estimated weights and the population by age groups computed by the DPM may be used to construct a time-series of weighted populations specific for each commodity. [15] Beside the use of this variable in the time-series estimation of the consumption expenditure system, the weighted populations may be used to analyse the impact of population age composition on consumption. Dowd *et al.* (1998) have proposed this analysis for the United States, by forming an index defined as following:

$$100 * (WPOP_i / POP) * (POP95 / WPOP_i 95) - 100$$

where $WPOP_i$ is the commodity specific weighted population and POP is the total population. This index show the percent difference from 1995 in real per-capita consumer spending due to changes in the age composition of the population. We must stress that this measure is calculated with relative prices and consumer preferences being constant. Following this approach, we have computed a series of commodity specific indexes for Italy. Some results for a selection of the 40 item classification is presented in Table 3 along with some aggregations of the indexes by using fixed 1995 consumption shares.

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[15] These are the weighted populations used in the time-series demand system and computed according to equation (4).

Table 3 - **Real Per Capita Consumer Spending Changes due to Age Composition Evolution**

| | Percentage change relative to 1995=0 | | | | | | |
	1985	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Average age of the population	36.6	40.9	43.2	45.5	47.4	48.6	49.2
Durable Goods	0.54	-0.08	-0.17	-0.36	-0.47	-0.44	-0.48
Vehicles	7.38	-2.80	-6.34	-9.07	-10.86	-12.11	-12.72
Orthopaedic Equipment	-3.06	5.04	10.70	13.13	15.68	19.52	20.47
Semi-Durables Goods	-0.51	0.03	-0.07	-0.22	-0.28	-0.37	-0.37
Clothing	-2.12	-0.08	-0.76	-1.42	-1.70	-1.87	-1.79
Operation of motor-vehicles	-2.41	-0.19	-1.47	-2.93	-3.62	-4.68	-4.92
Non-Durable Goods	-0.40	0.23	0.54	0.76	0.93	1.03	1.05
Electricity, Oil and Gas	-2.23	2.08	5.52	7.83	9.27	10.90	11.25
Drug Preparation	-4.45	2.78	4.69	7.13	10.17	11.61	11.51
Services	-0.95	0.31	0.68	1.08	1.34	1.50	1.60
Domestic Services	-0.77	1.38	5.37	8.67	9.46	9.80	10.18
Medical Services	-4.53	1.58	5.22	7.77	8.29	9.06	9.88
Hospitals, Nursing Homes	-3.05	5.04	10.69	13.13	15.68	19.52	20.46
Education	6.00	-4.82	-6.85	-5.95	-8.85	-11.76	-10.96

Note: Holding income and prices constant, a value of 1 indicates that real per capita spending is up 1 percent relative to 1995.
Source: authors' calculations.

At a first glance, this table confirms expectations about the foreseeable effects on consumer spending due to the population ageing, but the indexes of durables, semi-durables, non-durables and services do not show significant variations from 1995 as was found with the same analysis about US spending. However, a closer look at the commodity specific indexes reveals very useful information for explaining the result of the aggregate indexes. For instance, among durable goods, the purchase of motorvehicles shows a decrease of –10.86 percent in 2030, but this variation is compensated inside the aggregate by the opposite change of orthopaedic equipment (+15.68 percent). We may observe the same opposite dynamics among services, namely with domestics services and education: housing expenses, along with electricity, oil and gas purchases, medical services and pharmaceutical products are the most significant effects due to the ageing population.[16]

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[16] This result is strongly linked to the third channel of influence of demographic changes, that is the government budget effects due to medical care spending, pensions and education in the new demographic

Remember that the analysis based upon these indexes does not consider variations of income, prices and preferences. In fact, the weighted population series is constructed from the adult equivalent weights: these weights vary from 1985 to 1996 because they are estimated from the cross-section data, but they are fixed at their 1996 value for the period 1997-2050. This means that, for instance, if the elderly in 1996 have a consumption of wine greater than the young people the index of alcoholic beverages will show an increase in the future because of the ageing population. This evolution would be inconsistent with the historical trend of this commodity, which is showing a constant diminishing trend. In fact, we may think that the present young generation will age with its actual preferences and will not adjust to the elderly behaviour of today. This argument is valid for all commodities but particularly for some of them such as fats and oils, tobacco, alcoholic beverages, financial services, technical instruments. In these cases, we may observe a remarkable change of habits given to health reasons, technological progress and other causes: it's hard to believe in a backward involution.

The age effect: a digression

The main point here is to distinguish between a pure age effect and a cohort effect on consumption. The cohort effects prohibit considering a cross-sectional consumption profile as a life-cycle age-related profile. In fact, the consumption behaviour includes an age effect, that is the characteristic life-cycle profile of the variable, and a cohort effect, that leads to differences in the positions of age profiles for different cohorts. If these differences exist, it is not correct to extrapolate from cross-sectional data information about the life-cycle consumption of an individual household. The economic analysis based upon survey data has its advantages because of the wide variety of household characteristics in the sample. It has limits because we are not looking across ages for the same cohort of households, but at the experience at different ages of different groups of households. However, with a time series of cross sections, though there is no possibility of following the same households over time since different households are selected in each survey, it is still possible to follow cohorts of people from one survey to another. Tracking different cohorts through successive surveys allows us to disentangle the generational from the life-cycle components in consumption profiles. In order to do this, we need to construct cohort data. These semi-aggregated data provide a link between the microeconomic household-level data and the macroeconomic data from national accounts. There are some disadvantages of cohort methods. First of all, we assume that the cohort population is constant:[17] this causes problems with migration, ageing and death. But more serious difficulties come when data are collected only at the household level and we are forced to define cohorts of households by the age of the head. This choice create problems because households are not permanent, they change with divorces, remarriages, older people who go to live with their children. Therefore, old household in some surveys may become young households in others.

It is possible to use these cohort data to apply a decomposition into age effects, cohort

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scenario. The study of these very important economic aspects is not considered in this work, although the macroeconomic model may be implemented to evaluate also this kind of effects and simulate alternative policies.

[17] "An assumption that is needed if the successive surveys are to generate random samples from the same underlying population". Deaton (1997), p.121.

effects, and year effects. This technique is commonly used to test the life-cycle theory of consumption.[18] Here, since in our surveys there are not good data on income, we use this decomposition simply as a descriptive device to verify our idea of an age and a cohort effect interacting in our data.

We can present the consumption data in different ways. Figure 1 shows the cross.-sectional age profile of (constant-price) consumption for 1985, 1991, 1993 and 1995. Each curve plots against head's age the average consumption of all households with heads of that age.

Figure 1
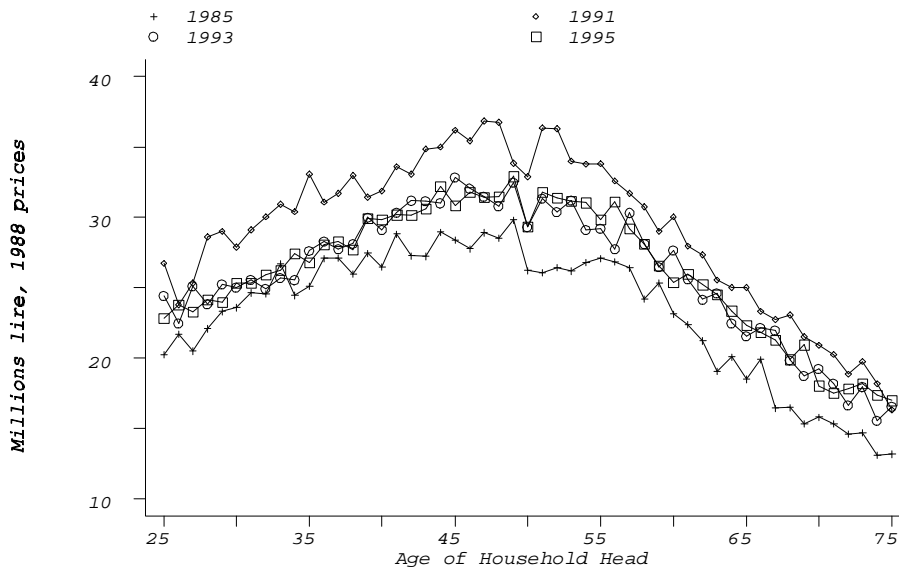
Cross-sectional consumption profiles, selected years

The growth of real consumption has raised these profiles from 1985 to 1991.[19] The 1993 negative macroeconomic shock with the accompanying lira devaluation has implied a fall of personal consumption expenditures, so the 1993 and 1995 consumption profiles are not far apart but below the one of 1991. The age profiles rise somewhat from age 25 through 50, and decline thereafter. However, these profiles tell us nothing about the experience of any given cohort. To trace the average consumption of each generation the points should be connected not within years but within cohorts: the age profile from a single cross section confounds the age effects with the generational effects.

This alternative representation is obtained with cohort data. Cohorts are constructed by date of birth of the household head, or more conveniently, by age in 1985. For each survey, we average the expenditures by age of head and then track the sample from the same cohort one

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[18] See Deaton and Paxson (1994), Jappelli (1999), Jappelli and Modigliani (1998).

[19] The years 1986-1990 missing in the figure have plots raising above the 1985 and below the 1991 curves.

year older in the next survey. For example, we can look at the average consumption of 30-year-olds in the 1985 survey, of 31-year-olds in the 1986 survey and so on. Figure 2 shows the cohort consumption for every fifth cohort beginning with those born in 1960. The first line segment -labelled with number 1- connects the average consumption of those who where 25 years old in 1985 to the average consumption of 26 years old in 1986, until the last observation of the cohort in 1996, when they were 36 years old. The second line segment repeats the

Figure 2
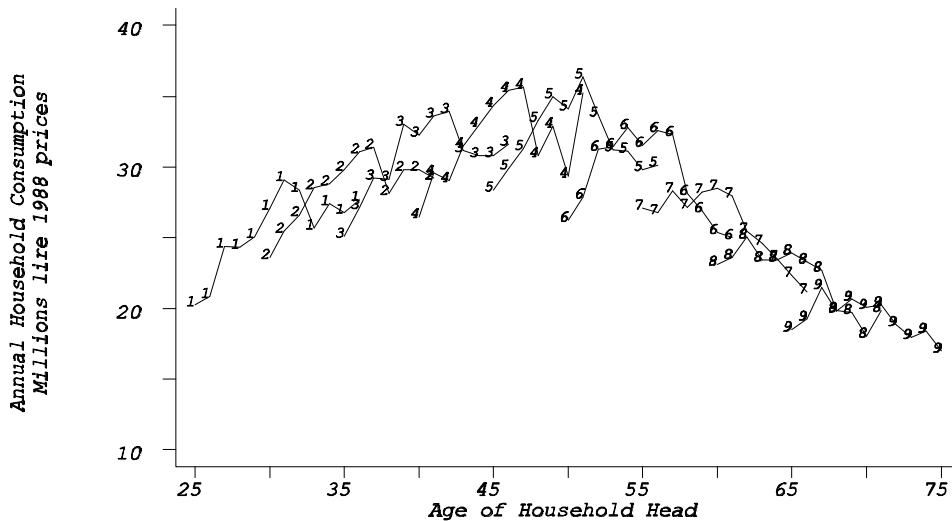
Total household consumption, by age of household head

exercise for those who were five years older until the last cohort considered in this graph of those born in 1920, labelled with number 9. There is a visible life-cycle pattern, rising with age and then falling with a peak around the age of 50. With few exceptions at older ages, the lines for the younger cohorts are very often but not always above the lines for the older cohorts, even when they are observed at the same age, that is when the cohorts overlap. This is because the growth at the end of the 80's made the younger generations better-off.

This is the cohort effect. We noticed that the younger cohorts tend to have a higher average consumption than the older but this is not always the case. In fact, there is also a great deal of within-cohort movements. We think that some of them may be explained by a common macroeconomic shock that is perhaps the hardest to see in this graph. Note that each connected line segment corresponds to the same contemporaneous span of 12 years, 1985-96. Each cohort, except those born before 1930, has a constant growth of average consumption from 1985 to 1991, a slowdown in 1992, then a clear fall in 1993 and a very modest growth after that. This is an example of year effect, that is an aggregate effect that synchronously but temporarily move all cohorts off their profiles, in this case a fall of the economy growth rate.

A deeper analysis of this figure requires us to distinguish these three effects: age, cohort, and year effects. In order to do this, we need to construct cohort data and to separate these three components. The data were constructed according to the principles outlined above. We have constructed cohorts at each age although we have eliminated the youngest and the oldest groups (below 25 and above 75 years old). We have truncated on age of head,

eliminating those below 25 because there were very few household heads so young, and those above 75 to avoid a selectivity problem.. We end up with 62 cohorts: the youngest of those 25 years old in 1996, the oldest of the 75-year-olds in 1985. We have, for each commodity, a stacked vector of cohort-year observations on the cohorts means of consumption.[20] We have decided to construct cohort data not only for the aggregate consumption but for the 40 expenditure categories of our model. This is because we are interested in verifying how relevant are the age and cohort effects for some commodities of our classification .

   In order to estimate the decomposition of effects, we may regress the cohort averages of consumption against dummy variables for all three sets of effects. Of course other restrictions could be used such as polynomials, but when data are plentiful we can use dummy variables and thus allow the data to choose any pattern. The model can be written as

$$y = \beta + A\alpha + C\gamma + Y\psi + u$$

where y is the stacked vector of observations, A is a matrix of age dummies, C a matrix of cohort dummies, and Y a matrix of year dummies.[21]
We must drop one column from each of the three matrices of dummies, to avoid singularity. However, it is still impossible to estimate this regression because of an additional linear relationship across age, cohort and year. That is, if we decide to label cohorts c as the age of household head in year $t = 0$ and t refers to the date, we can infer the cohort's age a as

$$a = c + t$$

Therefore, it is necessary to impose another restriction to obtain the normalization effects. There are several possible alternatives and each of them implies different results. One of the most common imposes the constraint that year dummies coefficients are orthogonal to a time-trend and sum to zero (Deaton and Paxson, 1994). To understand this normalization, we can consider an example of a variable, say consumption, growing at a 5 percent for each year as for each cohort. This growth can be represented by a time-trend of 5% a year in the year effects, without either cohort or age effects or by age effects that rise linearly with age added to cohort effects that fall linearly with age. Note that these two effects are equal (5 percent) but of opposite sign because cohort are labelled by age at a fixed date, so that older cohort (larger c) are poorer, not richer. In this case, where consumption is the variable to be decomposed, it seems reasonable to attribute growth to age and cohort effects not time, and to use the year effects to capture cyclical fluctuations that average to zero over the long run. The simplest way to implement this normalization is to estimate the model with the first age group, and the twelfth cohort omitted, so that the reference group is that of a household headed by a 25 year old in 1985. The year dummies are constrained to be orthogonal to a time trend and to add to zero.[22]

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[20]In fact, we have worked with the means of the logarithm of consumption.

[21] In our case, all matrices have m rows, that is the number of cohort-year pairs for each commodity. The number of columns is 51 (the number of ages) for matrix A, 62 (the number of cohorts) for C, and 12 (the number of years) for Y.

[22] Consider d_t as the usual zero-one dummy. To enforce this restriction we have used a set of T-2 year dummies, d_t *, defined as follows, from t = 3, ... T
$$d_t * = d_t - [(t-1) d_2 - (t-2) d_1]$$

We present some results of this decomposition with Figures 3. We have selected few expenditure categories of our 40-item classification which we consider interesting for this purpose: fats and oils, alcoholic beverages, tobacco, TV, radio and technical instruments,[23] and financial services. The three food categories showed high values of adult equivalency weights for older age groups and therefore these weights will be possibly driving up the households consumption of these items with the population ageing. The two non-food categories are interesting for the same kind of possible effect but with the opposite sign: their consumption is wide-spreading with technological progress although the elderly today have a low weight in the household expenditure for these items.

For each of these five items, we present four graphs. The first plot shows the average of log consumption for every fifth cohort (from the youngest labelled with number one, born in 1965, to the oldest labelled with number ten, born in 1920). The other three panels show the age effects, the cohort effects, and the year effects, respectively.

The consumption of fats and oils is decreasing from the older to the younger cohorts and, according to the age effects, this item is also a decreasing function of age. The same patterns may be observed for tobacco, but here the magnitude of age effects is greater than that of cohort effects. The awareness of health risks for the consumption of tobacco is more wide-spread as the household head ages rather than as generations change. As for alcoholic beverages, the first panel presents a hump-shaped age profile of consumption. That, in fact, is created by a pure age effect with a peak around the age of 50. Instead, the cohort effects are small and without a distinctive pattern. The year effects for all these categories are smaller than either the cohort or the age effects and they all show an economy growing slowly in the 90's, apart from tobacco with a rising profile after 1993.

Financial services are growing from older to younger cohorts but there is also a great deal of within-cohort variations partly explained by a peak in the year effects in 1989 and 1991. The first panel creates an impression of a hump-shaped age profile, which indeed comes from the age effects: according to these, there is less consumption of financial services after age 60 although there is no clear turning down of the profile. Cohort effects are more relevant for TV, radio and technical instruments and they decline steadily from younger to older cohorts. The age effects show a more rapid growth between ages 25 and 40, then a slower growth. The year effects present a distinctive hump-shaped profile with a peak in 1991, as we may notice for each cohort segment.

The decomposition of age, cohort, and year effects presented for these selected consumption categories led to mixed results. We wanted to test how "pure" was the age effect implied by the adult equivalency weights estimated in our cross-section analysis, and then used in forecasting. For the food categories, cohort effects are in general not very relevant while the "pure" age effect is dominant in the consumption profile. Therefore, our assumption of using the 1996 weights for the personal consumption expenditures forecasts is not so arbitrary and misleading. However, the other two categories show a decomposition where the generational effects play a distinctive role beside the "pure" age effects. Therefore, this analysis suggests the need for further study to find a procedure to distinguish these effects in forecasting and to project them for the future.

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[23] This category also includes personal computers and cellular phones.

Personal consumption expenditure analysis in the macro-interindustry model

The last step consists in the estimation of the demand system inside the macroeconomic model of Italian economy. It is always difficult to describe with adequate detail the complete framework of the model where a specific segment is included. In this case we will refer only to the variables involved in the consumption modelling, leaving aside the description of the overall macroeconomic model. For this purpose we refer mainly to Grassini (1998) and to the bibliographic references included in that work.

With reference to equation (2), the time-series consumption equation, prices are determined endogenously inside the macroeconomic model. The variable C_t^* is determined by equation (3) where the household disposable income is provided by the macro-model.

To show our approach as a whole, we compare some simulations. The forecast horizon of the macro-interindustry model is 2010, therefore the most relevant effects of population ageing are not completely developing by that date. However, it is possible to appreciate the first signs of a different evolution of personal expenditures from the one with a constant age composition as in 1995. For this exercise, we have imposed a limit on the growth rate of disposable income in order to underline the effect on consumption of non-income variables. We have designed the following scenarios:

1) Base Scenario: the population growth has been exogenously fixed, with the age composition and the other demographic characteristics held constant at the 1995 structure;

2) DPM Scenario: the demographic projections model results have been fully included, the population growth, the age composition and the estimates of non-age households characteristics are endogenously estimated and used for the personal consumption forecasts;

3) DPM-AGE Scenario: the population growth and the age structure are estimated by the demographic model but the non-age demographic variables are held constant to the 1995 structure. This scenario has been designed to isolate the population ageing effects on personal consumption expenditures.

Table 4 shows the simulations results on consumer spending disaggregated in 40 categories with some totals. The first three columns of the table present the values in constant prices (1988 base year), the others show the growth rates for some periods of the forecasting horizon. For each expenditure category, every row contains the result of one scenario but the second and third are presented as percentage deviations from the base scenario, that is the one without the DPM.

The overall results show a very modest growth of aggregate consumption due to the very limited disposable income dynamic and to the price increase:[24] this forecast is certainly not realistic but it was not our main interest to analyse the aggregate behaviour of consumption. For the purpose of the present study, it is decidedly more useful to observe the distribution of spending across sectors and its differences from the base scenario. The behaviour of food categories shows a decrease in the DPM scenario compared with the base. This negative trend is attenuated if we consider only the population ageing effect (DPM-AGE scenario): in this case, for some items such as meat, dairy products, fats and oils, fruit, and coffee, tea and cocoa, we notice an increase with respect to the base, even thought the dynamic is slowing down throughout the forecasting period. In fact, for these commodities the indexes computed along the procedure of Table 3 were tending to increase because of the population ageing. Instead, in the DPM-AGE scenario the non-food categories have a lower growth than the base. This result

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[24] The consumption deflator rises from 1 in the base year to 2.18 in 2010.

is explained by the negative performance - compared with the base - of some categories such as clothing and footwear, furniture, household appliances and transports. As expected, in the DPM-AGE scenario the medical expenses are larger while expenditures for education and books decrease.

As a conclusion from this simple exercise, we might say that some results of this work should be revised as we have outlined through the paper. We are well aware that these and other improvements are necessary for the analysis of demographic evolution economic effects to be complete. The interindustry model needs to be implemented in areas other than personal consumption expenditures to capture the overall impact of population ageing. However, these preliminary results may show a possible path, among many others, to model and forecast the influence of the changing structure of population on a long-term disaggregated model of the economy.

Table 4

PERSONAL CONSUMPTION EXPENDITURES

Line 1: Base Scenario
Line 2: DPM Scenario DPM - deviations from the base
Line 3: DPM-AGE Scenario - deviations from the base

Milliards lire 1988 prices

	2000	2005	2010	1995-2000	2000-2005	2005-2010
TOTAL PCE	731356	742064	748446	1.00	0.29	0.17
	-219	-828	-1146	-0.01	-0.02	-0.01
	-589	-1233	-1751	-0.02	-0.02	-0.01
-FOOD	115603	107511	100173	-0.85	-1.45	-1.41
	-651	-1179	-1283	-0.11	-0.11	-0.04
	170	285	280	0.03	0.02	0.00
-Cereals and Bakery Products	16248	15666	15125	0.18	-0.73	-0.70
	-119	-205	-235	-0.15	-0.12	-0.05
	-0	13	8	-0.00	0.02	-0.01
-Meat	31107	27950	25172	-1.94	-2.14	-2.09
	-159	-259	-268	-0.10	-0.08	-0.03
	41	83	84	0.03	0.03	0.01
-Fish	7746	7056	6429	-0.94	-1.87	-1.86
	-24	-52	-50	-0.06	-0.08	-0.01
	-10	-23	-35	-0.03	-0.04	-0.04
-Dairy Products	18904	18048	17248	0.09	-0.93	-0.91
	-111	-212	-240	-0.12	-0.12	-0.04
	40	57	48	0.04	0.02	-0.01
-Fats and Oils	4151	3658	3206	-2.16	-2.53	-2.64
	-4	-14	-16	-0.02	-0.06	-0.02
	27	40	43	0.13	0.09	0.05
-Fruit and Vegetables	26886	24898	23074	-0.99	-1.54	-1.52
	-193	-361	-393	-0.14	-0.15	-0.05
	32	45	51	0.02	0.01	0.01
-Potatoes	1217	1132	1055	-0.24	-1.45	-1.41
	-4	-7	-6	-0.07	-0.05	-0.00
	5	8	10	0.07	0.07	0.03
-Sugar	1631	1534	1437	-1.02	-1.21	-1.31
	-8	-16	-19	-0.10	-0.11	-0.06
	6	11	11	0.08	0.06	0.02
-Coffee, Tea and Cocoa	3093	2905	2729	-0.10	-1.25	-1.25
	0	-1	2	0.00	-0.01	0.03
	20	34	40	0.13	0.10	0.06
-Other food	4620	4663	4697	1.09	0.19	0.14
	-28	-52	-59	-0.12	-0.10	-0.03
	9	16	20	0.04	0.03	0.02
-BEVERAGES	8912	8208	7555	-0.79	-1.65	-1.66
	-13	-37	-50	-0.03	-0.06	-0.04
	36	49	47	0.08	0.04	0.00
-Non Alcoholic Beverages	3297	3571	3813	2.26	1.59	1.31
	-18	-36	-41	-0.11	-0.09	-0.02
	-2	-0	7	-0.01	0.01	0.04
-Alcoholic Beverages	5614	4637	3742	-2.39	-3.82	-4.29
	5	-2	-8	0.02	-0.02	-0.04
	37	50	40	0.13	0.08	-0.00
NON-FOOD	606841	626345	640718	1.40	0.63	0.45
	444	388	186	0.01	-0.00	-0.01
	-794	-1567	-2078	-0.03	-0.02	-0.01
-Tobacco	7902	6976	6084	-1.25	-2.49	-2.74
	-87	-144	-179	-0.22	-0.20	-0.18
	-41	-69	-107	-0.10	-0.10	-0.16
-Clothing and Footwear	65147	62876	59827	-0.69	-0.71	-0.99
	127	161	182	0.04	0.01	0.01
	-355	-687	-815	-0.11	-0.11	-0.05

(...continued)

PERSONAL CONSUMPTION EXPENDITURES

Line 1: Base Scenario
Line 2: DPM Scenario - deviations from the base
Line 3: DPM-AGE Scenario - deviations from the base

Milliards lire 1988 prices

	2000	2005	2010	1995-2000	2000-2005	2005-2010
-Clothing	51925	50197	47797	-0.70	-0.68	-0.98
	245	339	387	0.09	0.04	0.03
	-278	-576	-670	-0.11	-0.12	-0.05
-Footwear	13222	12679	12030	-0.68	-0.84	-1.05
	-118	-178	-205	-0.18	-0.10	-0.06
	-77	-111	-145	-0.12	-0.06	-0.07
-Housing and Energy	111397	117329	121683	1.74	1.04	0.73
	-411	-517	-79	-0.07	-0.01	0.08
	625	1394	2067	0.11	0.12	0.10
-Housing	88392	94075	98371	1.88	1.25	0.89
	-300	-340	13	-0.07	-0.00	0.08
	488	1114	1625	0.11	0.13	0.09
-Electricity, Oil and Gas	23005	23254	23312	1.21	0.22	0.05
	-111	-177	-92	-0.10	-0.06	0.07
	138	280	441	0.12	0.12	0.14
-Furniture and Household Appliances	65520	64331	62983	-0.09	-0.37	-0.42
	424	613	835	0.13	0.06	0.07
	225	323	522	0.07	0.03	0.06
-Furniture	18730	18061	17333	-0.61	-0.73	-0.82
	48	27	12	0.05	-0.02	-0.02
	2	-41	-44	0.00	-0.05	-0.00
-Household Linen	8607	9226	9856	0.51	1.39	1.32
	40	-1	-47	0.09	-0.09	-0.09
	-43	-106	-131	-0.10	-0.13	-0.04
-Kitchen and Household Appliances	6954	7011	7022	-0.75	0.16	0.03
	40	32	20	0.12	-0.02	-0.03
	-39	-98	-109	-0.11	-0.17	-0.03
-China, Glassware and Tableware	3215	3066	2909	-2.02	-0.94	-1.05
	35	51	43	0.22	0.11	-0.03
	-16	-36	-37	-0.10	-0.14	-0.02
-Domestic Services	8826	8577	8293	0.42	-0.57	-0.67
	281	459	589	0.63	0.42	0.33
	261	416	473	0.58	0.36	0.16
-Other non-durables	19188	18390	17569	0.52	-0.85	-0.91
	-19	45	218	-0.02	0.07	0.20
	60	188	369	0.06	0.14	0.21
-Medical Expenses	55757	60331	64005	2.76	1.58	1.18
	403	862	1315	0.14	0.14	0.12
	237	629	1168	0.08	0.12	0.15
-Drug Preparation and Sundries	23658	26355	28694	4.19	2.16	1.70
	-185	-316	-320	-0.16	-0.08	0.02
	-69	-55	62	-0.06	0.02	0.08
-Orthopaedic Equipment	2636	2767	2873	2.11	0.97	0.75
	46	89	126	0.35	0.28	0.22
	28	64	106	0.21	0.24	0.27
-Physicians, Dentists and Others	19455	20746	21687	2.22	1.29	0.89
	372	788	1082	0.38	0.37	0.23
	14	104	295	0.01	0.09	0.17
-Hospitals, Nursing Homes	10008	10462	10750	0.82	0.89	0.54
	169	302	428	0.33	0.23	0.21
	265	516	705	0.52	0.44	0.31
-Transports, Communications	93232	98572	103095	2.35	1.11	0.90
	948	1591	1343	0.20	0.12	-0.06
	-525	-956	-1441	-0.11	-0.08	-0.09

(continued...)

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PERSONAL CONSUMPTION EXPENDITURES

Line 1: Base Scenario
Line 2: DPM Scenario - deviations from the base
Line 3: DPM-AGE Scenario - deviations from the base

Milliards lire 1988 prices

	2000	2005	2010	1995-2000	2000-2005	2005-2010
-Motor-Vehicles	21078	20153	19178	0.45	-0.90	-0.99
	1806	3194	3591	1.64	1.30	0.49
	-34	-103	-79	-0.03	-0.07	0.02
-Operation of Motor-Vehicles	42848	45547	47911	2.37	1.22	1.01
	-551	-1077	-1653	-0.26	-0.22	-0.22
	-331	-642	-1150	-0.16	-0.13	-0.20
-Public Transportation	13399	14505	15447	2.24	1.59	1.26
	-239	-412	-491	-0.36	-0.22	-0.07
	-142	-223	-268	-0.21	-0.10	-0.04
-Communications	15907	18367	20557	5.21	2.88	2.25
	-68	-114	-105	-0.09	-0.04	0.02
	-18	12	56	-0.02	0.04	0.04
-Recreational Services, Education	71432	75763	79315	1.67	1.18	0.92
	-445	-885	-1095	-0.12	-0.11	-0.04
	-796	-1475	-1790	-0.22	-0.17	-0.06
-TV, Radio, Musical Instruments	34128	37248	39811	2.15	1.75	1.33
	90	17	-269	0.05	-0.04	-0.14
	-153	-359	-655	-0.09	-0.10	-0.14
-Books, Magazines and Newspapers	10888	10724	10519	0.42	-0.30	-0.38
	-94	-96	-60	-0.17	-0.01	0.07
	-140	-206	-233	-0.26	-0.13	-0.06
-Education	6023	6287	6497	1.79	0.86	0.65
	-117	-162	-145	-0.39	-0.13	0.07
	-222	-359	-390	-0.75	-0.43	-0.06
-Recreational Services	20394	21504	22488	1.53	1.06	0.89
	-324	-644	-621	-0.32	-0.29	0.05
	-282	-552	-513	-0.28	-0.24	0.06
-Personal Care	136454	140166	143728	1.76	0.54	0.50
	-514	-1294	-2135	-0.08	-0.11	-0.11
	-164	-726	-1681	-0.02	-0.08	-0.13
-Personal Care	24095	24907	25566	1.67	0.66	0.52
	-202	-408	-489	-0.17	-0.16	-0.06
	-45	-96	-128	-0.04	-0.04	-0.02
-Hotels, Motels, Restaurants	77077	81840	86420	2.22	1.20	1.09
	-1195	-2506	-3432	-0.31	-0.31	-0.19
	-123	-610	-1462	-0.03	-0.12	-0.19
-Other Goods	24931	22728	20762	0.70	-1.85	-1.81
	884	1665	1884	0.70	0.72	0.32
	-17	-11	-34	-0.01	0.00	-0.02
-Financial Services, Insurance	5520	5979	6407	2.74	1.60	1.38
	-4	-34	-72	-0.01	-0.10	-0.11
	13	-1	-30	0.05	-0.05	-0.09
-Other Services	4831	4712	4573	-0.46	-0.50	-0.60
	3	-10	-26	0.01	-0.06	-0.07
	8	-7	-27	0.03	-0.06	-0.09

Source: authors' calculations.

The cross-section household consumption function for each item is described as follows:[25]

$$c_{ht} = \left(\sum_{j=1}^{k} x_{hjt} \beta_{jt} + \sum_{j=1}^{m} d_{hjt} \delta_{jt} \right) \sum_{j=1}^{g} n_{hjt} w_{jt} \qquad h = 1, \ldots, N \qquad (1)$$

where

c_{ht} : consumption of household h at time t;
x_{hjt} : per capita income within household h divided in k=10 brackets at time t, j is the bracket index;
d_{hjt} : dummy variable j used to show inclusion of household h in m=15 demographic groups at time t;
n_{hjt} : number of members of household h for g=8 age groups at time t;
$\beta_{jt}, \delta_{jt}, w_{jt}$: parameters to be estimated for each commodity at time t;
N : number of households in the sample.

The choice of this functional form allows that the Engel curve may represent different types of commodities and estimate different propensities to consume for different income levels. For this purpose a linear spline function has been used: this is a very effective tool to reach an adequate degree of approximation without the function exact specification. A linear spline is a piecewise function in which the linear pieces are joined together in a smooth fashion. By applying this function to design the Engel curve, it is possible to approximate different functional forms according to the commodity type. To do this, income must be divided in brackets , the relationship between income and consumption is supposed linear in each bracket and, through the spline, these linear segments are joined at the knots. This curve is called *Piecewise Linear Engel Curve* (PLEC). An arbitrary number of brackets is defined whose boundaries $(B_L, L=1,...,k-1)$ are defined such that each bracket contains the same percentage of the total households in the sample (in our case we have designed deciles of the sample). The consumption of household h with a per capita income R_h in the j-th bracket is:

$$c_{hj} = b_{01} + \sum_{r}^{j} \beta_{1L}(B_L - B_{L-1}) + \beta_{1j}(R_h - B_{j-1})$$

This equation may be formulated as a standard regression whose deterministic term is

$$c_h = b_{01} + \beta_{11}x_{h1} + \ldots + \beta_{1j}x_{ij} + \ldots + \beta_{1k}x_{hk}$$

where per capita household income, R_h, is transformed in a vector where each component represents the amount of household income in each bracket. That is, for j=1,...,k:

$$x_{hj} \begin{cases} = B_j - B_{j-1} & \text{if } R_h \geq B_j \\ = R_h - B_{j-1} & \text{if } B_j > R_h \geq B_{j-1} \\ = 0 & \text{if } B_{j-1} \geq R_h \end{cases}$$

The parameters β_{1j} represent the slope of the function for each income bracket: the marginal propensity to consume is not only commodity specific but also different for each income variable.
The demographic variables are included in the cross-section function as zero/one dummies to indicate inclusion of the household in different demographic groups. The effect of these variables in the equation is to

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[25] The description of the cross-section consumption function draw heavily on Bardazzi *et al.* (1998).

shift the Engel curve up or down changing the intercept of the PLEC and no interaction among these demographic characteristics is assumed. The reference household here is a two earners family composed of three or four members and residing in central Italy with a non-college educated householder aged between 35 and 55 working as employee.

The specification of the effects on consumption of per capita income and household characteristics - the first term in parenthesis of the cross-section equation - allows one to compute for each item the per capita consumption within the family. To estimate the household consumption it is necessary to deal with the family size. In this case, in order to consider the age composition of the family, we have used the weighted sum of its members: we have estimated a set of weights to express the importance of each household member in contributing to the consumption of a specific item with respect to the reference adult (a 30-39 years old individual. The product of the per capita consumption by the household weighted size provide the household consumption of each good.

The demand system designed by Almon (1979, 1996) is the following:

$$\frac{q_{it}}{Pop_t} = (a_i + b_i y_t + c_i) \, y_t + d_i time_{)} \left(\frac{p_i}{P}\right)^{-\vartheta_i} \prod_{k=1}^{n} \left(\frac{p_i}{p_k}\right)^{-\vartheta_k s_k} \left(\frac{p_i}{P_G}\right)^{-\mu_G} \left(\frac{p_i}{P_g}\right)^{-\nu_g}$$

dove:

q_{it}/Pop_t is consumption per capita in constant prices of product i,

y_t is income (total expenditure) per capita in constant prices,

Δy_t is equal to $(y_t - y_{t-1})$,

time is time trend,

s_k is the budget share of product k in the base year,

p_k is the price index for product k, equal to 1 in the base year,

a, b, c, d, λ, μ, and ν are parameters to be estimated,

and P, P_G, P_g are over-all, group, and subgroup price indexes given by:

$$P = \prod_{all\ k} p_k^{s_k} \qquad P_G = \left(\prod_{k \in G} p_k^{s_k}\right)^{1/\sum_{k \in G} s_k} \qquad P_g = \left(\prod_{k \in g} p_k^{s_k}\right)^{1/\sum_{k \in g} s_k}$$

The demand equations have a multiplicative form between the income term - which is linear with a constant, the real per capita income, its first difference and a time trend - and the price term. The price effect is non linear and allows to use the idea of groups and subgroups of commodities which may be linked as complements or substitutes. The function provides: a price parameter for each commodity, λ; a price parameter for each commodities group, μ; a price parameter for each subgroup, ν. A positive value of these parameters indicates substitutability relative respectively to the other commodities, to the commodities in the group and within the subgroup. A negative value indicates complementarity. The groups designed for the Italian consumption categories are:

Group 1: Food

Group 2: Dress

Group 3: House furnishing and operation

Group 4: Medical expenditures

Group 5: Transportation

There are also 2 subgroups: 1) Protein-rich food; 2) Vehicles and operation

Not all commodities in the system must be in a group or subgroup, this depends from the available data set and from the researcher choice.

As for the income term in the first parenthesis of the right side of equation, it is not strictly necessary to use real per capita income to estimate the demand system. Instead, it is possible to use some income-based indicators of consumption specific for each commodity such as the C* computed here. Then, the dependent

variable of the time-series equation, the consumption per capita, is computed by using a different population for each commodity, that is the variables WPOP computed with the results of the demographic model.

The function described is non linear in all its parameters. For a description of the estimation procedure of the system, which is base on the Marquardt algorithm, we refer to Almon (1996).

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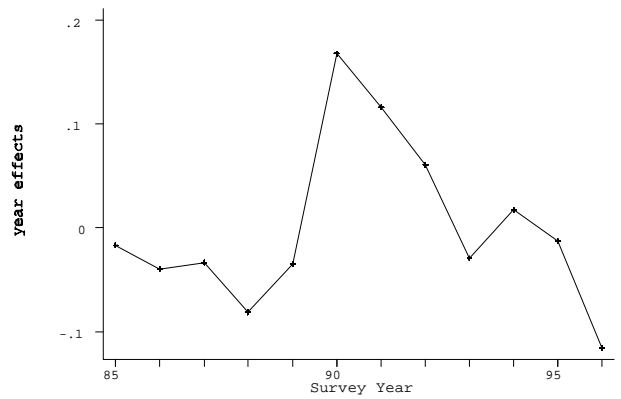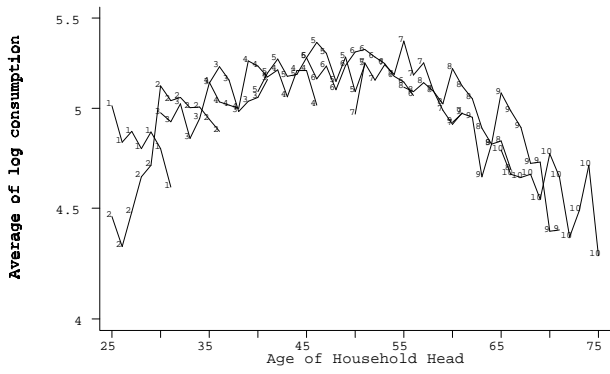
Figure 3 Consumption by cohort and their decomposition, 1985-1996, selected commodities
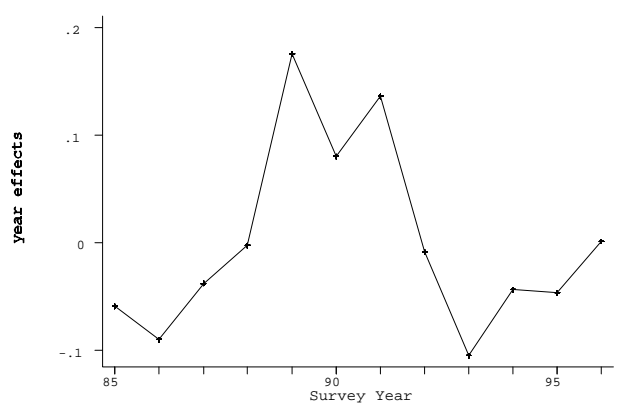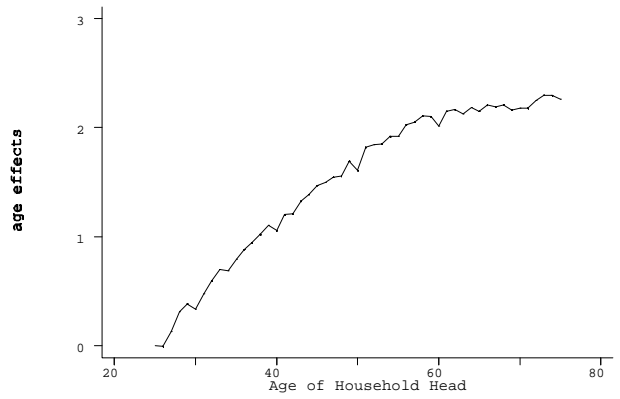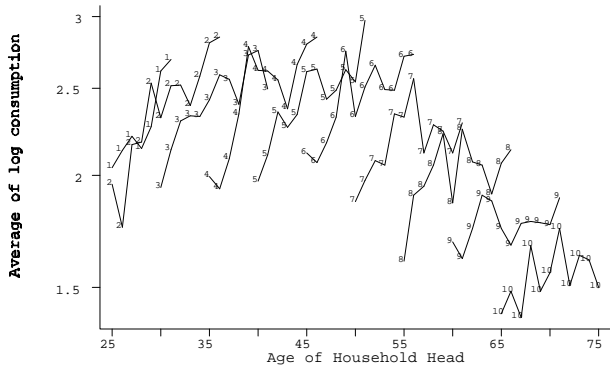
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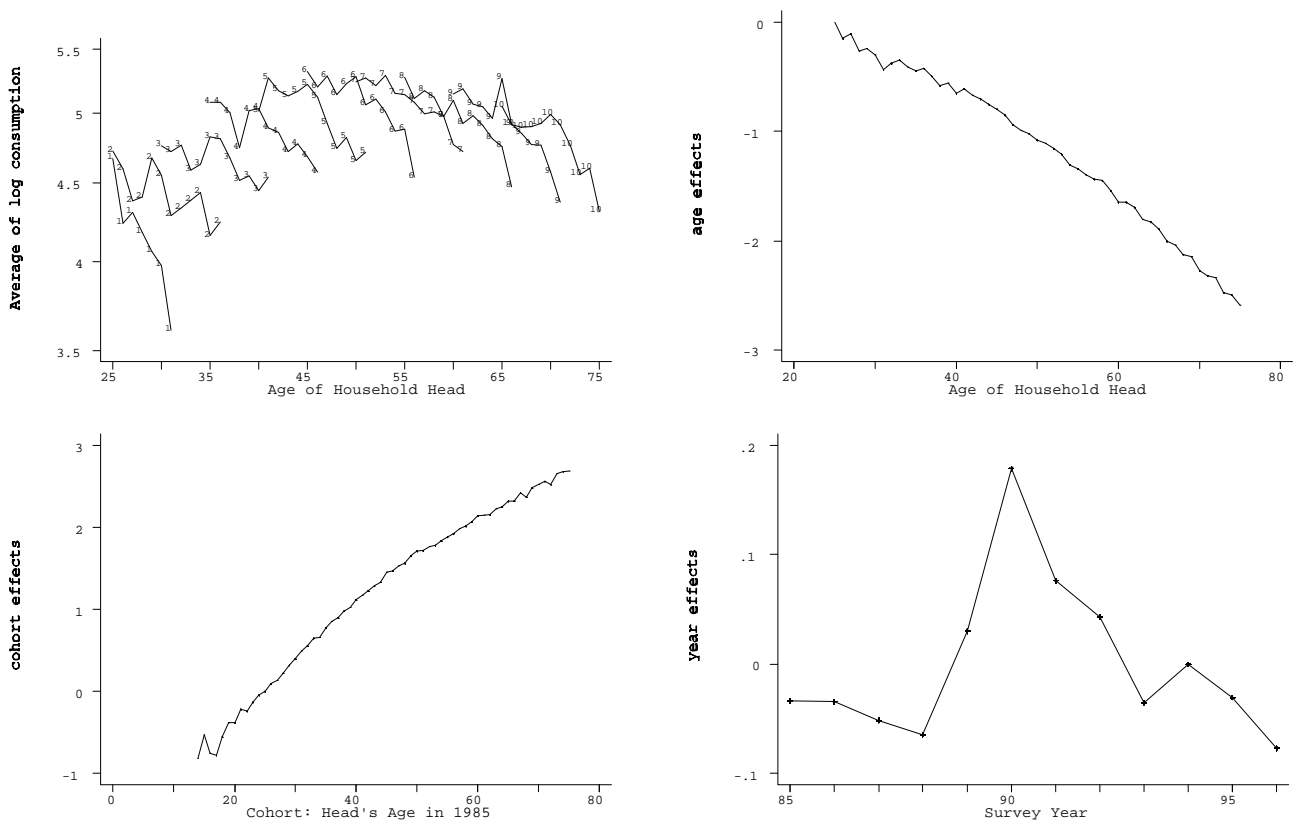
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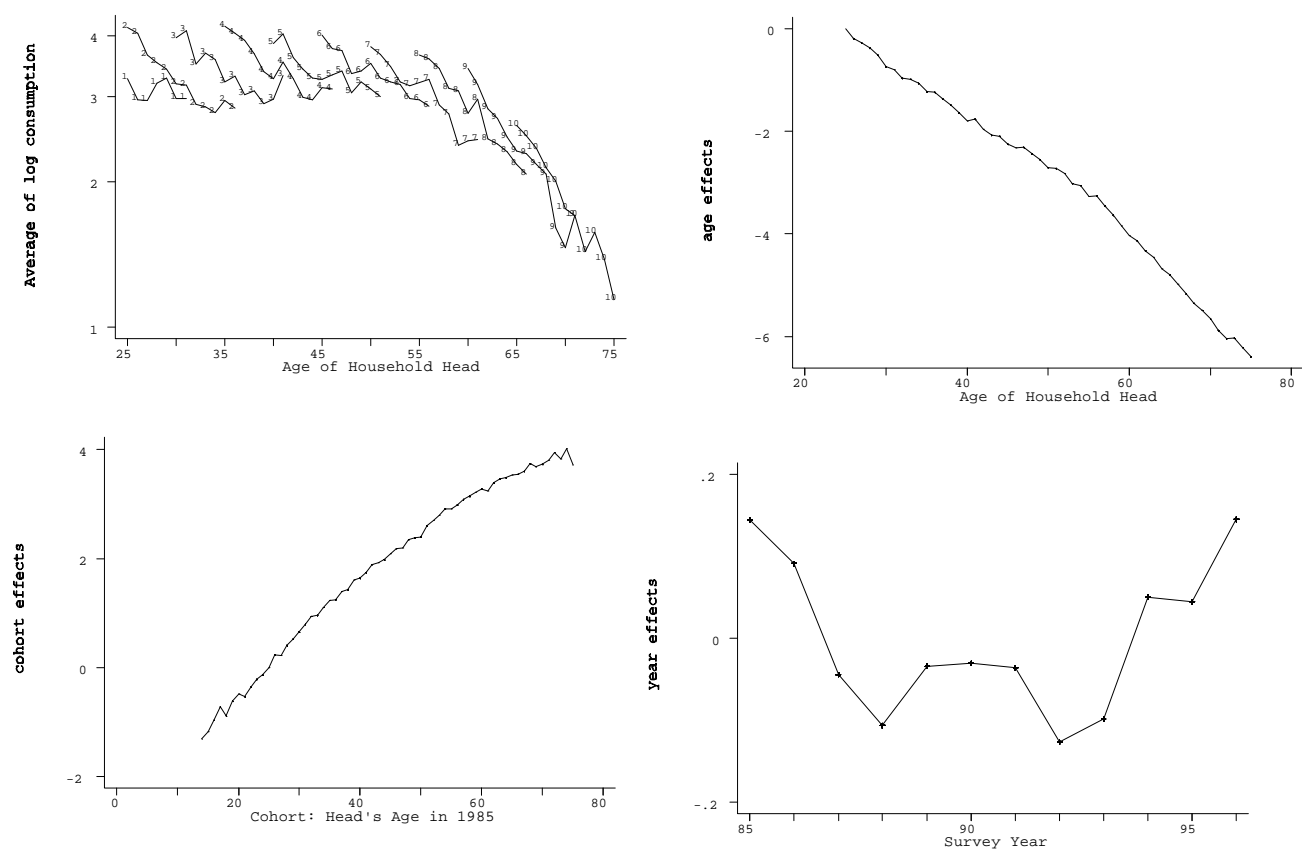
Alcoholic Beverages

Financial Services

TV, Radio, Technical Instruments