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Population Aging and the Demand for Goods & Services

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Abstract

This paper analyzes the macroeconomic effect of population aging on the aggregate demand for goods and services between 2000 and 2040. As the composition of goods and services consumed varies over the life cycle, the aggregate demand structure is likely to change as well when the population is aging. I estimate these microeconomic age-specific household demands for a set of eight composite goods using a quadratic almost ideal demand system model.

The projections are carried out in scenarios in order to distinguish: i) the direct effect of a shift of the age structure, ii) accompanying changes in the level and distribution of spending power and in household composition. The results point to significant increases in the expenditure shares of health and leisure goods and a decline in necessities like food and energy in all scenarios. The direct effect of a shift in the age structure as well as the asymmetric intergenerational distribution of spending power have significant effects on aggregate demand. Changes in household composition -decreasing average household size, but a slow reduction in the number of households- do not affect demand substantially. The future design of the pension system has only a minor impact on the distribution of incomes and total expenditures and thus also a negligible impact on aggregate demand.

Keywords: Demand analysis, Consumption, Population aging.
JEL classification: J11, D12, E21

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1 Introduction

This paper analyzes how population aging can affect the aggregate national structure of the demand for goods and services. Individual consumer spending for different goods change markedly over the life cycle. In an aging economy like Germany, these individual profiles translate into changes in the aggregate composition of goods demand.

The consumption and savings literature has become increasingly aware of the necessity to study the consumer behavior of households around retirement (Banks, Blundell, and Tanner 1998; Gustman and Steinmeier 1999; Hurd and Rohwedder 2003; Hamermesh 1984; Lundberg, Startz, and Stillman 2001; Miniaci, Monfardini, and Weber 2003). The behavior of retirees might differ substantially from that of working citizens, if one considers their time budget for leisure activities, their health status and the changes in income at retirement. In the course of the aging process, these households play an increasing role in the economy.

However, not only the behavior of the elderly attracts more interest in the course of an unprecedented aging process. What will be the macroeconomic changes? Will the differences in consumer demand over the life cycle change the national demand structure? If, for example, the share of health in overall expenditures rises significantly due to the needs of the elderly, this will affect the production of health goods in the future. More generally, changes in the age structure of the population are likely to trigger substantial sectoral shifts. Thus, predicting long-term demographic trends on demand is important for the planning of long-term investments. Such demand changes will also affect other areas of the economy. The effect on national production depends on the trade activities, which might react to demand changes as well. In addition, sectoral employment is closely linked to sectoral production. If sectoral mobility of employees is low, adjusting the sectoral production to changes in demand might be difficult, which increases the value of long-term predictions. Thus, this paper is part of a broader research agenda investigating the effects of demographic change on capital, labor and goods markets at the macroeconomic level and the above mentioned interactions between these effects.

A shift-share analysis by Börsch-Supan (2003) gives a coarse first investigation of the aggregate aging effects on the composition of consumer expenditures. Projected expenditures for health in Germany are found to be increasing with population aging, while transportation expenditures decrease markedly.

The paper contributes to the aging literature by extending this analysis, and to the demand literature by providing macroeconomic projections of the demand for various goods based on a micro-level analysis of age-specific household behavior. The analysis is conducted for West German households between 1978 and 1998. I apply the quadratic extension of the classical Almost Ideal Demand System model (QUAIDS) by Banks, Blundell, and Lewbel (1997) to household data from five waves of the EVS (Einkommens- und Verbrauchsstichprobe), a

German household budget survey.
Micro- and macroeconomic estimates of consumer demand are often difficult to reconcile. Blundell, Pashardes, and Weber (1993) find that micro-level forecasts of consumer demand do not necessarily outperform macro-level ones. In order to avoid aggregation bias, some basic distributional weights have to be included in macroeconomic forecasts. The stability of the macro-level results hinges upon low variation of these aggregation weights respectively their predictable evolution. I argue in this paper, that the aging process does not only alter the population age structure, but also other household characteristics. Hence, an aggregation of micro-level demands seems preferable given the expected instability of the aggregation weights over time.
I aim at disentangling various effects of population aging on demand. Thus, I construct four scenarios: First, I investigate the isolated effect of a change in the population age structure on demand. Second, I take economic growth into account, which leads to increasing household incomes and increasing total expenditures. Next, I analyze two indirect effects of population aging: The first is associated with the social security system. Demographic pressures in financing old-age pensions have to be borne either by higher contributions or lower benefits in a pay-as-you-go system. Depending on how the system is designed, the intergenerational distribution of this burden is in favor of the young or the old, creating different income distributions and consumer budgets. I analyze this change in the intergenerational distribution of economic resources by computing aggregate demand under two extreme pension schemes, that have been discussed in Germany. Second, aging goes along with changes in household composition. These are caused by lower fertility since the baby bust, the increasing number of single households and childless two-person households and the high number of elderly single households. This scenario technique helps understanding the various mechanisms through which population aging affects the aggregate demand for certain goods and services.
In the microeconomic analysis, I find strong age-specific differences in the demand of households for the eight composite goods considered. In the course of the life cycle, goods and services in the categories health and education & leisure become more important components of total nondurable expenditures. In an aging economy like Germany, these age effects translate into demand changes over time on the macroeconomic level. I show that these changes are substantial. Especially furniture, clothing, transport and education & leisure expenditures become less important factors in total spending - their share in total expenditures decreases by up to 20 percent. On contrary, the share of health in aggregate spending increases by 6 to 9 percent and Other goods sizeably gain in weight as well.
Analyzing the direct and indirect effects of aging, I find the following: While the pure effect of a shift in the population age structure does already trigger significant demand changes, the effects are magnified when moderate growth in total expenditures is assumed. Furthermore, different intergenerational distributions

of total expenditures -as modelled by the two pension schemes- do not result in large differences in the projected evolution of aggregate demand composition. This is due to the small distributional changes that are assumed, although two extreme pension schemes are modelled. Hence, even under extreme reform proposals, the effect of expenditure growth is much stronger than the indirect effect resulting from a pension reform and its effect on the spending power of households.
Finally, accounting for changes in family formation which lead to a rapidly decreasing household size, but a slow decrease in the number of households, does not alter the results substantially either. The effect of population aging becomes slightly smaller, but the qualitative results are the same.
In summary, the results indicate that future trends in consumer demand caused by population aging. However, these changes are not caused solely by age-specific tastes, but also to a large extent by the different spending power of the age groups.

The remainder of the paper is organized as follows: Section 2 contains the estimation of the age-specific demand patterns of households. Section 3 uses these estimates and projects the macroeconomic effects of population aging on demand. First, the aggregation procedure is developed (Section 3.1). Second, I describe the scenarios (Section 3.3) and subsequently present the results of the demand projections in the four scenarios (Section 3.4). Section 4 concludes.

2 The microeconomic analysis of the life cycle demand patterns of households

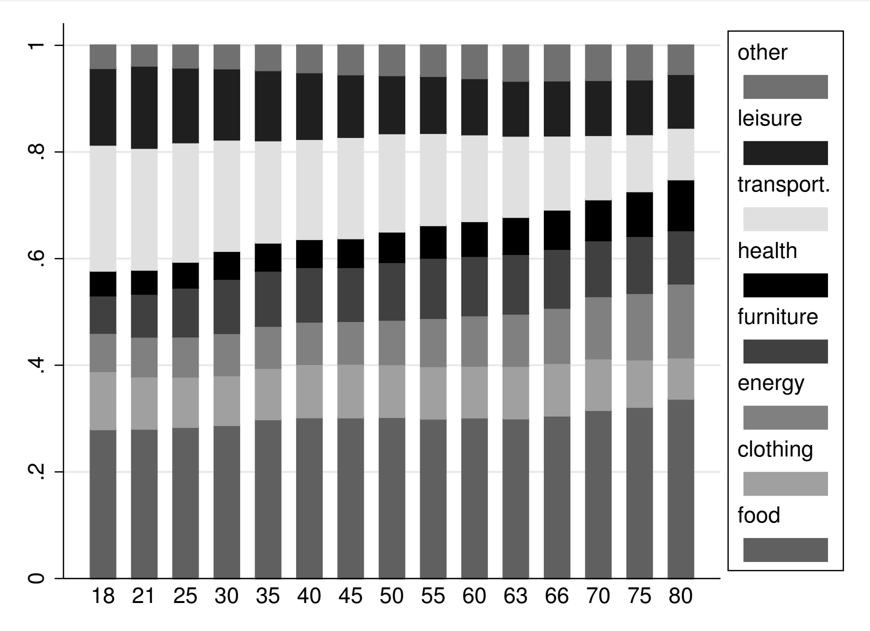
In this first part of the paper, I investigate the effects of household characteristics, especially the age of the household head, on the allocation of household expenditures to consumer goods. I estimate a demand system of eight composite goods.

2.1 Data

The data are five cross-sections of budget survey data on West German households, the German Einkommens- und Verbrauchsstichprobe (EVS). Although many households are recorded in multiple waves, it is not possible to track households over time. Hence, I conduct the analysis on pooled data, and thus cannot account for unobserved heterogeneity.
The EVS slightly over-samples middle-income households. However, sampling weights have been supplied by the Federal Statistical Office (Statistisches Bundesamt) to control for this. These sampling weights stem from the comparison between (representative) German micro census information and the EVS.

The consumption module of the survey contains diary information on expenditures for several categories of goods and services. These categories are quite comprehensive, but it is obvious that they do not capture all expenditures. Missing expenditures are those not paid for by the household directly. An example are subsidies like studying at university, which is being paid for by all citizens, but consumed only by those who receive it. Also missing are expenditures for goods and services, that contain an insurance component, like health insurance or liability insurance. These might also be partly subsidized like German public health insurance.

Figure 1: Mean expenditure shares by age, averaged over the sample years 1978-1998



Total expenditures are not equivalent to total consumption for additional reasons. First, changes in relative prices trigger changes in expenditures which might even be reverse, depending on the income and substitution elasticities. In the empirical analysis, overall inflation does not affect the results because I investigate expenditures for certain goods as a share of total expenditures, so that such price trends cancel out. Additionally, I account for commodity-specific price trends by including a time trend as will be explained in more detail in section 2.3.
Second, consumption is the outcome of a home production function which uses both expenditures and time as inputs (Becker 1965). So, households produce some goods and services at home and can substitute between market-purchased goods and self-produced ones according to their preferences and in reaction to changes in relative prices. In this paper, I do not take home production into account and I assume, that relative price changes between goods reflect respective

quality changes between them.
I use expenditure data for eight composite categories of goods and services: Food, Clothing & Shoes, Energy, Furniture & Home Electronics, Health & Body Care, Transportation & Communication, Education & Leisure Goods, and Other Goods including jewelry, holiday expenditures and travel costs.[1] Housing expenditures are omitted for reasons explained later, so total spending is computed as non-housing expenditures. In addition, a set of socioeconomic variables is available. Price information is taken from an online time series compilation of the Statistisches Bundesamt.
Figure 1 depicts the allocation of total spending on the eight goods by age, averaged over the sample period. The share of food stays roughly constant for households between ages 35 and 66, and increases thereafter. Young households spend an increasing share of their expenditures on furniture and household goods up to age 30, then this expenditure share remains constant at about 8 per cent. Health and body care expenditures gain an increasing weight in total spending from age 45 onwards; their expenditure share roughly doubles between age 45 and 75. A very similar pattern can be seen for the Energy expenditure share. The expenditure share of Transportation & Communication, on contrary, is highest at young ages and strongly declines until age 35 and again after age 60. The hump shaped age profile for the category "Other Goods" including holiday expenses is consistent with a strong rise in travelling activities around retirement between ages 60 and 70. However, note that Figure 1 confounds age, year and cohort effects. The displayed trends also do not disentangle the accompanying effects of household composition, income differences between households and the influence of other household characteristics. Thus, it only serves as a descriptive starting point for the analysis.

2.2 The theoretical framework

Preferences over all available consumer goods are represented by the utility function of the household $U(q, z)$ where q is a vector of the quantities of the composite goods consumed by the household and z is a vector of household characteristics. Households maximize their utility subject to their budget constraint $x = p^T q$, where p^T is the transposed price vector and x is total consumer spending.[2]
One might ask where the savings decision enters in this framework and why I use non-housing expenditures as a measure of total expenditures. The decision problem is separated into a general consumption-savings decision and a subsequent

[1] Appendix 5.1 describes how equivalent categories are created across the five waves of the survey. A detailed description of the goods and services contained in each composite group can be found in Appendix 5.1.

[2] Usually, x is referred to as income so that the budget constraint balances incomes and expenditures. I do not model the consumption-savings decision and use total expenditures instead of income as the disposable budget for consumption purposes.

decision about the allocation of total expenditures on different goods (Blundell 1988). By this separability assumption, I only need to model the decision at the second stage, where the household allocates its consumption budget to the different goods. This so-called two-stage budgeting is consistent with the intertemporal additive utility function of the standard life cycle model (Blundell and Walker 1986). In addition, I assume separability between the durable good housing and the other, non-durable (or less durable) goods. In addition to the problems generally associated with infrequently purchased goods, housing expenditures represent to a large part an investment and thus part of the asset portfolio of households. Therefore, total spending is calculated excluding housing expenditures. In the same fashion, I assume weak separability between labor supply and consumer demand. This is done simply due to data constraints: the Einkommens- und Verbrauchsstichprobe (EVS) does not provide information on the employment status of the spouse and no information on hours worked for either member of the household.

The utility maximization problem of each period is transformed into a cost minimization problem at given prices p and given utility level u for the cost function of each good i in a system of I goods. Thus, the underlying assumption is that prices are exogenously given for the household. I choose the classical functional form of the Quadratic Almost Ideal demand system :

$$\ln c(u, p, z) = \ln a(p, z) + \frac{u \cdot b(p, z)}{1 - u \cdot g(p, z)} \tag{1}$$

where $a(.)$, $b(.)$ and $g(.)$ are functions of prices and household characteristics. For $a(.)$ and $b(.)$, I choose the translog respectively the Cobb-Douglas form, and for $g(.)$, I use the specification from Banks, Blundell, and Lewbel (1997):

$$\begin{aligned} \ln a(p, z) = \alpha_0 + \sum_k \zeta_{ik} z_k + \sum_i (\alpha_i + \sum_k \eta_{ik} z_k) \ln p_i \\ + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j \end{aligned} \tag{2}$$

$$b(p, z) = \prod_i p_i^{\beta_{i0} + \sum_k \beta_{ik} z_k} \tag{3}$$

$$\ln g(p, z) = \sum_i (\lambda_{i0} + \sum_k \lambda_{ik} z_k) \ln p_i \tag{4}$$

z_k denotes the household characteristic k, p_i is the price of good i and p_j is the price of good j. $\alpha_i, \beta_i, \gamma_i, \eta_i, \lambda_i$ and ζ_i are the structural parameters of interest in the model. The time subscript is omitted here for ease of notation.

Shephard's Lemma (Shephard 1953) gives the Hicksian demand for each good i,

$h_i(u, p, z)$, here denoted as expenditure shares $w_i(u, p, z)$ due to the log specification of the cost function:

$$\begin{aligned} \frac{\partial c_i(u, p, z)}{\partial p_i} &= h_i(u, p, z) = q_i \qquad \text{and} \\ \frac{\partial \ln c_i(u, p, z)}{\partial \ln p_i} &= \frac{p_i q_i}{c(u, p, z)} = w_i(u, p, z) \end{aligned} \tag{5}$$

Using that $\ln c(u, p, z) = \ln x$, inverting and substituting gives the Marshallian demands in expenditure shares $w_i(x, p, z)$ as:

$$\begin{aligned} w_i(x, p, z) = \alpha_i + \sum_k \eta_{ik} z_k + \sum_j \gamma_{ij} \ln p_j + (\beta_{i0} + \sum_k \beta_{ik} z_k) \cdot \left[\ln \frac{x}{a(p, z)}\right] \\ + \frac{\lambda_{i0} + \sum_k \lambda_{ik} z_k}{b(p, z)} \cdot \left[\ln \frac{x}{a(p, z)}\right]^2 \end{aligned} \tag{6}$$

where x is total expenditures on all goods in the demand system.
In order to estimate this system, several constraints derived from economic theory are imposed on the parameters (Deaton 1986). The adding-up property requires that:

$$\begin{aligned} &\sum_{i=1}^n \alpha_i = 1 \qquad \sum_{i=1}^n \eta_{ik} = 0 \quad \forall k \qquad \sum_{i=1}^n \gamma_{ij} = 0 \\ &\sum_{i=1}^n \beta_{i0} = 0 \qquad \sum_{i=1}^n \beta_{ik} = 0 \quad \forall k \\ &\sum_{i=1}^n \lambda_{i0} = 0 \qquad \sum_{i=1}^n \lambda_{ik} = 0 \quad \forall k \end{aligned} \tag{7}$$

Homogeneity (of degree zero) of the indirect utility function in x and p adds further restrictions on the price parameters:

$$\sum_j \gamma_{ij} = 0 \quad \forall i \qquad \text{and} \quad \gamma_{ij} = \gamma_{ji} \tag{8}$$

Due to the adding-up condition, one equation can be left out and the remaining $(I - 1)$ equations are estimated. The parameters of the left out equation can be recovered using the constraints.

2.3 Estimation

I estimate the system using an instrumental variables approach with demands of the general form of equation (6), but restricting the price coefficient γ_{ij} to zero:

$$\begin{aligned} w_i = \alpha_i + \sum_k \eta_{ik} z_k + \left(\beta_{i0} + \sum_k \beta_{ik} z_k\right) \cdot \left[\ln \frac{x}{a(p,z)}\right] \\ + \left(\lambda_{i0} + \sum_k \lambda_{ik} z_k\right) \cdot \frac{1}{b(p,z)} \cdot \left[\ln \frac{x}{a(p,z)}\right]^2 + \epsilon_i \end{aligned} \tag{9}$$

where ϵ_i is a randomly distributed error term.

The price restriction is imposed because of too little price variation in the data.[3] If there are any price trends, they will be absorbed by the time trends included in the estimation. Any other short-term price fluctuations like cyclical fluctuations can be neglected here, since the focus of this study is on long-run trends.

The key explanatory variables are the age and time effects. The next Section contains a discussion of the identification approach for these effects. In addition, I control for household characteristics like household size, the number of children, and the employment status of the household head. Last, I include total non-housing consumer expenditures and squared expenditures in order to capture income effects. The endogeneity of non-housing expenditures (henceforth: total expenditures) is taken into account by instrumenting the expenditure variable with disposable household income. I also control for owner-occupier status, i.e. whether the household is renting his home or owning it, and also interact this dummy variable with the other household characteristics in order to capture behavioral differences between the renter and owner households.

The quadratic model is used because Banks, Blundell, and Lewbel (1997) showed that Engel curves are nonlinear, but well approximated by a quadratic functional form. Furthermore, I interact the two expenditure terms with a second order polynomial of age in order to allow for different shapes of the Engel curves for different age groups. Total expenditures are calculated as nominal expenditures divided by the price index $a(p, z)$. Since each household consumes individually composed sets of goods aggregated into the eight composite goods, I calculate a Stone price index for each household h as an approximation to $a(\cdot)$.[4]

[3] I only have eight price observations for each of the five waves, one price for each commodity group. Due to overall price trends, there is additionally a high correlation between the time series of the commodity prices.

[4] The Stone price index is the weighted sum of the prices p_i and the expenditure shares w_{ih} of the composite goods i: $p_{ih} = \sum_i p_i w_{ih}$.

2.4 Identification of age, cohort and time effects

The identification of age, cohort and time effects is a crucial step in this analysis. The identification problem arises from the fact that the age of the household head can be inferred by subtracting the year in which the household is born, i.e. his cohort information, from the sample year. In consequence, identifying assumptions are needed which are inherently untestable. In the following, I will describe the chosen identification approach (Variant 1). Furthermore, I will carry out a sensitivity analysis using two alternative identifying assumptions (Variants 2 and 3), and show that the resulting estimated age effects do not differ substantially:

- Variant 1: I assume cohort effects to be zero. Thus, I model demands to be age- and time-variant only. I expect strong cohort effects in the consumption-savings decision, e.g. behavioral differences between the post-war generation and the generation growing up during the German economic miracle. However, due to the two-stage budgeting approach, I am focusing on the decision how to allocate total expenditures to different goods, which I expect to be less prone to cohort effects. If the post-war generation is a high-saving one and the younger generations is more inclined to spend than to save, the former generation is likely to make its choice in a similar way as an individual of the latter one with a low income, given that their total expenditures will be similar.

- Variant 2: This identification strategy follows the approach by Deaton and Paxson (1994). Their decomposition attributes behavioral changes to cohort and age effects, and constrains the time effects to capture cyclical fluctuations or business-cycle effects that average to zero in the long-run. A more detailed description can be found in Appendix 5.2.

- Variant 3: This third approach is based on statistical identification. It includes age, time and cohort effects in the regressions by choosing different functional forms for either one.

For the age effects, I chose a 5-year dummy specification for all three variants. Variant 1 assumes that there are no cohort effects. The cohort variables in variants 2 (3) are cohort dummy variables in 5-year (10-year) intervals. Finally, time enters as transformed time dummies in the Deaton-Paxson approach in variant 2 (see Appendix 5.2), while it takes the form of a linear trend in the other specifications. Table 1 summarizes the estimated variants.

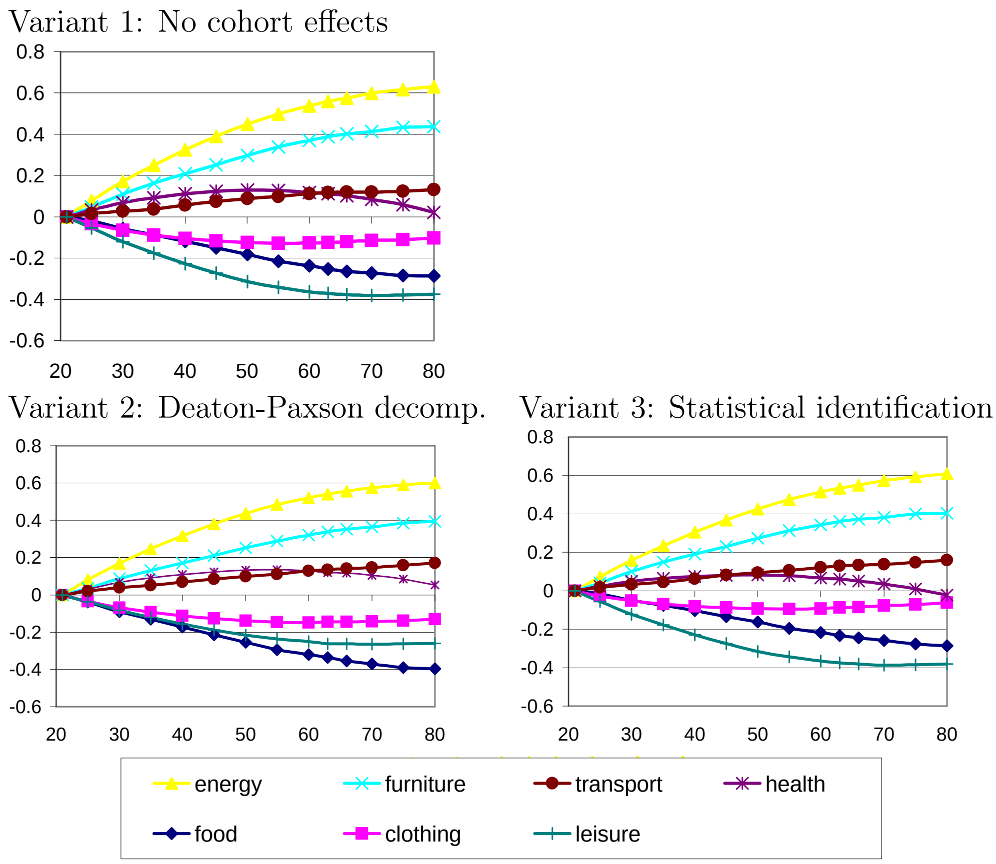
Table 1: Summary of the three alternative identification variants

Variant	Age effect	Cohort effect	Year effect
1 *	**5-year dummies**	**none**	**linear trend**
	5-year dummies	5-year dummies	transf. year dummies (see App. 5.2)
3	5-year dummies	10-year dummies	linear trend

* All results presented in the subsequent sections are based on Variant 1.

The pure age profiles for all eight composite goods are depicted in Figure 2. The estimated coefficients for the dummies show that the age profiles are distinctly nonlinear. A comparison of the profiles under these different identification approaches shows that there are no large differences in the estimated age coefficients. Hence, I will use variant 1 as the basis for the projections throughout this paper. It has some suitable properties that are helpful for the projections. For example, the absence of cohort effects rules out the necessity to make ad hoc assumptions about the cohort effects of newly born future cohorts.

Figure 2: Estimated age coefficients using Variants 1 to 3



Annotation: The coefficients are normalized to an initial zero at age 20 for ease of comparison.

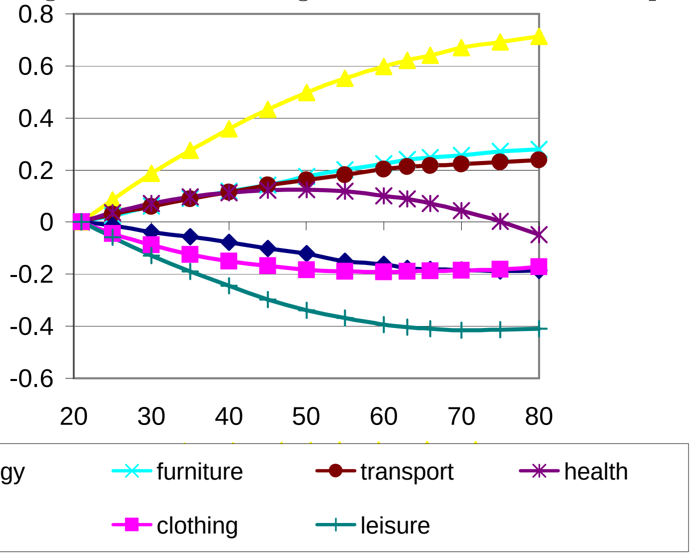
2.5 Results

Table 2 shows the results of the demand system estimation based on Variant 1. The regression includes age and time dummies, a linear and quadratic log expenditure term, and household characteristics such as a dummy which takes the value 1 if there are children at all in the household, the number of children and the number of children squared as well as log household size, a dummy variable indicating whether the household head is working, and a dummy for self-employed household heads.

Furthermore, I include additional interactions of all covariates with owner-occupier status. There might be systematic differences in the composition of demand depending on the decision whether to rent or own a house or a flat. Housing expenses can be pure consumption, but if a house or flat is owned by the household, expenses are also part of the savings of a household. In order to capture potential non-separability between the decision whether to own or rent a house and other consumer expenses, I introduce these interactions with the dummy of owner-occupier status taking the value one, if the household owns the flat or house it lives in (see Figure 3).

Finally, I interact the log expenditure terms with age and age squared in order to get age-specific Engel curves (see Section 2.5.2).

Figure 3: Estimated age coefficients using Variant 1 with ownership interactions



Annotation: The coefficients are normalized to an initial zero at age 20 for ease of comparison.

2.5.1 Age effects

Figure 2 illustrates the substantial age affects. While the expenditure shares for food, furniture and energy increase strongly with age, the shares spent on leisure, clothing and transport decline substantially. The pattern of health is hump-shaped. These patterns are surprising since one would expect health expenditures to increase even at advanced ages. However, one has to bear in mind that the category "Health & Body care" includes only out-of-pocket health expenditures. These may decrease to a minimum for the older old because their health costs are covered to a larger extent by health insurance and are thus not measured here. The treatment of major or more serious health problems which typically occur in older ages is much more likely to be covered by health insurance. The older old often have some chronical diseases like high blood pressure etc. and usually have to take prescribed pills on a daily basis. Additionally, they often receive assistance they do not pay privately.

Furthermore, Figure 2 does not incorporate the effect of total expenditures which also varies by age, due to the unequal distribution of overall expenditures over age groups. Therefore, one has to look at the age-specific Engel curves as well when trying to untangle the age profiles of demand.

Table 2: Regression results

	food	clothing	energy	furnit.	health	transp.	leisure
age dummies							
age21-24	-0.0093	-0.0407	0.0649	0.0245	0.0248	0.0165	-0.0294
	(1.17)	(8.52)***	(18.00)***	(3.02)***	(4.76)***	(1.65)*	(4.96)***
age25-29	-0.0219	-0.0851	0.1504	0.0489	0.0605	0.0470	-0.0881
	(1.41)	(9.15)***	(21.43)***	(3.10)***	(5.95)***	(2.41)**	(7.63)***
age30-34	-0.0484	-0.1286	0.2521	0.0868	0.0962	0.0765	-0.1584
	(1.91)*	(8.51)***	(22.12)***	(3.39)***	(5.83)***	(2.41)**	(8.44)***
age35-39	-0.0649	-0.1652	0.3406	0.1159	0.1210	0.1048	-0.2194
	(1.90)*	(8.11)***	(22.14)***	(3.35)***	(5.43)***	(2.45)**	(8.66)***
age40-44	-0.0878	-0.1907	0.4235	0.1434	0.1377	0.1319	-0.2745
	(2.09)**	(7.61)***	(22.37)***	(3.37)***	(5.02)***	(2.51)**	(8.81)***
age45-49	-0.1101	-0.2081	0.4975	0.1659	0.1481	0.1595	-0.3268
	(2.25)**	(7.14)***	(22.60)***	(3.36)***	(4.64)***	(2.61)***	(9.02)***
age50-54	-0.1309	-0.2240	0.5616	0.2007	0.1502	0.1777	-0.3688
	(2.39)**	(6.86)***	(22.77)***	(3.62)***	(4.20)***	(2.59)***	(9.09)***
age55-59	-0.1593	-0.2293	0.6172	0.2261	0.1435	0.1990	-0.3981
	(2.67)***	(6.44)***	(22.98)***	(3.75)***	(3.69)***	(2.66)***	(9.00)***
age60-62	-0.1725	-0.2323	0.6623	0.2488	0.1260	0.2189	-0.4226
	(2.71)***	(6.13)***	(23.14)***	(3.87)***	(3.04)***	(2.75)***	(8.97)***
age63-65	-0.1869	-0.2306	0.6871	0.2644	0.1132	0.2285	-0.4327
	(2.86)***	(5.91)***	(23.31)***	(3.99)***	(2.65)***	(2.79)***	(8.92)***
age66-69	-0.1913	-0.2277	0.7065	0.2720	0.0974	0.2339	-0.43874
	(2.86)***	(5.69)***	(23.40)***	(4.01)***	(2.23)**	(2.79)***	(8.83)***
age70-74	-0.1938	-0.2257	0.7343	0.2796	0.0695	0.2390	-0.4440
	(2.82)***	(5.51)***	(23.74)***	(4.02)***	(1.55)	(2.78)***	(8.72)***
age75-79	-0.1977	-0.2223	0.7578	0.2954	0.0281	0.2474	-0.4428
	(2.83)***	(5.33)***	(24.04)***	(4.17)***	(0.62)	(2.82)***	(8.54)***
age80+	-0.1942	-0.2128	0.7783	0.3032	-0.0232	0.2553	-0.4398
	(2.76)***	(5.07)***	(24.55)***	(4.26)***	(0.51)	(2.90)***	(8.43)***
time trend							
year	-0.00144	-0.00113	-0.00044	-0.00087	0.00143	0.00089	0.00186
	(43.08)***	(56.81)***	(29.35)***	(25.91)***	(65.95)***	(21.43)***	(75.15)***

The reference category for the age dummies is the age group between 18 and 20 years.

Table 2 (continued): Regression results

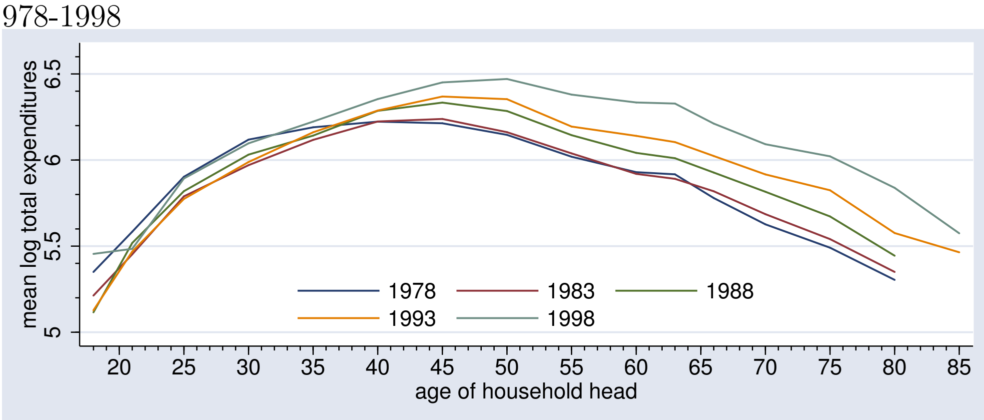
	food	**clothing**	**energy**	**furnit.**	**health**	**transp.**	**leisure**
log total expenditures							
ln(x)	-0.3757	-0.0522	0.1216	0.2298	0.2078	0.4124	-0.0816
	(9.68)***	(2.25)**	(6.96)***	(5.85)***	(8.20)***	(8.48)***	(2.84)***
ln(x)^2	0.0265	0.0036	-0.0090	-0.0168	-0.0175	-0.0385	0.0010
	(7.74)***	(1.78)*	(5.86)***	(4.84)***	(7.82)***	(9.00)***	(0.38)
ln(x)	0.0056	0.0040	-0.0075	-0.0024	-0.0064	-0.0061	0.0043
$*age$	(4.99)***	(5.97)***	(14.93)***	(2.15)**	(8.71)***	(4.33)***	(5.17)***
ln(x)^2	-0.0006	-0.0003	0.0005	0.0001	0.0006	0.0007	-0.00009
$*age$	(6.02)***	(4.20)***	(10.14)***	(1.37)	(8.79)***	(5.49)***	(1.25)
ln(x)	-0.00004	-0.00003	0.00004	0.00001	0.0001	0.00004	-0.00002
$*age^2$	(5.71)***	(5.91)***	(10.76)***	(1.65)*	(13.55)***	(3.96)***	(3.98)***
ln(x)^2	0.00001	0.0000	0.0000	0.0000	-0.00001	0.0000	0.0000
$*age^2$	(7.36)***	(2.88)***	(5.18)***	(1.07)	(13.10)***	(5.42)***	(1.13)
household composition							
ln($size$)	0.0874	-0.0114	0.0054	0.0109	-0.0143	0.0105	-0.0247
	(83.68)***	(18.32)***	(11.48)***	(10.31)***	(20.91)***	(8.03)***	(31.83)***
$nokids$	0.0132	-0.0085	-0.0073	-0.0101	-0.0028	0.0053	0.0128
	(3.98)***	(4.29)***	(4.90)***	(3.02)***	(1.30)	(1.27)	(5.20)***
$\#kids$	-0.0173	0.0073	-0.0001	-0.0150	0.0081	-0.0252	0.0230
	(4.62)***	(3.28)***	(0.07)	(3.97)***	(3.31)***	(5.38)***	(8.30)***
$\#kids^2$	0.0025	-0.0013	0.0005	0.0027	-0.0019	0.0035	-0.0039
	(2.72)***	(2.39)**	(1.13)	(2.90)***	(3.19)***	(3.09)***	(5.67)***
$self-$	0.0156	0.0005	0.0061	-0.0081	-0.0004	-0.0021	-0.0023
$empl.$	(14.45)***	(0.76)	(12.55)***	(7.42)***	(0.53)	(1.55)	(2.89)***
not	0.0000	-0.0060	0.0088	-0.0088	0.0022	-0.0191	0.0048
$work.$	(0.00)	(9.58)***	(18.51)***	(8.26)***	(3.27)***	(14.51)***	(6.15)***
$owner$	1.1298	-0.4654	0.7469	-0.6265	-0.4353	-0.5044	-0.8316
$occup.$	(8.01)***	(5.53)***	(11.75)***	(4.39)***	(4.73)***	(2.85)***	(7.95)***
Obs.	203746	203746	203746	203746	203746	203746	203746
R^2	0.29	0.04	0.43	0.04	0.08	0.09	0.08

Annotation: Further covariates are interacted terms of owner-occupier status with the household composition variables, the age dummies and the expenditure terms. The results are reported in Appendix 5.3. Absolute values of t statistics in parentheses. *,**,*** denote significance at 10, 5, 1%

2.5.2 Estimated Engel curves

As Table 2 shows, total expenditure affects the composition of demand in a significant and nonlinear way, as the significance of the quadratic term in most of the estimated equations shows. Furthermore, the interaction between age-specific and budget-specific demand is important. Most of the interacted terms are significant. Figure 5 underlines the role of age in the relation between income, respectively total expenditures, and demand for the different composite goods.
The Engel curves of transportation and furniture are distinctly hump-shaped. However, while transport shares decrease distinctly with age, conditional on total expenditures, furniture shares decrease with age only for households with large spending, and decrease significantly otherwise.
Health & Body Care is also inversely u-shaped and its share increases substantially with age. The latter is consistent with common knowledge that health expenditures increase almost exponentially with age. It is obvious from the figure that there is not much heterogeneity in the Engel curves of the age groups until age 50. It is only for the retirees of 60 years and over, that the share spent on out-of pocket health increases strongly with the level of total expenditures.

Figure 4: Average log total real expenditures over age groups by sample years 1978-1998

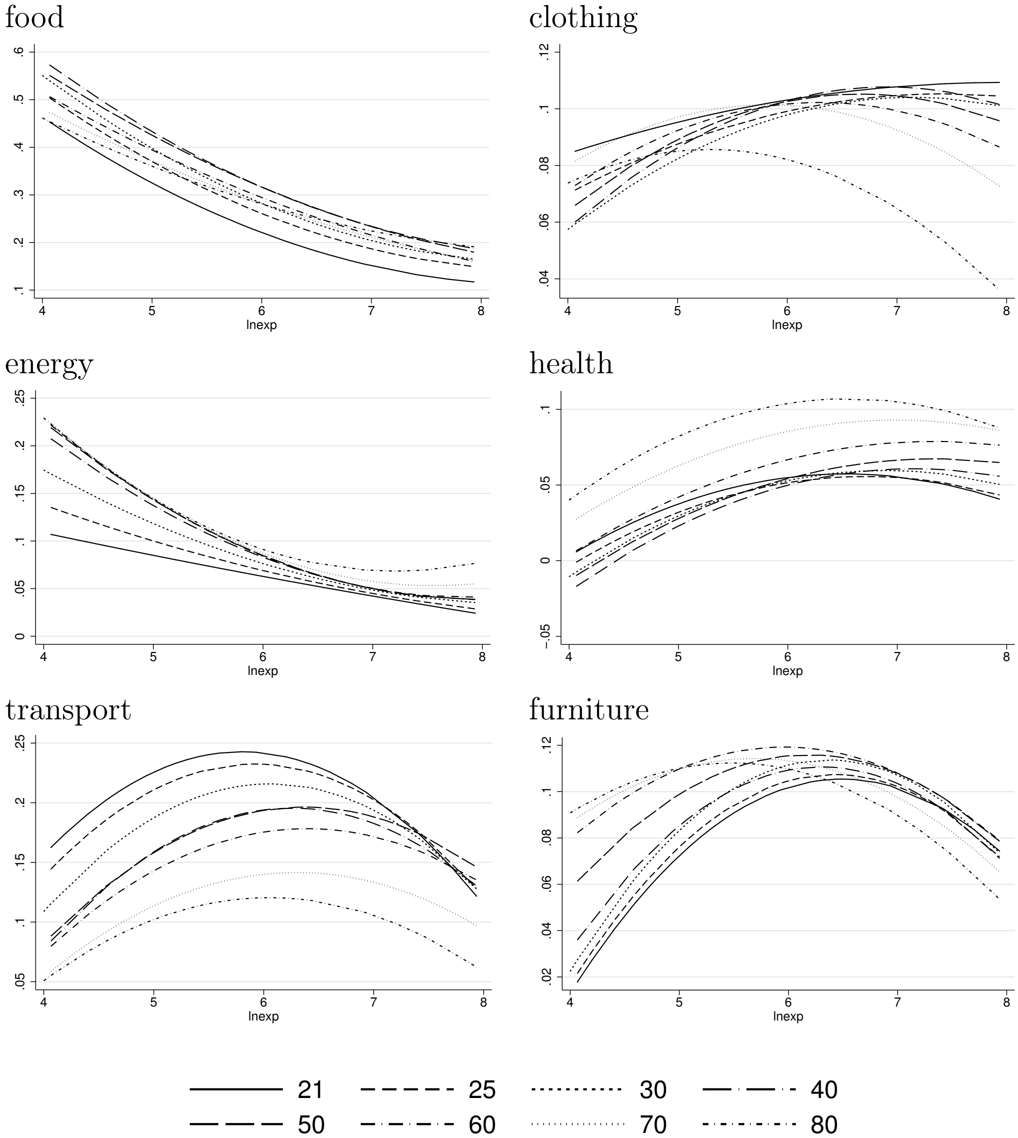


Food and energy shares are necessities that decline with rising total expenditures. Food expenditures are the largest part of total nondurable expenditures of households of medium age, and is smaller for young and older households. The share spent on energy, on contrary, is increasing remarkably by age, especially for households with lower total expenditures. For richer households, the share increases by much less, with the exception of those aged 80 years or more.
Considering total spending, it is important to understand that much of what we interpret as an *age* effect on expenses actually confounds with effects of total consumption, or, loosely speaking, *income* effects. Household resources change over the life-cycle - often as a function of age, and thus influence household behavior in

addition to potential age-related taste changes. For example, households usually experience income cuts when they enter retirement, probably be even so in the future when the demographic pressure on the social security systems becomes even more severe.

Therefore, it is important to look at the age distribution of total expenditures which is depicted in Figure 4 (without correcting for cohort effects). The age profile of total expenses, however, is very pronounced and of a hump-shaped form. This distinct age profile has to be accounted for when analyzing the aggregate effects of aging: although elderly households gain weight in the aggregate by simply becoming more numerable, they have, on average, a smaller budget than prime-age households.

Figure 5: Engel curves for some selected composite goods



The other explanatory variables are set to their age-specific means.

Total expenditures are allowed to vary around the mean by two standard deviations.

2.5.3 Household characteristics

The relative small set of household characteristics included in the analysis results mainly from data restrictions. The more recent waves of the EVS (1993 and 1998) contain richer information about households including education variables and female employment status. However, this information is not available for the older waves.

As expected, larger households have a higher expenditure share for goods that

cannot be shared, like food, energy, furniture and transportation. Synergy effects within the household decrease the share spent on furniture and transportation & communication. On contrary, large households tend to reduce their expenditures for luxury goods like education & leisure expenditures.
Households without children spent a lower share on clothing, energy and furniture, but relatively more on food and leisure goods. If there are kids in the household, the shares of leisure and clothing initially rise in the number of children and decline above the threshold of three children. The opposite holds for furniture, food and transportation: shares decrease with the first two children and increase after the third child. Only the energy share is monotonously increasing.
Households with a non working head spend a significantly higher share of their total expenditures on health, energy and leisure activities, and less on clothing, furniture and transportation than their employed counterparts. This is intuitive since work-related expenditures for transportation and clothing cease to apply. At the same time, non workers have more leisure and want to complement them with leisure goods. They spend probably more time at home, therefore energy demand rises.

The age-specific expenditure patterns found in this section are not only relevant for determining household demands for goods and services at the micro-level - they also affect the aggregate demand structure of an economy. The aging of societies across the world does not only alter the functioning of social security systems and capital markets. It is also likely to affect the market for goods and services, in particular through the distinctly age-specific expenditure patterns shown in this section which trigger changes in aggregate demand.

3 Effects of aging on aggregate demand

As is widely known, the demographic changes have been substantial in the last decades and the aging process of the population will become even more severe in the future. Within Europe, the aging process in Germany is among the most pronounced.
Figure 6 shows population pyramids for the years 1980, 2010, 2030 and 2050. It clearly illustrates the significant drop in the population share of the young and the increase in the elderly population. While in 1980, the majority of the population was younger than age 45, this pattern reverses until 2030. The intensity of the aging process underlines the importance of researching into its macroeconomic consequences, e.g. the implications for goods markets and demand composition. Hence, I explore how population aging can affect the aggregate demand structure of the household sector. First, I explain the aggregation procedure which is based

on the micro-economic estimates conducted previously (Section 3.1). Second, I carry out an aggregation of the West German demand structure for the in-sample years 1978, 1983, 1988, 1993 and 1998 (Section 3.2). Then, I project changes in the demand composition induced by population aging using demographic projections by the Rürup Kommission (Bundesministerium für Gesundheit und Soziale Sicherung 2003).[5]. Section 3.3 gives an overview of the scenarios that are used in the analysis. The demand changes that result from these scenarios are then discussed in Section 3.4.

Figure 6: Population by age (in 100 thousand), 1980-2050

Source: Rürup Commission (2003)

In the demand projections presented in the following, I neglect all supply side effects by assuming that supply is perfectly price-elastic. This assumption is certainly not warranted in the short-run. However, demographic change is a long-term phenomenon. In the long run it is not clear, whether the relative prices react to the demographically induced demand changes at all, and if, in which direction they change. This depends on the evolution of technical progress and other

[5]This commission was appointed by the German government in order to work out reform proposals for the German social security system. The projections build on a set of demographic assumptions that were agreed upon by leading experts in the field. They are deemed more precise than the UN projections for Germany, however, the results do not change much if one uses the UN projections.

factors. Thus, instead of making arbitrary assumptions about the future evolution of these variables, I present the ceteris paribus results of demographically induced changes to isolate the influence of population aging and associated foreseeable changes in household characteristics. These are threefold: From the demographic projections, one can derive the future path of household composition including the partnership decision and the fertility decisions. Second, the evolution of total expenditures over time can be approximated by projections of future economic growth. Third, the distribution of total expenditures across households depends on the social security reforms carried out, since they substantially influence the intergenerational distribution of income.

I approach the projection task in scenarios. They are designed to disentangle the direct effect of a shift in the population age structure and the above mentioned accompanying effects of aging. These scenarios start with a simple baseline case where I assume that all household characteristics etc. remain at the base year level of 1993.[6] The only variation in the future stems from the changing age structure of the population. In the subsequent scenarios (see Section 3.3), I relax some of these restrictive assumptions: I allow for growing incomes, and investigate two accompanying effects of aging, namely changes in the household composition and changes in the distribution of spending power over age. Next; I explain the aggregation procedure.

3.1 The aggregation procedure

The aggregation idea is simple. The estimation results from section 2.5 shed light on the household behavior during the sample years. I assume that the behavior of households with the same socio-economic characteristics and the same age does not change over time. However, due to population aging, the *number* of households with the same characteristics changes. This accords well with the identifying assumptions made in the estimation where I excluded cohort effects and identified household behavior by age and time effects. In the projections, I assume a constant time effect at the base year level of 1993. Then, I predict the expenditure shares for the various goods of the base year sample population and aggregate them using household weights.

To aggregate over households, I have to map the *households* observed in the micro-data onto the population data which displays the number of *individuals* per age group. Therefore, I cannot simply use the population age shares as weights in the aggregation. Instead, these age shares have to be transformed into weights

[6] The most recent sample year, 1998, was not used as the base year, because the survey design changed between 1993 and 1998. The changes affect the grouping of goods into categories and the way, in which households were asked to record their expenses. Therefore, I chose 1993 as the base year, because the survey design in 1993 is very consistent with that of the former years, and closest to that of the year 1998. Appendix 5.1 describes the procedure that I used to make the 1998 data consistent with the older waves of the EVS.

at the household level.
The idea for constructing the weights is simple: From aggregate population data, I know the number of West German citizens of age a at each point in time t. Using the sampling weights provided in the EVS, I can calculate the age distribution of household heads in West Germany for the sample years. Next, I impose the restriction that the household characteristics change over age, but not over time.[7] According to the definition of the sampling weights, each household of age a in the EVS in year t is representative for a certain number of households of age a in the population at time t. By the assumption made above it will also be representative for households of age a in any other year. Therefore, with changes in the population age structure, the number of households of age a will vary. The weights used to aggregate the data are thus:

$$weight_{a,h,t} = \frac{sw_{a,h,93}}{pop_{a,93}} \cdot pop_{a,t} \cdot x_{a,h,t} \qquad (10)$$

where $sw_{a,h,93}$ is the sampling weight of a household h with a head of age a in the base year 1993, $pop_{a,t}$ is the population of age a at time t, $pop_{a,93}$ is the respective population in the base year, and $x_{a,h,t}$ are total expenditures of the household at time t. By using total population figures per age group instead of age shares, the weights reflect not only changes in the age structure, but also changes in population growth. The first and second terms in the weighting function reflect the assumption that household characteristics for households with a head of age a are time invariant, while the number of similar households of the same age varies over time. By the third term, I take into account that households differ in total spending due to differences in incomes and consumption-savings decisions. Thus, they also have different weights in aggregate spending, reflected by their total expenditures $exp_{a,h,t}$. Finally, the weights are normalized by the sum of all household-specific weights.

3.2 Population aging and the aggregate demand structure from 1978-1998

In this section, I present the inter-sectoral demand shifts that have already taken place within the sample period. I calculate it by simply multiplying the predicted expenditure shares for the eight goods by the weights for each household and summing over all households. The weights simplify to

$$weight_{h,t} = sw_{h,t} * x_{h,t} \qquad (11)$$

[7]This restrictive assumption about the evolution of the covariates is made only for the baseline scenario. It will be relaxed step by step in the other scenarios to allow for changes in income and household composition.

since the sampling weights allow the direct aggregation from the sample population to the West German population.
Figure 7 compares the actual aggregated demand shares for the eight goods with the fitted ones. It shows that the specification of the demand system fits the data quite well in general. Disparities are only visible between the actual and fitted values for transportation which pass through to the left-out quantity Other goods. This is potentially due to the durable nature of part of the transportation category which I cannot model in detail due to the lack of data on car ownership. However, even for these two categories, the prediction error is not larger than 10 percent.
Figure 8 shows a clear upward trend in the shares of health and education & leisure expenditures as well as a decline in the shares of food and clothing. However, this might be also due to time trends like the erosion of health insurance benefits resulting in higher health costs, the spreading of cheap food discounters and more competition among food retailers etc. The time trend also picks up short-term price trends, therefore I also looked at the in-sample projections keeping time constant at the base year level of 1993. When doing so, the demand trends over time become much less pronounced. The downward trend in Food and the upward trend in Other Goods are strong, but there are only small increases in health (about 4%) and small decreases in clothing and energy expenditure shares.

Figure 7: Fitted and actual aggregate expenditure shares during the sample years: 1978-1998

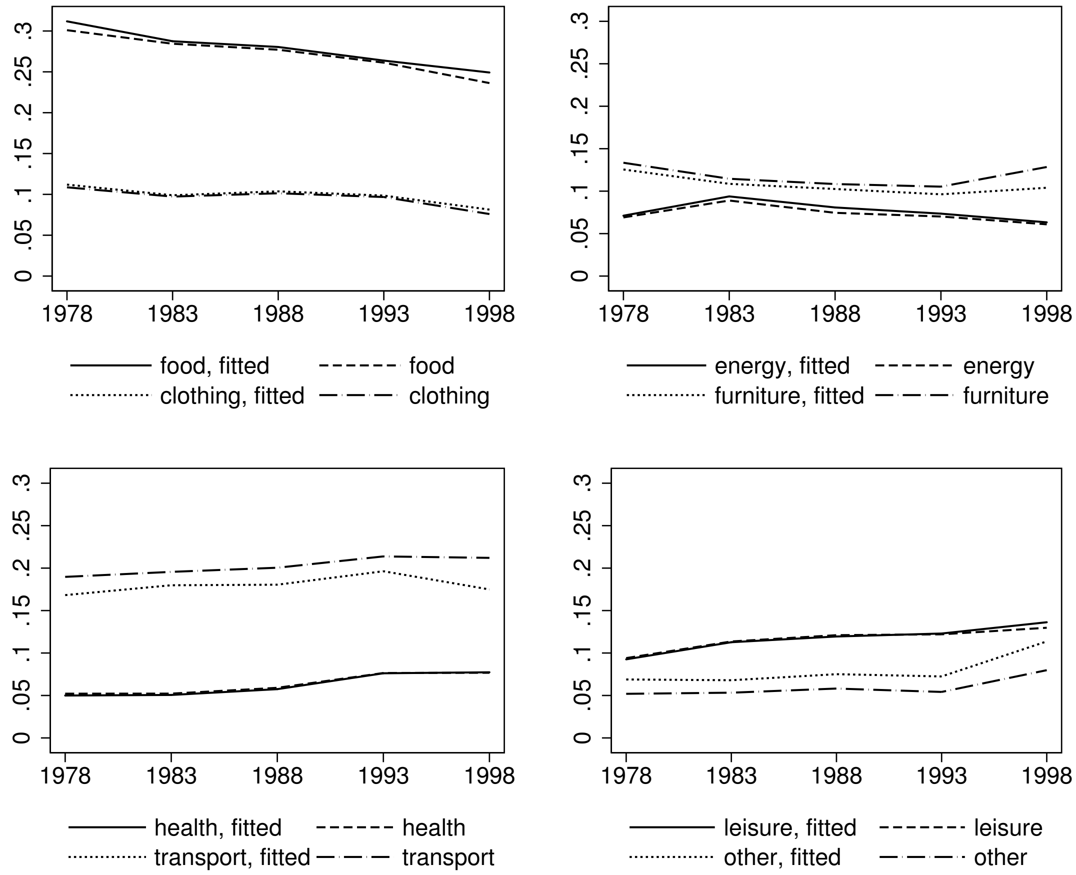
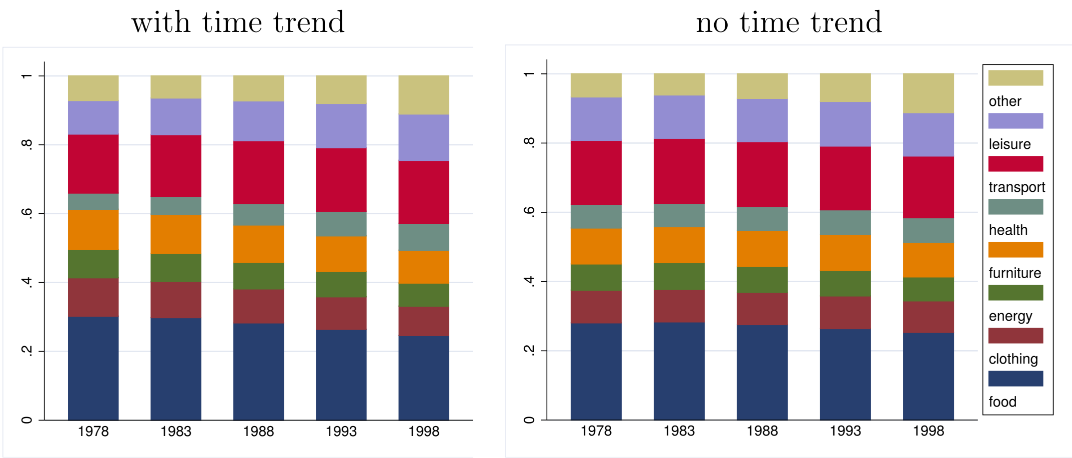


Figure 8: Fitted aggregate expenditure shares during the in-sample years: 1978-1998



3.3 Projecting aggregate demand in scenarios

The aim of this paper is to demonstrate the impact of population aging and various socio-economic changes associated with it. Therefore, the projections are done in four scenarios. The comparison of the scenarios allows to separately analyze the effects of changes in socioeconomic variables in the course of aging.

Scenario I: pure population aging
In this scenario, I assume that the composition and characteristics of households of the same age contained in the EVS 1993 remain constant. Of course, this assumption is not innocent. Family formation, the timing of entry into the labor force and other important life cycle decisions underly changes over time. Hence, this scenario serves as a baseline and illustrates the isolated direct effect of population aging on consumer demand without any accompanying effects.

Scenario II: population aging and expenditure growth
In this scenario, I relax the assumption that all household characteristics remain constant over time. The first household characteristic that is modelled as changing over time is household income. Income growth triggers changes in total expenses. Therefore, I include a general growth trend in incomes which passes on to total expenditures. I assume that total expenditures rise by 1.4% each year. This corresponds to the growth assumptions made in official forecasts (Sachverständigenrat Zur Begutachtung der Gesamtwirtschaftlichen Entwicklung 2005). Additionally, some sensitivity checks are performed assuming alternative growth rates.
This scenario helps to answer the question whether aggregate demand changes

are mainly caused by the shift in the population age structure itself, i.e. a genuine taste shift between young and old. If the demand changes in this scenario are considerably stronger than in the baseline scenario, then it is mainly the difference in spending power between the age groups which causes demand changes.

Scenario III: population aging and increasing intergenerational heterogeneity in total spending

This scenario explores the question whether aggregate demand reacts to changes in the distribution of income and hence of total spending. Distributional changes in total expenditures between old and young or rich and poor households might be an accompanying effect of population aging, since pension reforms necessary to sustain social security systems are not neutral in terms of inequality. They change the intergenerational distribution of income.

The projection of the future distribution of total expenses is based on the multi-country OLG model described in Börsch-Supan, Ludwig, and Winter (2005). A brief description of the features of the model can be found in Appendix 5.4. The OLG model simulates the pattern of net income under different pension systems respectively reform proposals which change the intergenerational distribution of income.

I assume that the age- and time-specific changes in net income lead to equivalent changes in total expenditures. This assumption rules out adjustments in the savings behavior of households in response to such permanent income changes. However, I compute the growth rate of each age group's projected income over time and compute the time pattern of expenditure changes based on the level of total expenditures in the base year. Thus, I only assume that expenditures rise proportionally with incomes, but take the observed (initial) consumption-savings decision into account. This assumption is supported by (Blundell, Browning, and Meghir 1994) who find that income and consumption move closely together and that consumption tracks income closely over the life cycle.

Assuming a representative agent per age group, the OLG model does not reflect that pension reforms might also change the intra-generational distribution of total expenditures. In the German expenditure survey (EVS), I observe heterogeneity in total expenditures and incomes between *and* among age groups. To maintain the intra-generational heterogeneity in the sample, I calculate the income growth rate from the OLG projections for the different age groups. Then I assume that the *intra*-generational heterogeneity remains constant and allow for changes in the *inter*-generational heterogeneity only. The weights developed in section 3.1 then change accordingly:

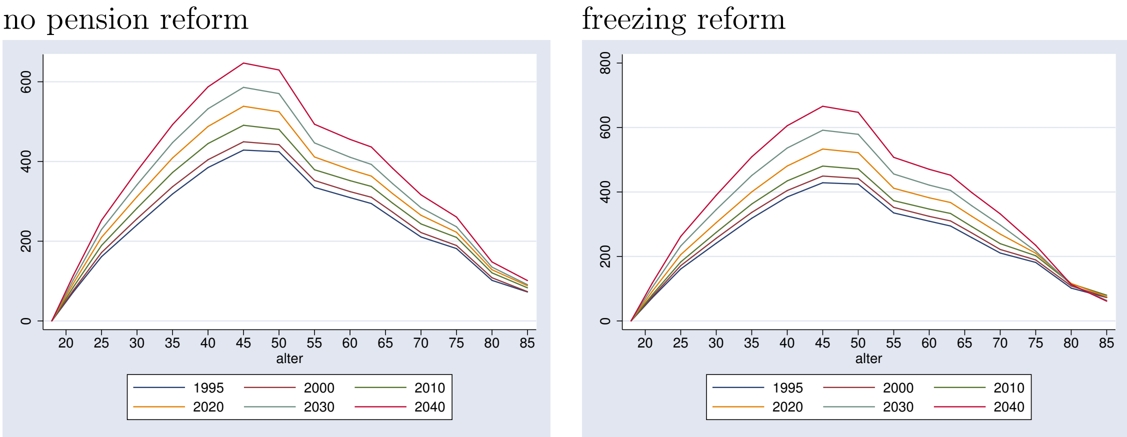
$$weight_{a,h,t} = \frac{sw_{a,h,93}}{pop_{a,93}} \cdot pop_{a,t} \cdot x_{a,h,t,OLG} \tag{12}$$

where $x_{a,h,t,OLG}$ is:

$$x_{a,h,t,OLG} = x_{a,h,t} * (1 + \Delta_{a,t}(x_{OLG})) \tag{13}$$

In contrast to scenario I, which assumed that everybody's total expenditures rise by a fixed rate, total expenditures are now increasing heterogeneously over time according to the projection from the OLG model.

Figure 9: Monthly total expenditures by age under alternative pension schemes, 1995-2040



I use two extreme scenarios for pension reform in Germany in order to show the upper and lower bounds of the effects: The first case assumes no pension reform. Retirement benefits are held constant at a replacement rate of 70% of the former labor income. Contributions are variable in this scenario and have to increase from 20% to 32% of labor income in 2040 in order to keep the pension system financially sustainable. This scenario will be labelled "no pension reform". It imposes the entire demographic burden on the working population - to the benefit of the retirees. With no pension reform, there will be virtually no change in the distribution of total expenditures, as can be seen in the left part of Figure 9. This scenario also includes expenditure growth in the magnitude of about 1.22 percent which is only slightly lower than in scenario II. Hence, I compare the results of the two pension reforms with scenario II.
The second pension reform proposal postulates the other extreme. The contribution rate is frozen at the current level of 20%. I henceforth call this scenario "freezing reform". Under this reform, benefits are variable and the replacement rate falls from 70% to only 42% of former labor income in 2040. Total expenditures increase for all age groups, but the elderly loose relative to the younger age groups (see Figure 9). This is not surprising since this reform proposal freezes the contribution rates so that the demographic burden is borne by the retirees alone.

Scenario IV: population aging and a changing household composi-

tion
Average household size shrinks in the course of population aging. This is partly due to the decreasing number of children. Furthermore, little downsizing is observed in housing demand when children leave the house or when spouses die. On contrary, the better health status of today's elderly enables them to live on their own for a longer time. Due to these factors, the number of households shrinks much more slowly than the population. According UN data, the German population will start to shrink in 2005, while the number of households will decline only after a 15 year delay in 2020 (Börsch-Supan, Ludwig, and Sommer (2003)). However, in the meantime, households' demographics like household size and the number of kids will change. In consequence, I relax the assumption of time-constant household characteristics to incorporate the reduction in household size in the fourth scenario.
The projections will be conducted using the FAMY household projection by the Statistisches Bundesamt (2003).[8] The tool provides age-specific projections of the average household size. I relax the assumption of the base scenario, that the characteristics of a household of age a do not vary over time. Instead, I assume that the socio-economic characteristics of households with a head of age a and household size s do not vary over time. The weights used to aggregate the data are:

$$weight_{a,h,s,t} = \frac{sw_{a,h,s,93}}{hhpop_{a,s,93}} \cdot hhpop_{a,s,t} \cdot x_{a,h,s,t} \qquad (14)$$

where $hhpop_{a,s,t}$ denotes the number of households with size s and age of the head a at time t. Again, I use 1993 as base year. Notice that it is no longer necessary to map the individual demographic data to the household data. Instead, I directly use a demographic projection based on households. This new weighting procedure captures changes in the age structure of the population *and* changes in the number and composition of households. It reflects the trend towards a higher fraction of single households and small families. No change in incomes over time is modelled in this scenario.

3.4 Projection Results

Scenario I: The direct effect of an aging population on demand
Table 3 displays the projected aggregate demand of the household sector and its total percentage change between 1995 and 2040. At first glimpse, the aging effects on the aggregate do not appear large. Looking more closely at the percentage changes over time, however, increasing health and energy shares in the order of about 5 to 7 percent are to be expected until 2040 and the share of the category Other increases by about 16 percent. These increases are counteracted by a

[8] A detailed description of FAMY can be found in Appendix 5.5.

decline in the share of transport goods and services of about 7.6 percent and smaller declines in the share spent on leisure and clothing of about 3 to 4 percent.

Table 3: Projected aggregate expenditure shares (in %), 1995-2040, base line scenario

year	1995	2000	2010	2020	2030	2040	% change	
							1995-2030	1995-2040
food	25.0	25.1	25.0	24.9	24.9	24.9	-0.7	-0.7
clothing	9.6	9.6	9.6	9.5	9.4	9.3	-2.1	-3.0
energy	7.1	7.2	7.2	7.3	7.4	7.5	4.2	5.3
furniture	9.1	9.2	9.1	9.1	9.1	9.0	0	-2.1
health	7.8	7.8	7.9	8.0	8.2	8.3	5.1	6.6
transport	18.7	18.5	18.2	18.0	17.7	17.3	-5.3	-7.6
leisure	12.0	12.0	11.9	11.7	11.6	11.5	-3.3	-4.4
other	10.6	10.7	11.1	11.4	11.8	12.3	11.3	16.3

Thus, if aging took place without any accompanying changes of the socio-economic environment of households, the demand composition would change in an intuitive way: The higher fraction of elderly people in the economy would lead to relatively higher energy demand and higher demand for health goods. Furthermore, the demand for personal goods, hotels and package holidays (Other goods) would increase as well. The results are due to the fact that in 2040, the age group under 40 years will have a low weight in the aggregate demand. On contrary, not only people above 60 years will be numerous, but also the age group 40-60 years will form a large fraction of the West German population - and will therefore have an important weight in the aggregate. This latter group has much higher total expenditures than the elderly and will heavily influence the aggregate demand structure.
However, as has been shown by other authors (e.g. Börsch-Supan (2003, Börsch-Supan, Ludwig, and Sommer (2003)), the age structure of the population brings about and is accompanied by additional changes in the socio-economic situation of households. Some of these are reflected in the following.

Scenario II: population aging and economic growth
The results in Table 4 show that population aging in a growing economy would lead to an increase in the share of health expenditures of about 9 per cent until 2040, and raise the expenditure shares of Other goods like holiday travel by more than 90 percent. This massive increase is due to the high income elasticity of this category. All other expenditure categories including energy would experience declines measured in shares. The difference to the baseline scenario is caused by the increases in consumer expenses over time. Since I let expenditures rise by the

same percentage for all households, this scenario shows the demand changes if we all become richer in addition to the demographic changes ahead. The increase in the health share is due to the rising expenditures for out-of-pocket health with age, and due to the low income elasticity of health expenditures. The Engel curve for health depicted in Figure 5 shows this effect clearly. On contrary, the expenditure shares of necessities like food and energy would decrease by about 18 respectively 13 percent. Furniture and transport shares are cut back in the same range. Appendix 5.6 contains the projection results for alternative assumptions about expenditure growth. Higher growth rates obviously yield more pronounced changes of the demand pattern over time, and vice versa. The qualitative trends are robust.

Table 4: Projected aggregate expenditure shares (in %), 1995-2040, scenario II

year	1995	2000	2010	2020	2030	2040	% change	
							1995-2030	1995-2040
food	24.5	24.0	22.9	21.9	21.0	20.1	-14.3	-18.0
clothing	9.6	9.6	9.5	9.4	9.2	9.0	-4.2	-6.3
energy	6.9	6.8	6.5	6.2	6.1	6.0	-11.6	-13.0
furniture	9.1	9.0	8.7	8.5	8.1	7.6	-11.0	-16.5
health	7.8	8.0	8.1	8.3	8.4	8.5	7.7	9.0
transport	18.6	18.3	17.8	17.3	16.5	15.7	-11.3	-15.6
leisure	12.1	12.0	11.9	11.7	11.6	11.3	-4.1	-7.1
other	11.4	12.3	14.6	16.7	19.2	21.8	68.4	91.2

However, one may ask how plausible the assumption of symmetric growth in incomes and expenditures is. The intensive political discussion about the sustainability of social security systems and intergenerational fairness shows, that aging leads to changes in the income distribution through the pension system. It is the goal of most pension reform proposals to "correct" this built-in automatism of a pay-as-you-go system towards a more equal burden-sharing between generations. The following section uses projections of the future income distribution under alternative pension reform proposals.

Scenario III: population aging and increasing intergenerational heterogeneity in total spending

In this scenario, I compare the effects of the two extreme pension systems, the "no pension reform" case and the "freezing reform". The results, depicted in Table 5, show that the effects of the reforms are very similar. The high population age share of the old and the middle-aged decreases the share of transportation expenditures in both scenarios. Food and energy erode even more strongly than in the first two scenarios. Meanwhile, the fraction of total expenditures spent on health increases slightly less. Finally, the decrease in the education & leisure expenditure share is slightly more under the freezing reform than under the current system.

Table 5: Projected aggregate expenditure shares (in %), 1995-2040, scenario III

year	1995	2000	2010	2020	2030	2040	% change 1995-2030	% change 1995-2040
current system								
food	24.4	24.0	22.9	22.1	21.3	20.7	-12.9	-15.5
clothing	9.6	9.6	9.5	9.4	9.3	9.1	-3.5	-5.3
energy	6.9	6.8	6.5	6.3	6.2	6.1	-11.1	-12.1
furniture	9.1	9.0	8.7	8.5	8.2	7.8	-9.5	-13.5
health	7.8	8.0	8.1	8.2	8.4	8.5	7.1	8.1
transport	18.6	18.3	17.8	17.4	16.7	16.1	-10.1	-13.6
leisure	12.1	12.0	11.9	11.8	11.6	11.4	-3.5	-5.0
other	11.4	12.4	14.5	16.3	18.3	20.3	60.1	77.6
freezing reform								
food	24.4	24.0	23.4	22.5	21.7	21.0	-11.4	-14.3
clothing	9.6	9.6	9.6	9.5	9.5	9.3	-1.7	-2.8
energy	6.9	6.8	6.6	6.3	6.2	6.0	-11.0	-13.0
furniture	9.1	9.0	8.8	8.7	8.4	8.1	-7.3	-11.1
health	7.8	8.0	8.0	8.1	8.3	8.3	5.6	6.3
transport	18.6	18.3	18.0	17.7	17.2	16.6	-7.8	-10.8
leisure	12.1	12.0	11.9	11.9	11.8	11.7	-1.9	-2.8
other	11.4	12.4	13.6	15.2	17.1	19.0	49.2	65.7

Generally, the freezing reform triggers slightly smaller changes in aggregate demand, because it redistributes toward the younger population with lower spending power, while maintaining the current system accelerates the demographic burden on the working population. The difference is small because of the small expected difference in the income distribution profiles shown in Figure 4. The reforms yield relatively similar outcomes because they do not model the intragenerational redistribution of the pension system. The pension system in the OLG model is an insurance system in which benefits are paid according to contributions.[9] Both reforms, however, once more illustrate the influence of rising total expenditures on the composition of demand: the age dependency of total expenditures has a hump-shaped profile. Thus, the growth in expenditures,

[9]Hence, the impact of a pension reform like the proposed "Grundrente", which redistributes towards the poor, is not incorporated here.

which is present in both scenarios, will increase the weight of the middle-aged in aggregate demand due to their higher absolute spending.
In summary, the range of proposed pension reforms in Germany will not have strong effects on the demand patterns. The macroeconomic implications of aging societies are caused primarily by the direct effect of aging on capital, labor and goods markets, and not by indirect effects via the social security system.

Scenario IV: population aging and a changing household composition

In this scenario, I account for age-specific changes in the household size. These are natural accompanying effects of population aging, as i) the number of single households among the younger population increases, ii) fertility is low, iii) increased life expectancy implies that parents live on their own for a longer time, after their children have left home, and iv) more elderly will live in single households after the death of the partner. All these factors contribute to a decreasing average household size. Moreover, iii) and iv) delay the reduction of the number of households. According to the underlying household projection, the number of single households is going to almost double until 2030, while the number of households larger than two persons is going to shrink by about 30%. Average household size is projected to fall from 2.44 to 2.07 between 2000 and 2030.
What effects on the composition of aggregate demand should be expected when accounting for changing household size? It is most likely, that a larger number of single households in the population is associated with a higher demand for a certain range of goods, i.e. washing machines, furniture, energy etc. Especially those goods that exhibit returns to scale should be demanded relatively more in societies with many single households than in a society with a larger average household size. In addition, the trend towards larger apartments and houses in the last decades in spite of decreasing average household size is also expected to increase aggregate demand for durables like furniture and also for energy.

Table 6: Projected aggregate expenditures shares (in %), 1995-2030, scenario IV

year	2000	2010	2020	2030	% change 1995-2030
food	26.4	26.3	26.3	26.3	-0.2
clothing	9.9	9.8	9.8	9.7	-1.6
energy	7.3	7.5	7.7	7.9	8.2
furniture	9.6	9.5	9.5	9.5	-1.4
health	7.6	7.8	7.9	8.0	6.1
transport	19.7	19.1	18.9	18.6	-5.6
leisure	12.3	12.3	12.2	12.2	-0.8
other	7.2	7.6	7.6	7.7	6.5

Table 6 shows that the demand changes are much more moderate than in scenario I, where I did not account for changing household composition. However, the demand change in favor of health has with 6.1 percent about the same size as in the baseline scenario. The results show that the assumption of constant household composition in scenario I does not hold. By this assumption, one underestimates the demand changes for energy and Other goods and overestimates the change in demand for furniture, clothing, transport and leisure. This is due to the fact that the number of households decreases more slowly and average household size decreases faster than assumed in scenario I. Hence, the the increasing number of single households is accounted for in this scenario. In consequence, the future demand share for energy is higher, since economies of scale cannot be realized in single households and a lower decrease of the share for expenses on clothing and leisure. The latter accord well with the microeconometric results in Section 2.5, as clothing and leisure expenditure shares decrease in household size. However, some caveats have to be mentioned: First, the changes are smaller, because we look at the shorter timespan between 2000 and 2030. Comparing the results from this scenario and scenario I for 2000 until 2030, however, does not alter the differences substantially. Second, the household projection does not reach back to the past so far, so I proxy the household distribution in the base year 1993 by the distribution in the year 2000. This approximation renders the computation less precise and potentially leads to a slight underestimation of the demand changes.

4 Conclusions

In the microeconomic analysis, strong age-specific differences in household demand structures in West Germany are identified. In the course of the life cycle, health, and education & leisure goods become more important components of total nondurable expenditures—mainly due to their higher total expenditures compared with young households. In an aging economy like Germany, these age effects translate into aggregate demand changes for the composite goods over time. These changes are substantial. Especially furniture, clothing, transport and education & leisure expenditures become a less important factor in total spending, while health and Other goods gain in weight in aggregate demand.
The use of separate scenarios, which separate various aspects of population aging, helps to better understand the transmission mechanisms of population aging. While the pure effect of a shift in the population age structure does already trigger significant demand changes, the effects are magnified when moderate growth in total expenditures is assumed. Furthermore, changes in the intergenerational distribution of total expenditures do not result in large differences in the projected evolution of aggregate demand composition. This is due to the small distributional changes that are assumed, although two extreme pension schemes

are modelled.
Hence, even under extreme reform proposals, the effect of expenditure growth is much stronger than the indirect effect resulting from a pension reform and its effect on the spending power of households.
Finally, taking into account the changes in family formation which lead to a rapidly decreasing household size, but a slow decrease in the number of households, does not alter the results much. The effect of population aging becomes slightly smaller, but the qualitative results are the same.
In summary, the results indicate that future trends in consumer demand caused by population aging. However, these changes are not caused solely by age-specific tastes, but also to a large extent by the different spending power of the age groups. These effects trigger changes in sectoral production and employment. If relatively more of health and leisure goods are demanded then sectoral production has to adjust, too. Thus, there might be a higher demand for professions associated with health services and pharmaceutical production as well as for services in the leisure goods sector which comprises sports activities, cultural activities like cinema, theater etc., gardening, and so forth. This way, population aging does not only change demand trends in the (West) German economy substantially, but can also affect the German labor market unless the changes in demand are absorbed by changing trade patterns.

5 Appendix

5.1 Description of the composite goods & services

In the four EVS waves 1978, 1983, 1988 and 1993, the eight composite goods categories are defined in the same way. The single exception are travel expenditures: they are contained in the category "Other goods" in 1993 while they form a separate category in the older waves. Therefore, I construct a category "travel & other" which is consistent over the four waves.
In 1998, the European COICOP classification of goods was adapted so that the categories are now consistent with those in other European surveys, but not consistent with the definitions in the preceding waves. Therefore, I reconstruct the classification adapted for the older waves for 1998. The detailed information on the subcategories available in the EVS 1998 enables me to regroup expenses.
The resulting eight categories are:

Food	Food at home, food out, tobacco, alcohol
Clothing & Shoes	Mens', womens', childrens' and sports clothing, shoes; repairs and amendments of shoes & clothing
Energy	Energy (excluding fuel)
Furniture & Home Electronics	Furniture, home textiles, furnishings, electrical appliances, other household equipment, household consumables, repairs
Health & Body Care	(Out-of-pocket) health goods and services, body care goods and services
Transportation & Communication	Motor vehicles, bikes, fuel, repairs of and services for motor vehicles & bikes, car travel expenses, driver's licence fees, travel fares, telephone charges, mail charges
Education & Leisure	Holiday expenses, audio-visual equipment, records, toys, photo & sports goods, personal articles, books & newspapers, gardening products, subscriptions, lesson charges, theater, cinema etc., petcare
Other goods	Personal goods, hotels and similar expenses, package holidays

5.2 The Deaton-Paxson decomposition

This decomposition is achieved by making the time effects orthogonal to a time trend (Deaton and Paxson 1994). The year dummies have to be replaced by:

$$d_t{}^* = d_t - [(t-1)d_2 - (t-2)d_1] \tag{15}$$

where d_t is a year dummy for the year t, and d_1 and d_2 are the dummies for the first two years in the sample. The "base year" is thus a timeless average of all

years, and any time trend is attributed to cohort and ages, rather than to time. Due to the additional restriction, that the time effects sum to zero, the dummies for the years 78 and 83 are left out in the estimation.
Moreover, I estimated different specifications of the cohort effects. First, the cohort effect enters as a spline function with kinks at birth years 1930 and 1950. This is advantageous compared to using cohort dummies, because this parameterization allows straightforward projections in the second part. With dummies, I would have to make ad hoc assumptions about the cohort effects of newly entering cohorts that are not included in the sample. The spline function avoids such ad hoc assumptions. However, this specification of the cohort effect might be too restrictive, so I also show results with a full set of dummies.

5.3 Regression results: owner-occupier status

This section contains the estimated coefficients for the interaction variables of household characteristics and income with the owner-occupier dummy not reported in Table 2:

	food	**clothing**	**energy**	**furnit.**	**health**	**transp.**	**leisure**
log total expenditures interacted with owner-occupier status							
$ln(exp)$	-0.54527	0.25214	-0.37914	0.36865	0.14381	0.19278	0.45435
	(6.84)***	(5.30)***	(10.56)***	(4.57)***	(2.76)***	(1.93)*	(7.69)***
$ln(exp)^2$	0.04142	-0.01821	0.02851	-0.03062	-0.01022	-0.0135	-0.03456
	(6.28)***	(4.62)***	(9.59)***	(4.58)***	(2.37)**	(1.63)	(7.06)***
$ln(exp)$	0.0131	-0.00735	0.00921	-0.0105	-0.00068	-0.00312	-0.01237
$*age$	(5.91)***	(5.56)***	(9.23)***	(4.68)***	(0.47)	(1.12)	(7.53)***
$ln(exp)^2$	-0.00097	0.00051	-0.00068	0.00091	0.00002	0.00018	0.00095
$*age$	(5.16)***	(4.56)***	(8.05)***	(4.78)***	(0.17)	(0.78)	(6.84)***
$ln(exp)$	-0.00007	0.00005	-0.00005	0.00007	-0.00002	0.00002	0.00008
$*age^2$	(4.91)***	(5.12)***	(7.46)***	(4.57)***	(1.67)*	(1.09)	(7.01)***
$ln(exp)^2$	0.00001	0.00000	0.00000	-0.00001	0.00000	0.00000	-0.00001
$*age^2$	(3.96)***	(3.68)***	(5.81)***	(4.68)***	(1.99)**	(0.61)	(6.12)***
age21-24	-0.15202	0.05564	-0.05862	0.08828	0.03568	0.07837	0.07166
	(4.94)***	(3.03)***	(4.23)***	(2.83)***	(1.78)*	(2.03)**	(3.14)***
age25-29	-0.29768	0.13414	-0.14726	0.18222	0.05297	0.09088	0.18561
	(7.04)***	(5.32)***	(7.73)***	(4.26)***	(1.92)*	(1.72)*	(5.92)***
age30-34	-0.44514	0.21654	-0.25763	0.27755	0.07839	0.13009	0.31625
	(7.35)***	(5.99)***	(9.44)***	(4.53)***	(1.98)**	(1.72)*	(7.04)***
age35-39	-0.58425	0.29472	-0.35136	0.36703	0.10677	0.15561	0.43726
	(7.45)***	(6.29)***	(9.94)***	(4.62)***	(2.09)**	(1.58)	(7.51)***
age40-44	-0.70551	0.35763	-0.43851	0.44303	0.13533	0.19447	0.53995
	(7.44)***	(6.31)***	(10.26)***	(4.61)***	(2.19)**	(1.64)	(7.67)***
age45-49	-0.81881	0.40913	-0.51514	0.51616	0.16336	0.22361	0.63826
	(7.48)***	(6.26)***	(10.44)***	(4.66)***	(2.29)**	(1.63)	(7.86)***

	food	clothing	energy	furnit.	health	transp.	leisure
age dummies interacted with owner-occupier status							
age50-54	-0.91712	0.45672	-0.58202	0.56945	0.19525	0.25286	0.71771
	(7.51)***	(6.27)***	(10.58)***	(4.61)***	(2.45)**	(1.65)*	(7.92)***
age55-59	-0.99496	0.48979	-0.63994	0.62357	0.22739	0.26618	0.78492
	(7.50)***	(6.18)***	(10.70)***	(4.64)***	(2.62)***	(1.60)	(7.97)***
age60-62	-1.06767	0.51837	-0.68983	0.65962	0.2625	0.28172	0.84345
	(7.55)***	(6.14)***	(10.83)***	(4.61)***	(2.85)***	(1.59)	(8.04)***
age63-65	-1.09586	0.53166	-0.71741	0.67233	0.28579	0.28678	0.87166
	(7.53)***	(6.12)***	(10.94)***	(4.56)***	(3.01)***	(1.57)	(8.07)***
age66-69	-1.13342	0.54085	-0.7377	0.69226	0.30996	0.29039	0.89652
	(7.60)***	(6.08)***	(10.98)***	(4.59)***	(3.19)***	(1.55)	(8.11)***
age70-74	-1.17377	0.55381	-0.76395	0.71099	0.34181	0.2922	0.92197
	(7.69)***	(6.08)***	(11.10)***	(4.60)***	(3.43)***	(1.53)	(8.14)***
age75-79	-1.21126	0.55945	-0.78643	0.724	0.38719	0.28894	0.93986
	(7.79)***	(6.03)***	(11.22)***	(4.60)***	(3.82)***	(1.48)	(8.15)***
age80+	-1.22977	0.55058	-0.8064	0.71974	0.42929	0.28782	0.9543
	(7.86)***	(5.90)***	(11.44)***	(4.55)***	(4.21)***	(1.47)	(8.23)***
household composition interacted with owner-occupier status							
ln($hhsize$)	-0.00274	0.00699	0.00037	-0.01945	-0.00509	0.00464	0.00063
	(1.74)*	(7.43)***	(0.52)	(12.20)***	(4.95)***	(2.35)**	(0.54)
no kids	-0.01293	0.0068	0.00424	0.01696	0.00386	-0.02136	-0.00399
	(2.86)***	(2.52)**	(2.08)**	(3.71)***	(1.31)	(3.78)***	(1.19)
$\#kids$	-0.00184	-0.00008	-0.00177	0.01458	-0.00101	-0.00061	-0.00046
	(0.37)	(0.03)	(0.79)	(2.90)***	(0.31)	(0.10)	(0.12)
$(\#kids)^2$	0.00018	0.00011	0.00015	-0.00247	0.00105	-0.0009	0.00078
	(0.15)	(0.15)	(0.29)	(2.05)**	(1.35)	(0.60)	(0.88)
not working	-0.00817	0.00221	-0.00238	0.00784	0.00507	0.00703	-0.00329
	(4.98)***	(2.26)**	(3.23)***	(4.72)***	(4.73)***	(3.42)***	(2.71)***
constant	1.4085	0.18163	0.15867	-0.43255	-0.42951	-0.72629	0.05683
	(22.67)***	(4.90)***	(5.67)***	(6.88)***	(10.59)***	(9.33)***	(1.23)

5.4 Description of the OLG-model

In scenario III, I use income predictions from the OLG model by Börsch-Supan, Ludwig, and Winter (2005) which is based on the traditional model of Auerbach and Kotlikoff (1987). It is a large scale simulation model comprising 80 overlapping generations and multiple countries respectively world regions. The model simulates the key macroeconomic variables such as GDP, savings and consumption over the period 2000 to 2050. It is especially designed to simulate international capital flows between countries and world regions, and for the evaluation of policy reform, in particular pension reform.

The model contains one representative agent per generation who maximizes her utility fully rationally over the life cycle. The agent's utility depends on his consumption. Labor is exogenous and is calibrated according to a projection of labor market participation. This forecast originates from a demographic projection by the UN and additional assumptions about female labor force participation, a decline of EU-wide unemployment to the natural rate of 5 per cent until 2030, and a rise in the retirement age in the same period.
The total consumption of the representative agent of age a is the difference between net labor and asset income minus savings.

5.5 Description of the FAMY-model

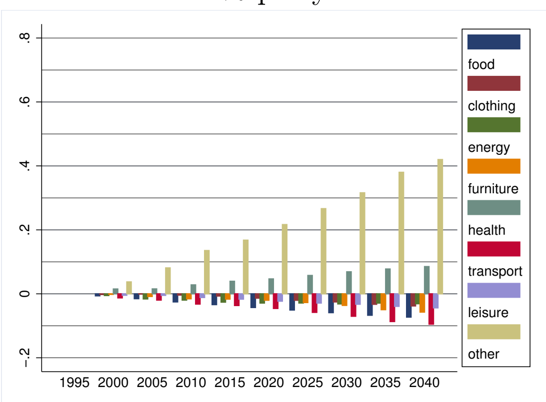
In scenario IV, I use the household projections that are derived from demographic projections using the Pro-FAMY simulation model. This tool was developed jointly by the Bundesinstitut für Bevölkerungswissenschaft, the Max-Planck Institut für Demografie and empirica. The projections have kindly been provided to me by Harald Simons.
The Pro-FAMY model combines demographic projections with projections about the changes in living arrangements, i.e., the composition of households, marital status, and the number of children. For a detailed description of Pro-FAMY see Hullen (2003).

5.6 Alternative growth rates in Scenario II

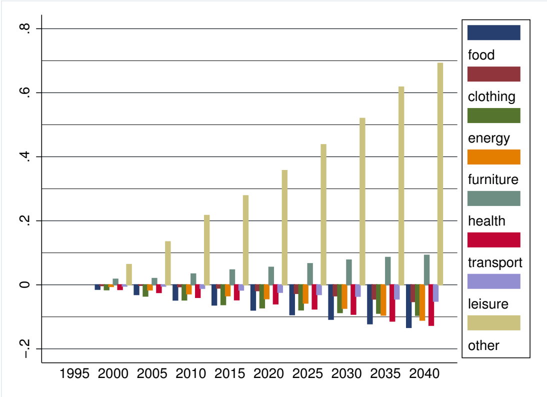
The section shows the results of scenario II if one makes alternative assumptions about the growth rate of income. In addition to the assumption of 1.4 percent growth annually, the demand changes are projected in a low variant assuming 0.5 percent, and a high variant assuming a growth rate of 1 percent annually.

Figure 10: Projected percentage change in aggregate expenditure shares under various growth rates in total expenditures

0.5% per year



1% per year



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