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Allocation of Expenditures in Elderly Households and the Cost of Widowhood

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Allocation of Expenditures in Elderly Households and the Cost of Widowhood*

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Abstract

Widowhood and retirement are likely to change the economic environment of elderly households. While retirement primarily changes income and expenditure patterns, widowhood fundamentally changes the structure of the household. Beside high non-monetary cost of losing the partner, resources are no longer shared and economies of scale arising from joint consumption are lost. This paper applies the Lewbel and Pendakur (2008) collective household model to expenditure data on elderly households in Switzerland. The findings suggest that between 40 and 50% of household resources are assigned to wives and both spouses save approximately 25% on expenditures due to economies of scale in consumption. Widowers tend to have higher wealth than widows. Estimates of indifference scales, however, indicate that the financial loss related to widowhood is larger for men than for women. Moreover, ignoring within household inequality, as implicitly done by traditional equivalence scales, underestimates total inequality among individuals.

JEL classification: D12, D13, C30

Keywords: Collective Household Model, Indifference Scale, Resource Shares, Economies of Scale in Consumption, Demand System Estimation, Engel Curves, Elderly Households

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1 Introduction

The elderly face specific economic conditions because they are at the age of transition to retirement. This is likely to change the economic environment of households and thereby the behavior of its members. In addition, elderly people eventually become widow or widower. Beside of high non-monetary costs, widowhood entails economic costs because income and expenditure patterns are altered by changes in the size of the household. Opportunities for economies of scale in joint consumption are lost and resources are no longer shared between household members.[1]

This paper contributes to the literature on the standard of living of elderly people and the impacts of retirement and widowhood using the collective household model proposed by Lewbel and Pendakur (2008). Estimation of the model parameters is based on consumption data provided by the Swiss Household Budget Survey.

Traditional models of household behavior treat households as single decision makers that maximize household utility subject to some household budget constraint. This simplifies the analysis since standard results of consumer theory can be applied to decisions like the consumption choices of the household. Furthermore, it does not matter who earns which fraction of income. Since only total income is relevant, this approach is referred to as the income pooling hypothesis.[2] For one-person households, the link of this unitary model to consumer theory is quite natural. Maximizing household utility can be viewed as maximizing the utility function of the consumer subject to her or his budget constraint given by household income that is entirely at the single consumer's disposal. For multi-person households, however, Browning and Chiappori (1998) show that the unitary model requires additional strong restrictions, which they reject in the empirical part of their paper. In particular, Browning and Chiappori (1998) find evidence against the income pooling hypothesis, meaning that bargaining power matters and income shares have an impact on the composition of goods purchased by the household. Numerous additional articles reject income pooling, examples thereof are Schultz (1990), Thomas (1990), Bourguignon et al. (1993), Browning et al. (1994), Lundberg et al. (1997), and Bütikofer et al. (2009).

Increasing criticism of unitary models has led to the development of collective households models initiated by the work of Chiappori (1988) and Chiappori (1992). Such models account for a possibly unequal distribution of resources among household members, each of whom has their own preferences. Typically, these models only assume

[1]For households of younger couples, the role of children is also important. In a recent paper, Dunbar et al. (2013) extend collective household models to children. An earlier application of a collective model to children was proposed by Donni and Bargain (2011).

[2]See, e.g., Chiappori (1992, p. 464).

that household decisions are Pareto efficient.[3] More recent collective household models, e.g., Browning et al. (2013) and Dunbar et al. (2013), take into account economies of scale in consumption in addition to heterogeneous preferences. Economies of scale arise when goods are jointly consumed by wives and husbands. An example hereof is a couple that travels together by car since gasoline use is only weakly affected by the number of passengers.

This paper addresses the following questions: How are resources allocated to wives and husbands in elderly couples? How large are economies of scale of living together and do they change with retirement? How large are indifference scales, i.e., the fraction of couple-household expenditures individuals living alone need to reach the same indifference curve? Resource shares, scales economies and indifference scales of elderly couples are estimated using the methodology proposed by Lewbel and Pendakur (2008). Estimation of the model is based on expenditure data on elderly households from the Swiss Household Budget Survey. The sharing rule is identified by comparing data between singles and couples, which is a common strategy in the literature on collective household models.[4]

The main results indicate that the share of resources that is allocated to the wife is for most couples in the range between 40 and 50%. Scale economy estimates and indifference scale estimates indicate that both spouses save 25% on expenditures due to jointness of consumption and that approximately 60% of couple household resources are needed by widows or widowers to maintain the same standard of living. Mean expenditures of widowers are 16% higher than those of widows. However, the comparison to expenditures of couples adjusted to the level of individuals by indifference scales shows that the loss related to widowhood is higher for men than for women. This is mainly due to the result that more than half of household resources are assigned to husbands. Inequality measures based on adjusted expenditures show that traditional equivalence scales underestimate total inequality among individuals by approximately 13%.

To my knowledge, this paper is the first to estimate a Lewbel and Pendakur (2008) type model using expenditure data on Swiss households. Specifically for elderly households in Switzerland, it is the first application of a collective model. Applications of collective household models for other age groups include Bütikofer et al. (2009) and Bütikofer and Gerfin (forthcoming). Switzerland represents an interesting case because the percentage of the elderly population is continuously increasing, which is the case for most developed countries.[5] The focus on standards of living of elderly people is appealing because of changing economic conditions at the transition from the labor force to

[3]There are articles that do not assume Pareto efficient household decisions, see Cherchye et al. (2011) for a recent example.

[4]Other strategies exists. For a general discussion, see Cherchye et al. (2013).

[5]See, e.g., OECD data at *http://data.oecd.org/pop/elderly-population.htm* (accessed November 2014).

retirement.

The structure of the paper is as follows: Section 2 introduces the model in detail and discusses issues of identification. The data used for estimation is described in section 3. Section 4 shows the empirical implementation of the model. The subsequent section 5 presents the main results, related sensitivity checks, and provides an analysis of economic well-being and consumption inequality. Section 6 concludes.

2 The Model

This paper applies the model proposed by Lewbel and Pendakur (2008) to elderly households at the age of transition from the labor force to retirement. Their approach allows to estimate how household resources are divided between wives and husbands and to identify the returns to scale from joint consumption. The Lewbel and Pendakur (LP) model is related to the approach by Browning et al. (2013), which is less restrictive but comes at the cost of requiring data on price variation.[6] Since data on prices are not available, this paper sticks to the LP model.

The LP model is a collective household model. Such models do not consider households as a single decision maker. Instead, "the household is characterized as a collection of individuals, each of whom has a well defined objective function, and who interact to generate household level decisions" (Lewbel and Pendakur, 2008, p. 350).

2.1 Single Households Engel Curves

Before dealing with the process of intra-household division of resources, consider the consumption decisions of single women and single men. Singles are the only decision maker within their household, therefore their optimal choice of the bundle of goods is the optimal choice of the household. This simplifies the analysis of consumption patterns, since the entire household wealth is at their own disposal and there are no economies of scale in consumption which are potentially arising in multi-person households.

Following the LP model, let $\omega_j^k(\mathbf{p}, x, \mathbf{z}_j)$ denote the budget share demand function for good k of person j with observable characteristics $\mathbf{z}_j$ and log total expenditures x. Person j faces a vector of market prices $\mathbf{p} = \left[p^1, ..., p^K\right]'$ and decides optimally to spend the fraction $\omega_j^k(\mathbf{p}, x, \mathbf{z}_j)$ of total expenditures (e^x) on good k, for $k = 1, ..., K$. Since data on prices are not observed, it is not feasible to exploit any price variation and $\mathbf{p}$ is restricted to a vector of constants. Similar to LP and Bütikofer et al. (2011), budget shares (Engel curves) are specified as a rank three demand system that is quadratic in log

[6] Identification of the Browning et al. (2013) model does not require assumption 4 that is imposed in section 2.2.

total expenditures. Banks et al. (1997) show that this specification provides a sufficiently general approximation to Engel curves. Person j is either a woman ($j = f$) or a man ($j = m$). The quadratic form for each good k yields a system of K budget-share equations for each type j:

$$\omega_f^k(x, \mathbf{z}_f) = a_f^{k0} + \mathbf{a}_f^{k\prime}\mathbf{z}_f + (x - \mathbf{e}_f'\mathbf{z}_f)b_f^k + (x - \mathbf{e}_f'\mathbf{z}_f)^2 c_f^k + \varepsilon_f^k \tag{1}$$

$$\omega_m^k(x, \mathbf{z}_m) = a_m^{k0} + \mathbf{a}_m^{k\prime}\mathbf{z}_m + (x - \mathbf{e}_m'\mathbf{z}_m)b_m^k + (x - \mathbf{e}_m'\mathbf{z}_m)^2 c_m^k + \varepsilon_m^k. \tag{2}$$

Parameters to be estimated are a_j^{k0}, $\mathbf{a}_j^k$, b_j^k, c_j^k, $\mathbf{e}_j$, where letters in bold mark column vectors. The coefficients b_j^k by itself would only allow for a linear relation between log expenditures x and budget shares ω_j^k. The inclusion of c_j^k captures Engel curvature, which Banks et al. (1997) found to be of particular importance. Parameter vectors $\mathbf{a}_j^{k\prime}$ and $\mathbf{e}_j'$ permit Engel curves to depend on individual control variables that are denoted by $\mathbf{z}_f$ and $\mathbf{z}_m$ respectively. The variables ε_j^k denote error terms.

2.2 Resource Shares, Economies of Scale and Indifference Scales

In the LP model, each household member j determines the demand for consumption goods by maximizing her or his own utility function. Person j's budget constraint in this maximization problem is given by the share $\eta_j \in (0, 1)$ of total household expenditures e^x that is under control of person j, where $\sum_j \eta_j = 1$. In logs, personal expenditures of j cannot exceed $\ln(\eta_j e^x) = (\ln \eta_j + x)$. The specifications chosen for estimation will allow η_j to depend on a vector $\mathbf{z}$ including characteristics of the wife ($\mathbf{z}_f$), of the husband ($\mathbf{z}_m$) as well as distribution factors ($\mathbf{z}_h$) that are relevant on the household level. This will formally be indicated by the expression $\eta_j(\mathbf{z})$. One can think of η_j as a measure of bargaining power.

The model allows for economies of scale in consumption. That is, some goods consumed by the wife and the husband in a couple household are in total cheaper than the sum of expenditures of two single households who also buy that good. The couple household saves money due to jointness of consumption. In the example of sharing a car, the couple saves money when wife and husband travel together. They nearly need half as much gasoline compared to two singles, each of them traveling in their own car. Of course, car usage does not have to be fully public, i.e., members of couple households do not always travel together, sometimes they travel alone.

For goods k that are not purely private, jointness of consumption leads to shadow

prices p_s^k faced by individuals living in couple households that are lower than market prices p^k, which are relevant for singles. Cost savings for household member j arising from joint consumption are incorporated in the model as illustrated by assumption 1.

Assumption 1. *For $j = f$ and $j = m$, there exists a function $D_j(\mathbf{z}_j)$ measuring the cost savings resulting from economies of scale such that it holds for an indirect utility function V_j*

$$V_j(\mathbf{p}_s, x) = V_j\big(\mathbf{p}, x - \ln D_j(\mathbf{z}_j)\big)$$

where $\mathbf{p}_s \leq \mathbf{p}$.

Assumption 1 states that the utility a person j can achieve when facing shadow prices $\mathbf{p}_s$ and total (log) expenditures x is the same as utility under market prices $\mathbf{p}$ but having expenditures upscaled by some function $D_j(\mathbf{z}_j) \in (0, 1]$. $D_j(\mathbf{z}_j)$ is an aggregate over goods measure of cost savings that equals 1 when there are no economies of scale, and $D_j(\mathbf{z}_j)$ is < 1 when some goods are shared. Note that assumption 1 restricts $D_j(\mathbf{z}_j)$ to be independent of log expenditures x.[7] As indicated by the dependence on $\mathbf{z}_j$, economies of scale are allowed to vary by observable individual characteristics.

To compare singles with wives and husbands living in couple households, not only economies of scale are relevant. Utility comparisons on the individual level need to consider $\eta_j(\mathbf{z})$, the sharing rule assigning resources to wives and husbands, and they involve further assumptions. Assumption 2 relates indifference curves of singles to members of couple households.

Assumption 2. *For $j = f$ and $j = m$, individual j's indifference curves over goods remain the same whether living as a member of a couple household or as a single.*

Assumption 2 is potentially restrictive, because preferences of wives (husbands) may differ from single women (men), but it is crucial for identification of the LP model. One way to deal with it is to consider only specific types of singles. This approach is applied for the estimates presented in section 5 and explained in further detail in section 2.4. Two additional assumptions on household behavior are imposed to relate budget share functions of single and couple households.

Assumption 3. *Household decision are Pareto efficient.*

Assumption 4. *Resource shares η_j are independent of base expenditures x.*

[7] For a discussion on restrictiveness and testability of the independence assumption, see Lewbel and Pendakur (2008, p. 353).

Assumptions 3 ensures that households do not waste resources. Assumption 4 is essential to derive an expression for budget shares of couple households. However, the latter can potentially be mitigated, the model in general allows for dependence of resource shares on measures of household wealth other than total expenditures, e.g., household income, or education levels. Given these assumptions, LP show that indifference scales allow us to compare the utility of someone living alone to the utility that the same individual would achieve when living in a couple household.

Definition 1. *The indifference scale $I_j(\mathbf{z})$ puts individual j living alone on the same indifference curve as she or he would attain living in a couple household.*

$$V_j(\mathbf{p}, x - \ln I_j(\mathbf{z})) = V_j(\mathbf{p}_s, \ln \eta_j(\mathbf{z}) + x)$$

The left-hand side of the equation denotes the utility of individual j living alone, the right-hand side describes the utility level achieved by j when living in a couple household. Indifference scales can be used for statements such as: Suppose person j lives in a couple household. If that person would live alone, what fraction of total (couple) household expenditures would be necessary to reach the same in difference curve?[8] The number that answers this question is $(1/I_j(\mathbf{z}))$. LP show that the indifference scale is given by the scale economy parameter divided by the measure of resource shares. That is,

$$I_j(\mathbf{z}) = \frac{D_j(\mathbf{z}_j)}{\eta_j(\mathbf{z})}. \tag{3}$$

An appealing property of the LP setup is that indifference scales are invariant to how utility is cardinalized, which is not the case for traditional equivalence scales.[9]

2.3 Couple Households Engel Curves

Based on resource shares and indifference scales as defined in section 2.2, LP show that the budget share demand functions of couple households, denoted by $\omega_h^k(x, \mathbf{z})$, are

$$\omega_h^k(x, \mathbf{z}) = \sum_j \eta_j(\mathbf{z}) \Big[\psi_j^k(\mathbf{z}_j) + \omega_j^k\big(x - \ln I_j(\mathbf{z}), \mathbf{z}_j\big) \Big] \tag{4}$$

for a fixed price regime and some good k. $\psi_j^k(\mathbf{z}_j) = (\partial \ln D_j(\mathbf{z}_j)/\partial \ln p_k)$, the elasticity of $D_j(\mathbf{z}_j)$ with respect to the price of good k, is constant when prices are invariant. Equation 4 shows that the couple household budget shares are essentially a weighted sum of individual budget shares, adjusted by some constant $\Psi^k = \sum_j \eta_j(\mathbf{z}) \psi_j^k(\mathbf{z}_j)$. The

[8] This is the question we should ask for people that become widow or widower.

[9] See Lewbel and Pendakur (2008, p. 352) for the proof.

weights are given by the resource shares $\eta_j(\mathbf{z})$. Household total expenditures x downscaled by the indifference scale $I_j(\mathbf{z})$ lead to the expenditure level that is relevant for the choice of (individual) budget shares of household member j. It is useful to drop index j from the resource share parameter. Since only couples of wives and husbands are considered, let $\eta(\mathbf{z})$ denote the resource share of the wife. Consequently, the share of the husband is $(1-\eta(\mathbf{z}))$. Combining equation 4 with equations 1 and 2 yields a system of K equations to be estimated for couple households:

$$\begin{aligned}
\omega_h^k = \eta(\mathbf{z}) \Big[& a_f^{k0} + \mathbf{a}_f^{k\prime}\mathbf{z}_f + \Big(x - \ln I_f(\mathbf{z}) - \mathbf{e}_f'\mathbf{z}_f\Big) b_f^k \\
& + \Big(x - \ln I_f(\mathbf{z}) - \mathbf{e}_f'\mathbf{z}_f\Big)^2 c_f^k + \psi_f^k(\mathbf{z}_f)\Big] \\
& + \Big(1 - \eta(\mathbf{z})\Big) \Big[a_m^{k0} + \mathbf{a}_m^{k\,\prime}\mathbf{z}_m + \Big(x - \ln I_m(\mathbf{z}) - \mathbf{e}_m'\mathbf{z}_m\Big) b_m^k \\
& + \Big(x - \ln I_m(\mathbf{z}) - \mathbf{e}_m'\mathbf{z}_m\Big)^2 c_m^k + \psi_m^k(\mathbf{z}_m)\Big] \\
& + \varepsilon_h^k.
\end{aligned} \tag{5}$$

It remains to parametrize how indifference scales I_j, resource shares η and price elasticities ψ_j^k are allowed to vary by observable characteristics $\mathbf{z}$. This component of the model is clarified in section 4.1.

2.4 Identification

The model consisting of equations 1, 2 and 5 is identified given expenditure data for couple households, single women and single men. Assumption 2 allows to express couple budget shares as a function of individual budget shares, as shown in equation 4. When expenditure data for couples and women as well as men living alone is observed, budget shares ω_h^k, ω_f^k and ω_m^k are identified for each k. Identification of resource shares η and indifference scales I_j requires Engel curves that are nonlinear and different across goods as well as across people, i.e., not the same for females and males.[10] Suppose in contrary ω_f^k and ω_m^k were equivalent, then "weights" of the sum in equation 4 would not matter and η_j would not be identified. Nonlinearity and variation across goods is required to identify all b_j^k and c_j^k parameters. Linear functions instead would not identify c_j^k. When everything else is known, the constant parameters Ψ^k, capturing the price elasticity of D_j, are identified as well. For a more detailed and technical proof of identification in the LP model, see Lewbel and Pendakur (2008, p. 353).

[10] We need the last condition to hold for at least as many goods as there are people in the household.

Assumption 2 imposes that preferences of individuals need to be comparable whether living as a member of a couple household or as a single. However, when comparing data of all singles with members of couple households, this assumption could be violated due to the fact that marriage is not randomly assigned. Therefore, the main results shown in section 5.1 are estimated using data on couples, widows and widowers only. Widows and widowers are singles that once decided to get married. Therefore, they are not likely to be systematically different from people living in couple households, assuming that preference changes related to widowhood are negligible.

3 Data

The model introduced in section 2 is estimated using data from the Swiss Household Budget Survey (HBS), conducted by the Swiss Federal Statistical Office. Beside key individual attributes, this dataset provides comprehensive expenditure data at the household level for various goods and services.[11] This study explores pooled cross-section data of the years 2000 to 2005, adjusted for inflation, for one- and two-person households where the sample is restricted to households consisting of members that are between 50 and 80 years old. Individuals in this age bracket are of economic interest since they pass the transition from the labor force to retirement. The sample consists of 3459 married couples, 1034 single woman and 316 single men. All singles live in one-person households and 823 of them are widowed (669 widows and 154 widowers).

Individual control variables used for the estimation of the Engel curves are retirement status, education and age of each household member. The retirement and education variables are dummies. The former is 1 for those that are retired (0 otherwise) and the latter equals 1 for individuals with tertiary education (0 for lower education levels). For couple households, an additional binary variable that indicates whether the wife or the husband earns more is available. If the wife provides the larger fraction of household income, this binary indicator equals 1, otherwise 0. Summary statistics of the demographic characteristics are shown in table 1. On average, widows and widowers are older and more often retired than singles and married couples. Single women tend to have relatively high levels of education, while educational achievements of widows are lower but comparable to wives in couple households. For men, education levels are the highest for married husbands. For 7% of couple households, the wife earns more than her husband.[12]

[11] The HBS provides the data that is used to determine the basket of commodities listed in the Swiss Consumer Price Index.

[12] The share is 12% for couples where the husband is retired but the wife is still working.

Table 1: Mean characteristics (z vectors)

	Widowed Women	Widowed Men	Single Women	Single Men	Married Women	Married Men
Retired	0.86	0.82	0.78	0.61	0.47	0.58
Education	0.07	0.25	0.10	0.27	0.07	0.31
Age	71.09	70.82	69.31	65.76	63.09	65.51
Wife earns more					0.07	
Observations	669	154	1034	316	3459	3459

Note: Singles include widows and widowers.
Data source: Household Budget Survey (HBS).

Six expenditure categories are considered: food products and nonalcoholic beverages, housing, housekeeping, transportation, entertainment and recreation and culture, and telecommunication. They have been chosen for two reasons. First, these are goods and services on which households can freely choose how much to spend. This would, for instance, not be the case for health insurance premiums.[13] Second, these are the ones for which most households reported non-zero expenditures. Note that food and nonalcoholic beverages denote products consumed at home. Housing contains the rent or mortgage interest payment and energy cost of the principal residence. Housekeeping includes ordinary household expenditures such as furniture, home textiles, home appliances, tools, or decoration but excludes comestible goods. Transportation excludes car purchases because these are large but infrequent expenditures that distort ordinary monthly expenditures.

The distribution of expenditures across household types is shown in table 2. Single women assign two percentage points more of their expenditures to food products and nonalcoholic beverages as well as to housing than single men. Single men, on the other hand, spend five percentage points more on transportation than single women. These differences are significant on the 5% level and they are of the same magnitude when widows are compared to widowers. Even though the differences are small for budget shares of other goods, the descriptive statistics reveal the importance of models allowing for unequal preferences among members of multi-person households. Couples' budget shares related to housing are considerably lower than corresponding shares of one-person households, the differences are in between seven and ten percentage points and they are

[13]Health insurance is compulsory in Switzerland.

significant on the 1% level. Moreover, couples spend significantly more on food products and nonalcoholic beverages. For other goods, the differences are small.

Table 2: Mean budget shares by household type

	Widowed Women	Widowed Men	Single Women	Single Men	Married Couples
Food Products and Nonalcoholic Beverages	0.22	0.20	0.21	0.19	0.26
Housing	0.47	0.44	0.47	0.45	0.37
Housekeeping	0.06	0.06	0.06	0.06	0.07
Transportation	0.08	0.13	0.08	0.13	0.12
Entertainment, Recreation, Culture	0.13	0.13	0.14	0.14	0.14
Telecommunication	0.04	0.04	0.04	0.04	0.04
Observations	669	154	1034	316	3459

Note: Singles include widows and widowers. Transportation excludes car purchases.
Data source: Household Budget Survey (HBS).

Table 3: Mean budget shares for couples by retirement status

	Both Working	Wife Retired	Husband Retired	Both Retired
Food Products and Nonalcoholic Beverages	0.24	0.26	0.26	0.28
Housing	0.39	0.38	0.36	0.35
Housekeeping	0.07	0.07	0.07	0.07
Transportation	0.13	0.11	0.12	0.12
Entertainment, Recreation, Culture	0.14	0.15	0.15	0.14
Telecommunication	0.04	0.04	0.04	0.04
Observations	1283	247	634	1295

Note: Singles include widows and widowers. Transportation excludes car purchases.
Data source: Household Budget Survey (HBS).

Table 3 summarizes budget shares for married couples differentiated by retirement

status. Expenditures related to home production as food products and nonalcoholic beverages tend to receive slightly higher budget shares in households where at least one member is retired. Budget shares allocated to housing are lower for retirees. Other goods show little variation by retirement status.

4 Empirical Implementation

4.1 Parametrization

Parametric forms chosen for this paper follow, with an exception concerning the price elasticities of $D_j(\mathbf{z}_j)$, the specifications proposed by Lewbel and Pendakur (2008). That is, the resource share of the wife $\eta(\mathbf{z})$, and consequently $(1-\eta(\mathbf{z}))$ for the husband, is parametrized to be linear in individual and household characteristics.

$$\eta(\mathbf{z}) = \mathbf{r}'\mathbf{z} = r_0 + \mathbf{r}_h'\mathbf{z}_h + \mathbf{r}_f'\mathbf{z}_f + \mathbf{r}_m'\mathbf{z}_m \tag{6}$$

The cost savings functions $D_j(\mathbf{z}_j)$, resulting from economies of scale when living with others, are specified to be log-linear in individual characteristics.

$$\ln D_f(\mathbf{z}_f) = d_{0f} + \mathbf{d}_f'\mathbf{z}_f \tag{7}$$

$$\ln D_m(\mathbf{z}_m) = d_{0m} + \mathbf{d}_m'\mathbf{z}_m \tag{8}$$

Equation 3 shows that log indifference scales can be expressed as the difference of log cost savings and log resource shares. With the parametrizations of equations 6, 7 and 8, this yields parametric expressions for log indifference scales.

$$\begin{aligned} \ln I_f(\mathbf{z}) &= \ln D_f(\mathbf{z}_f) - \ln \eta(\mathbf{z}) \\ &= d_{0f} + \mathbf{d}_f'\mathbf{z}_f - \ln\left(r_0 + \mathbf{r}_h'\mathbf{z}_h + \mathbf{r}_f'\mathbf{z}_f + \mathbf{r}_m'\mathbf{z}_m\right) \end{aligned} \tag{9}$$

$$\begin{aligned} \ln I_m(\mathbf{z}) &= \ln D_m(\mathbf{z}_m) - \ln\left(1 - \eta(\mathbf{z})\right) \\ &= d_{0m} + \mathbf{d}_m'\mathbf{z}_m - \ln\left(1 - r_0 - \mathbf{r}_h'\mathbf{z}_h - \mathbf{r}_f'\mathbf{z}_f - \mathbf{r}_m'\mathbf{z}_m\right) \end{aligned} \tag{10}$$

It remains to parametrize the elasticities of $D_j(\mathbf{z}_j)$ with respect to prices of goods k, denoted by $\psi_j^k(\mathbf{z}_j)$. In general, these parameters can be different for wives and husbands $(j = f, m)$ and depend on individual characteristics $\mathbf{z}_j$. In the HBS data, however, there

is limited variation to identify these parameters. The specification of this paper allows these coefficients to differ by gender j, but not to depend on further covariates.

$$\psi_f^k(\mathbf{z}_f) = \delta_f^k \tag{11}$$

$$\psi_m^k(\mathbf{z}_m) = \delta_m^k \tag{12}$$

The structure imposed by equations 11 and 12 is not considered to be particularly restrictive. An alternative approach, followed by Bütikofer et al. (2011), would be to omit $\psi_j^k(\mathbf{z}_j)$. Results for this specification, which reduces the number of estimands, are reported in section 5.4.2.

4.2 Estimation

The vectors of individual control variables, $\mathbf{z}_f$ and $\mathbf{z}_m$, include retirement status, education and age. Included in $\mathbf{z}_h$ as a distribution factor is the binary variable indicating who is the main contributor to household income. Engel curves are estimated for all goods except telecommunication because budget shares sum to 1. In summary, this model for 3 types of households and five different goods leads to a system of 3×5 equations that are jointly estimated by nonlinear seemingly unrelated regression. Similar to Lewbel and Pendakur (2008), precision of the estimates is examined using asymptotic standard errors. Joint estimation of a total of 92 parameters is inevitable since the model contains parameter restrictions over budget share equations of different goods as well as over household types.

5 Results

The model is estimated using normalized covariates such that a vector of zeros corresponds to an individual that is not retired, has no tertiary education and is 60 years old. For couples, the additional normalization that the husband is the main contributor to household income is imposed. This normalization allows for a meaningful interpretation of the intercepts as estimates for a well defined reference group.

5.1 Resource Shares and Scale Economies

This section shows the results for the resource share and economy of scale parameters. Coefficients and corresponding standard errors are reported in table 4. The estimates of all Engel curve parameters are in the appendix (table 10).

For couples where the husband earns more than his wife, where both spouses are still in the labor force, have no tertiary education and are 60 years old, the wife is estimated to receive the fraction $\eta = 0.462$ with a standard error (SE) of 0.056, which is 46.2% of household resources. The point estimate indicates that slightly less than half of household resources are allocated to the wife. Note, however, that equal shares of 50% are inside the 95% confidence interval. When the wife earns more, her share is estimated to significantly increase by 2 percentage points. This leads to a point estimate that is very close to fifty-fifty shares. Concerning age effects, the share of the wife is estimated to be lower for older couples. Increasing the age of both spouses by 5 years significantly reduces the fraction assigned to the wife by 3.7 percentage points (SE: 1.3 percentage points). Education and retirement status have small and insignificant effects on how resources are divided within couples. Note that the education level of wives and husbands is highly correlated within households. For 73% of all couples in the data, the binary education variable is the same for both spouses.

Table 4: Sharing rule and scale economy parameter estimates

	Sharing rule $\eta(\mathbf{z})$		Wife scale economy $\ln D_f(\mathbf{z}_f)$		Husband scale economy $\ln D_m(\mathbf{z}_m)$	
	Est	*Std Err*	*Est*	*Std Err*	*Est*	*Std Err*
Intercept	0.462***	0.056	-0.214	0.135	-0.217	0.172
Wife earns more	0.020*	0.011				
Wife retired	-0.009	0.010	-0.139	0.092		
Husband retired	0.016	0.014			-0.060	0.109
Education wife	0.009	0.013	-0.013	0.113		
Education husband	0.009	0.010			0.100	0.076
Age wife	-0.001	0.001	-0.012*	0.007		
Age husband	-0.006***	0.002			-0.023**	0.009

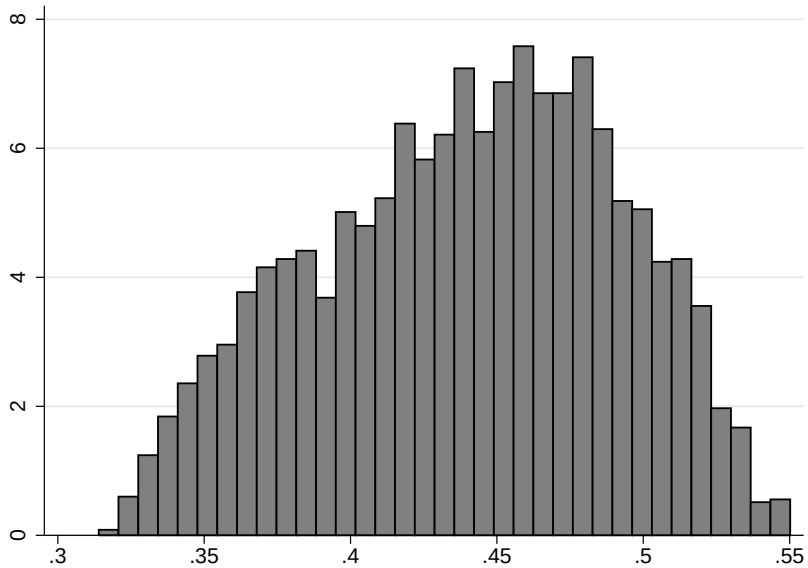
Number of observations: 4282. Number of parameters in the model: 92.
*Significance levels: * 10%, ** 5%, *** 1%*

Figure 1 shows the histogram of predicted female resource shares $\eta(\mathbf{z})$. These predictions have an average of 43.5%. For 63% of all couples, resource shares of wives are estimated to lie in the relatively narrow interval between 40% and 50%.[14] The estimates

[14] All female resource shares are predicted to lie in the interval between 30% and 55%.

are comparable to the results of Lewbel and Pendakur (2008) who find slightly lower shares between 36 and 46%. Specifically for elderly households, diverging results are reported in the literature. Bütikofer et al. (2011) find that approximately 33% are allocated to the wife, Cherchye et al. (2012) estimate shares in the order of 63%. An application using Swiss data is Bütikofer and Gerfin (forthcoming).[15] Their results indicate that almost 50% are allocated to wives in non-elderly households.

Figure 1: Histogram of estimated female resource shares $\eta(\mathbf{z})$



Economies of scale arising from joint consumption reduce the expenditures necessary to reach some level of utility. Wives living in couple households are estimated to face the fraction $D_f = \exp(-.214) = 80.7\%$ of the cost when they live alone due to widowhood.[16] Husbands are estimated to face 80.5% of the cost. Note, however, that $\ln(D_f)$ and $\ln(D_m)$ are not precisely estimated with standard errors of 0.135 and 0.172 respectively. The cost savings of wives and husbands significantly increase when they get older. Retirement tends to augment scale economies as well. This is plausible because former workers are likely to spend considerably more time at home when they retire. A wife who is 65 years old and retired is estimated to face 66.2% of the cost of a widow,[17] which is clearly less than the estimate before retirement. The estimate for a husband who is 65 and retired is 67.6%. Higher education does not have a large impact on the economies of scale of wives. For husbands, economies of scale are estimated to be lower for those with higher

[15] Bütikofer and Gerfin (forthcoming) estimate a collective model based on satisfaction data.
[16] This is the estimate for the reference group with covariates normalized to zero.
[17] The calculation of D_f for illustration: $0.662 = \exp(-.214 - .139 - 5 \times .012)$

education. When integrated over the covariate distribution, the average estimates are 73.5% for D_f and 72.0% for D_m.

The parameters of the sharing rule are more precisely estimated than those constituting the scale economies. This pattern also occurs in alternative specifications and is similar to the standard errors reported in the application of Lewbel and Pendakur (2008).

The results for resource shares and economies of scale allow us to construct estimates of indifference scales. For the reference group (couples where both spouses are 60 years old, not retired, do not have higher education and where the husband is the main contributor to household income), the point estimates of the indifference scales are $I_f = 1.746$ and $I_m = 1.497$ with standard errors of 0.162 for I_f and 0.184 for I_m. These results indicate that wives need 57.3% (= 1/1.746) of total couple households resources to maintain the same standard of living when becoming a widow. Husbands are estimated to need 66.8%. Especially for wives, other authors find somewhat larger scales. Browning et al. (2013), Lewbel and Pendakur (2008), and Bütikofer and Gerfin (forthcoming) report values of approximately 70%. For the present paper, however, the point estimate of the indifference scale for women who are retired and 65 years old is 1.525, assuming their husbands are also 65 years old and retired. Hence, the fraction of (former) couple household resources a widow needs to maintain the same standard of living increases to 65.6%, mainly because of larger returns to scale in consumption after retirement.

5.2 Economic Well-Being among Widows and Widowers

Based on the parameter estimates in section 5.1, indifference scales can be constructed for each person in the sample separately. These scales depend on individual as well as household characteristics and allow to compare utility levels of members of couple households to individuals living alone, in this case to widows and widowers. This comparison helps to investigate the economic (monetary) consequences of widowhood. Non-monetary costs of losing the spouse are not part of the analysis. The sample median inverse indifference scale for wives in couple households ($1/I_f$) is 59.0% of household resources, the median for husbands is 79.9%.[18] Note that for one-person households, e.g., widows and widowers, the scale is 100% by construction. Female indifference scales are distributed in a small interval. Male indifference scales have a larger variance. The reason is that there is considerable variation in the estimates of D_m that summarize economies of scales for husbands while resource shares (η) and female scale economies (D_f) are distributed in small intervals.

Table 5 shows the mean and three quartiles of the expenditure distribution for widows,

[18]The median of female resource shares (η) is 43.9%. The medians of the cost savings functions are 0.733 for D_f and 0.700 for D_m.

widowers and couple households (not yet adjusted by any scale). Only expenditures on goods and services used for estimation of the model are included in the numbers shown in the table.[19] Table 6 compares these quantities to the corresponding means and quantiles of couple households, adjusted by an equivalence scale as well as indifference scales. The equivalence scale is the modified OECD equivalence scales that divides household level variables by 1.5. The downscaling is the same for husbands and wives and thereby imposes the assumption of equal intra-household division of resources. Indifference scales, however, are different for women and men.

Table 5: Expenditures by household type

	Mean	Percentiles		
		25%	50%	75%
Widows	2000.5	1459.2	1815.4	2285.2
Widowers	2328.7	1414.1	2097.8	2816.6
Couples	3095.7	2141.7	2828.4	3727.8

Measured in Swiss Francs per month, adjusted to the price level of the year 2000.

The summary statistics of table 5 show that widowers are often in a better financial situation than widows and are therefore able to spend more on consumption. Their mean expenditures as well as the median and higher percentiles are larger than for widows. Higher expenditures are affordable for widowers because their salary or pension tends to be larger. Nevertheless, low quantiles of the expenditure distribution of widowers are very similar to the ones of widows. Total expenditures of couples are considerably higher compared to one-person households.

Couple households expenditures adjusted by the OECD equivalence scale are in the range of expenditure levels of widowers and widows (table 6). In particular, mean expenditures indicate that individuals in couples are slightly better off than widows but worse off than widowers. While average monthly expenditures of widows are 3.1% lower, those of widowers are 12.8% higher.

Indifference scales, however, show that economies of scale in consumption and the intra-household bargaining process are particularly beneficial for husbands. Therefore a husband needs relatively high expenditures to maintain the same standard of living

[19] This is because the indifference scales are estimated based on these goods and services.

when his wife dies. Compared to the means of actual expenditures reported by widows and widowers, only men suffer a financial loss when becoming widower. While women are estimated to need 1842 Francs per month to maintain the same standard of living, mean expenditures of widows are roughly 160 Francs higher. Men are estimated to need 2466 Francs. Actual expenditures of widowers are, however, 137 Francs lower. That is, widowers are estimated to lose 5.6%, while widows in fact have 8.6% higher expenditures at their disposal.

Table 6: Expenditures assigned to individuals in couple households

	Mean	Percentiles		
		25%	50%	75%
OECD equivalence scale				
Individuals in couples	2063.8	1427.8	1885.6	2485.2
Indifference scales				
Women in couples	1842.1	1265.0	1675.0	2231.9
Men in couples	2465.7	1696.7	2253.1	2946.2

Measured in Swiss Francs per month, adjusted to the price level of the year 2000. The (modified) OECD equivalence scale divides expenditures of couple households by 1.5.

In summary, while widowers are often financially better off than widows, their loss compared to the situation living in couple households is larger. First, this is because slightly more than half of household resources are allocated to husbands. Second, their returns to scale in consumption seem, although not very precisely estimated, to be quite large.

5.3 Consumption Inequality

This section provides an analysis of inequality between households of different types. In this regard, inequality measures are computed for couple households, widows and widowers. The first three rows of table 7 show the commonly used Theil and Gini indices

for these types of households. The numbers indicate that consumption inequality among widows is similar to inequality among couples. Inequality among widowers is slightly higher. The indices for couple households are based on total household expenditures. Using total household expenditures entails the assumption of no within-household inequality, which is implicitly done by equivalence scales. Therefore, couples' expenditures adjusted to the individual level by any equivalence scale does not change the inequality measures (row four of table 7).

In contrast, indifference scales consider inequality among couple households taking into account the unequal distribution of resources between wives and husbands. The bottom row of table 7 shows that both indices increase when couples expenditures are transformed by individual-specific indifference scales. This indicates that traditional equivalence scales tend to underestimate individual level inequality because they disregard this potential second factor arising from within-household inequality. Based on indifference scales, the additively decomposable Theil index is 0.104, while it is 0.092 when differences between wives and husbands are ignored. These numbers indicate that 11.5% of total inequality among women and men living in couple households arises from within household inequality. Other authors report even higher proportions, e.g., Bütikofer and Gerfin (forthcoming) find 16% and Lise and Seitz (2011) estimate that 25% is due to within household inequality.

Table 7: Consumption inequality

	Theil index	Gini index
Widows	0.090	0.229
Widowers	0.119	0.268
Couples	0.092	0.238
Equivalence scale		
Individuals in couples	0.092	0.238
Indifference scales		
Individuals in couples	0.104	0.251

5.4 Robustness Checks

This section provides robustness checks for the results of section 5.1. First, the identical model is estimated using additional data on all singles (section 5.4.1). Second, the price elasticity parameters $\psi_j^k(\mathbf{z}_j)$ are excluded from couples' budget share equations (section 5.4.2).

5.4.1 Estimates based on data for Widows, Widowers, Singles and Couples

Table 8 shows the estimates of the sharing rule and scale economy parameters for an alternative, extended data set using information on singles in addition to widows, widowers and couples. This adds 528 observations to the data, but makes assumption 2 less credible because preferences over goods are assumed to be equal for singles and married individuals. That is, we use data on single women (men) to identify preferences of wives (husbands).

Table 8: Estimates based on data for widows, widowers, singles, and couples

	Sharing rule $\eta(\mathbf{z})$		Wife scale economy $\ln D_f(\mathbf{z}_f)$		Husband scale economy $\ln D_m(\mathbf{z}_m)$	
	Est	*Std Err*	*Est*	*Std Err*	*Est*	*Std Err*
Intercept	0.403***	0.061	-0.038	0.125	-0.413***	0.161
Wife earns more	0.022	0.020				
Wife retired	-0.008	0.011	-0.055	0.077		
Husband retired	-0.025	0.024			-0.302***	0.092
Education wife	0.023	0.022	-0.003	0.101		
Education husband	-0.003	0.011			-0.027	0.062
Age wife	-0.001	0.001	-0.009	0.006		
Age husband	-0.001	0.001			0.002	0.005

Number of observations: 4810. Number of parameters in the model: 92.
*Significance levels: * 10%, ** 5%, *** 1%*

The intercept of the female resource share is estimated to be somewhat lower (40.3%) compared to the baseline model (46.2%) of section 5.1. This is, however, no major difference since the 95% confidence intervals of both estimates overlap. The age variables, which were estimated to increase the share of the husband, turn out to be insignificant.

Similar to the main model, retirement status and education are insignificant for the sharing rule. Economies of scale for husbands are estimated to be larger than reported in section 5.1, while those for wives are smaller. The returns to scale are, however, not very precisely estimated; standard errors are similar to the baseline model and 95% confidence intervals overlap for most of the coefficients. As in section 5.1, retirement is estimated to increase scale economies which indicates that opportunities for joint consumption rise when wife and husband drop out of the labor force.

5.4.2 The model without price elasticity parameters

The LP model involves estimation of many parameters. A reduction in the number of coefficients, proposed by Bütikofer et al. (2011), is to omit $\psi_j^k(\mathbf{z}_j)$, the parameters capturing the elasticities of $D_j(\mathbf{z}_j)$ with respect to prices of goods k. For the present paper, this approach reduces the number of parameters from 92 to 82 and potentially increases efficiency. There are less parameters because the budget share equations for couples simplify to equation 13:

$$\begin{aligned}
\omega_h^k = \eta(\mathbf{z}) \Big[& a_f^{k0} + \mathbf{a}_f^{k\prime}\mathbf{z}_f + \Big(x - \ln I_f(\mathbf{z}) - \mathbf{e}_f'\mathbf{z}_f\Big) b_f^k \\
& + \Big(x - \ln I_f(\mathbf{z}) - \mathbf{e}_f'\mathbf{z}_f\Big)^2 c_f^k \Big] \\
& + \Big(1 - \eta(\mathbf{z})\Big) \Big[a_m^{k0} + \mathbf{a}_m^{k\,\prime}\mathbf{z}_m + \Big(x - \ln I_m(\mathbf{z}) - \mathbf{e}_m'\mathbf{z}_m\Big) b_m^k \\
& + \Big(x - \ln I_m(\mathbf{z}) - \mathbf{e}_m'\mathbf{z}_m\Big)^2 c_m^k \Big] \\
& + \varepsilon_h^k.
\end{aligned} \tag{13}$$

The results for this model are shown in table 9. For the reference group, the restricted model yields a female resource share of 0.355. This estimate is 10.7 percentage points lower than the coefficient found when price elasticities are included. While scale economies of husbands are similar to the baseline model, the estimate for wives is considerably different. Women in couples are now estimated to face 93.1% of the cost, which is clearly more than the 80.7% that were found in the unrestricted model. Moreover, the impact of covariates on resource shares and scale economies is not stable, e.g., the previously positive effect of higher income of the wife on resource shares turns insignificant.

The restriction $\psi_j^k(\mathbf{z}_j) = 0$, i.e., price elasticities of $D_j(\mathbf{z}_j)$ are zero, is found to have more impact on the results than including additional data on all singles in the unrestricted model. In addition, the restriction did not make the estimation much more efficient. In

line with these findings, the joint null hypothesis of price elasticities equal to zero in the main model (section 5.1) is rejected on the 1% level.

Table 9: Estimates for the restricted model without price elasticity parameters

	Sharing rule $\eta(\mathbf{z})$		Wife scale economy $\ln D_f(\mathbf{z}_f)$		Husband scale economy $\ln D_m(\mathbf{z}_m)$	
	Est	*Std Err*	*Est*	*Std Err*	*Est*	*Std Err*
Intercept	0.355***	0.045	-0.072	0.099	-0.231**	0.116
Wife earns more	-0.008	0.019				
Wife retired	-0.004	0.017	-0.068	0.071		
Husband retired	0.025	0.021			-0.156	0.099
Education wife	0.039	0.026	-0.176**	0.088		
Education husband	-0.044*	0.024			0.106	0.077
Age wife	-0.001	0.001	0.001	0.005		
Age husband	-0.015***	0.002			0.029***	0.007

Number of observations: 4282. Number of parameters in the model: 82.
*Significance levels: * 10%, ** 5%, *** 1%*

6 Conclusion

This paper provides an analysis of the standards of living of elderly Swiss households using a model that takes changes in consumption expenditures related to retirement and widowhood into account. While retirement essentially impacts income and expenditure patterns, widowhood alters the composition of a household. As the number of household members declines from two to one, economies of scale arising from joint consumption in couple households disappear. Moreover, resources are no longer shared. Identification and estimation of the LP model applied in this paper is based on household-level expenditure data for couples, widows and widowers. The latter are used to identify preferences of individuals living in couples.

The main findings can be summarized as follows: wives control between 40 and 50% of household resources and both partners save approximately 25% on expenditures due to joint consumption of some goods. Retirement is estimated to increase these returns to scale. Resource shares and scale economies are combined to indifference scales that adjust couple households' expenditures to the individual level. The findings suggest that

the financial loss related to widowhood is larger for widowers than for widows. Moreover, indifference scales are useful to examine measures of inequality. The estimates indicate that about 12% of total inequality among women and men living in couple households arises from within-household inequality.

There are limitations that cannot not be addressed with the model and available data. First, the results are based on a static model. Any dynamic aspects, as for instance the transition process to retirement, cannot be captured. Individuals are either observed as being part of the labor force or as retirees. An important extension for future research would therefore be to extend the model to capture dynamics in consumption expenditures but also in retirement decisions. The LP model implicitly assumes that retirement is exogenous. Although most individuals retire during the period of one or two years around the ordinary retirement age, there is still some leeway in decision-making that is not captured by the model. Second, there is no information concerning health status in the data. However, it would be useful to investigate how parameters of interest like resource shares vary by health status.[20] Third, the HBS data does not include time-use data on home production, e.g., cooking. As emphasized by Apps and Rees (1997), these activities considerably contribute to overall consumption. Aside from these limitations, the present paper provides a first step into the analysis of the financial consequences of widowhood for elderly Swiss households.

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[20]For an application that controls for health, see e.g., Bütikofer et al. (2011).

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A Appendix

Table 10: Estimates of the 92 parameters of the main model

	Est	*Std Err*		*Est*	*Std Err*		*Est*	*Std Err*
am10	-0.106	0.645	af10	5.276	0.422	r0	0.462	0.056
am20	0.067	0.021	af20	-0.006	0.012	rh1	0.020	0.011
am30	-0.009	0.016	af30	-0.068	0.013	rm1	0.016	0.014
am40	-0.011	0.001	af40	-0.002	0.001	rm2	0.009	0.010
am50	-7.889	1.128	af50	-13.402	0.860	rm3	-0.006	0.002
am11	-0.062	0.020	af11	0.002	0.015	rf1	-0.009	0.010
am21	-0.052	0.015	af21	0.032	0.019	rf2	0.009	0.013
am31	0.008	0.002	af31	0.004	0.001	rf3	-0.001	0.001
am41	0.634	0.584	af41	3.367	0.412	dm0	-0.217	0.172
am51	-0.020	0.011	af51	0.001	0.007	dm1	-0.060	0.109
am12	-0.007	0.008	af12	-0.003	0.008	dm2	0.100	0.076
am22	0.005	0.001	af22	0.001	0.000	dm3	-0.023	0.009
am32	0.819	0.597	af32	2.410	0.413	df0	-0.214	0.135
am42	0.006	0.009	af42	0.002	0.007	df1	-0.139	0.092
am52	0.022	0.007	af52	0.013	0.008	df2	-0.013	0.113
am13	-0.001	0.001	af13	0.000	0.000	df3	-0.012	0.007
am23	6.936	0.774	af23	2.866	0.468	δm1	0.426	0.161
am33	0.006	0.011	af33	0.001	0.008	δm2	-0.327	0.136
am43	0.037	0.009	af43	0.035	0.009	δm3	-0.122	0.061
am53	-0.001	0.001	af53	-0.002	0.000	δm4	-0.036	0.032
bm1	0.245	0.171	bf1	-1.222	0.114	δm5	0.070	0.046
bm2	2.195	0.295	bf2	3.632	0.226	δf1	-0.465	0.205
bm3	-0.223	0.154	bf3	-0.942	0.112	δf2	0.275	0.166
bm4	-0.209	0.157	bf4	-0.638	0.113	δf3	0.191	0.084
bm5	-1.866	0.200	bf5	-0.736	0.128	δf4	0.069	0.046
cm1	-0.026	0.011	cf1	0.073	0.008	δf5	-0.084	0.062
cm2	-0.144	0.019	cf2	-0.237	0.015			
cm3	0.019	0.010	cf3	0.067	0.008			
cm4	0.015	0.010	cf4	0.044	0.008			
cm5	0.127	0.013	cf5	0.050	0.009			
em1	-0.297	0.115	ef1	0.136	0.060			
em2	-0.023	0.080	ef2	0.472	0.056			
em3	0.041	0.007	ef3	0.006	0.004			

Note: Indices running from 1 to 5 denote goods k in the order: Food Products and Nonalcoholic Beverages, Housing, Housekeeping, Transportation, Entertainment. Indices running from 1 to 3 denote covariate effects in the order: retirement, education, age.