

Estimating private health expenditures within a dynamic consumption allocation model

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Abstract - This paper presents a model of Belgian household consumption, with a focus on private health expenditures. To do so, we have formulated and estimated an extension of the classic Almost Ideal Demand System. The original model has been modified by introducing a dynamic adjustment mechanism and by the inclusion of demographic variables. These were expected to capture shifts in consumption patterns related to the changing age composition of the population. The results confirm the expected effects: the ageing of the population is likely to increase the share of private health expenditures (and consumer durables) in the household budget over the coming decades.

Jel Classification - C8, E24, J23

Keywords - Consumption allocation model, AIDS, private health expenditures, ageing

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1. Introduction

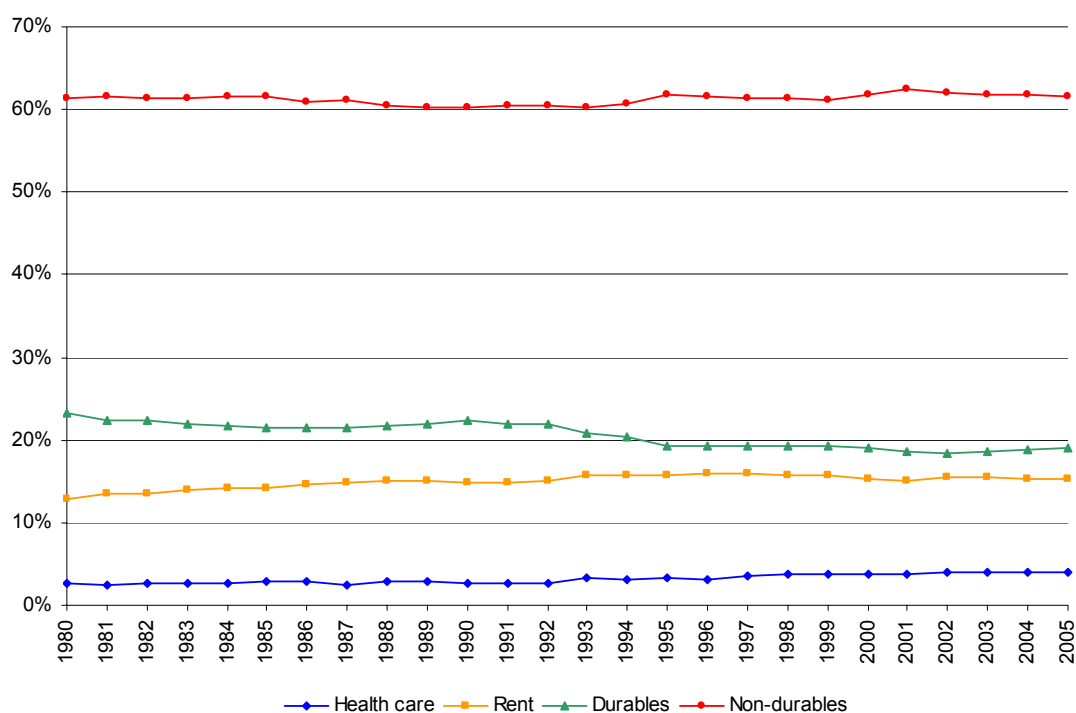
In the health economics literature, it is customary to model total (private and public) aggregate health expenditures as a function of income, demographic ageing and a host of other variables (for an overview, see Gerdtham and Jönsson, 2000). Private health expenditures are rarely modelled separately and if they are, as in Van de Voorde et al. (2001) or Cockx & Brasseur (2003), the models are often based on individual data and limited to specific medical services such as physician visits. In this paper we specify a model of aggregate private health expenditures, embedded in a generalisation of Deaton & Muellbauer's (1980) Almost Ideal Demand System (AIDS). The main advantage of specifying a complete demand system is that this is the only way to take into account the fact that all household consumption decisions, including the ones about the use of health care services, are subject to the same budget restriction. By implication, every determinant of spending on any consumption item has a potential influence on health care spending. Conversely, any determinant of health care spending is a potential determinant of spending on all or some other goods and services.

The paper is organized as follows. The next section provides a brief and mainly graphical overview of the data used to estimate the model. Section 3 presents the specification of the model. Taking the original AIDS specification as a starting point, the model is extended by introducing a dynamic adjustment mechanism and by the inclusion of demographic variables. These were expected to capture shifts in consumption patterns related to the changing age composition of the population. The estimation results, including the implied income, price and demographic elasticities, are discussed in section 4. Projections of the budget shares, obtained from simulations over the 2006-2050 period, are presented in section 5. Section 6 concludes.

2. Description of the model data

The data used to estimate the demand system in section 4 consist of total expenditures, budget shares and price indices of four aggregate consumption categories over the period 1980-2005. They are the broad aggregates Non-durables and Durables, which formed the core of the current consumption model, and Health Care and Rent, which were modelled separately (see Bracke & Meyermans, 1997)¹. The evolution of the budget shares of these aggregates is shown in Figure 1. It is worth noting that out-of-pocket health care spending remains a relatively small fraction of the total household budget, despite its rising trend over the period (from 2.5% in 1980 to 4% in 2005).

Figure 1 Budget shares of four consumption categories (1980-2005)

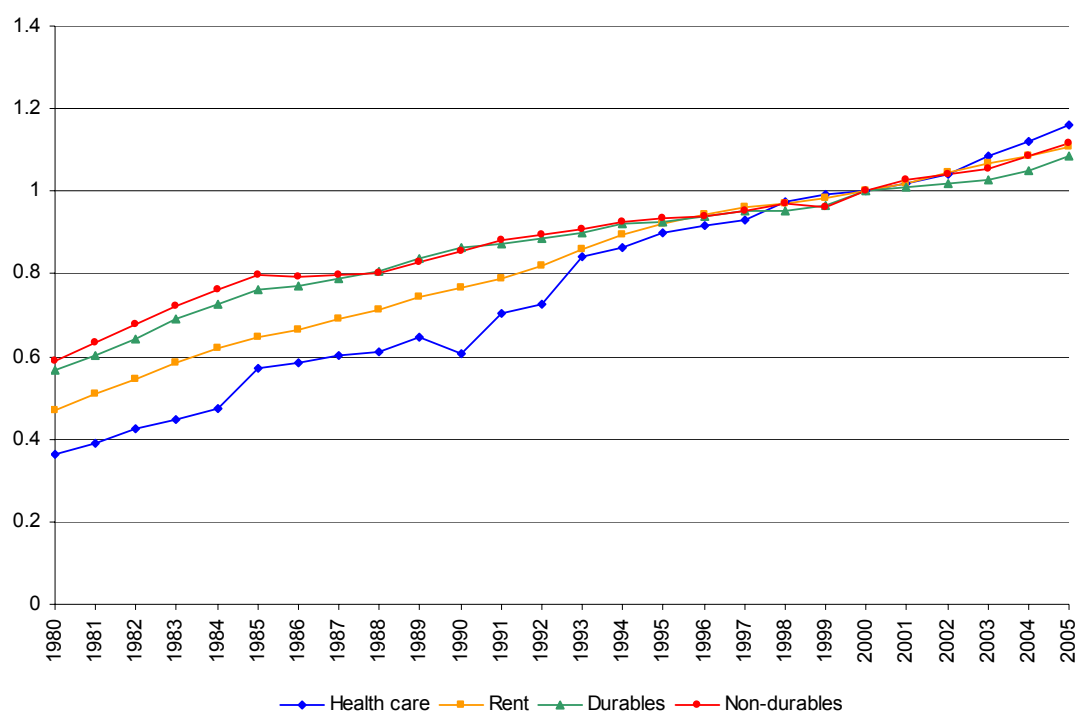


Source: FPB.

¹ The aggregates are groups of goods and services defined by the COICOP classification. Health care spending as used here corresponds with COICOP Group 6.

The price indices (base year 2000) of the four consumption categories are depicted in Figure 2. Constructing price indices for medical services is a notoriously difficult task (see Triplett, 1999). The index used here is the Belgian national accounts price index, obtained from the Belgian National Bank. The graph clearly shows the rather rapid increase in the price of private health care services relative to the prices of other goods and services.

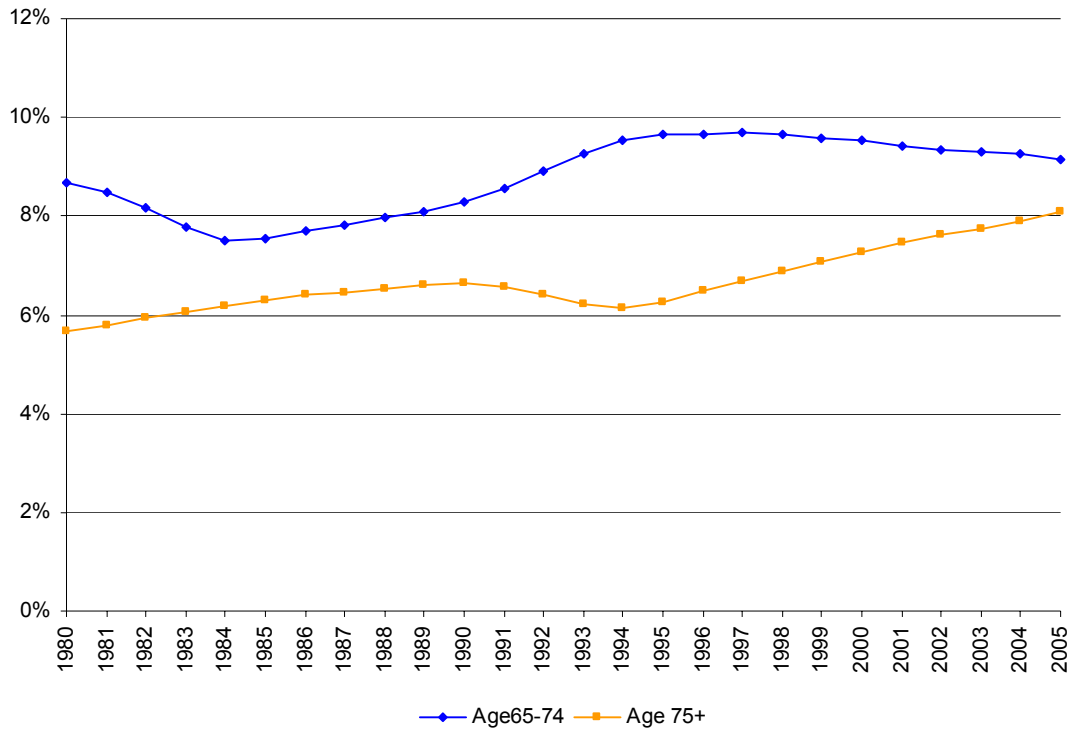
Figure 2 Price indices of four consumption categories (1980-2005)



Source: FPB.

Two demographic variables, which capture the ageing of the population, are used in the empirical model in this paper. They are defined as the population aged 65 to 74 and the population aged 75 and over, both expressed as a percentage of the total population. Their evolution over the sample period is shown in Figure 3.

Figure 3 Population aged 65-74 and 75+ as a percentage of the total population (1980-2005)



3. Specification of the consumption allocation model

3.1. The static AIDS model

One of the most widely used consumption allocation models in empirical research is the Almost Ideal Demand System (AIDS) (Deaton & Muellbauer, 1980). Its popularity stems from its generality (combining appealing features of both the Rotterdam and the translog models) and the ease with which (restrictions on) its parameters can be estimated. The demand system is specified in terms of a set of budget share equations of the following form (all variables measured in current period, observation subscripts dropped for clarity):

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln \left(\frac{X}{P} \right), \quad i = 1, \dots, n \quad (1)$$

where

$$\ln P = \alpha_0 + \sum_i \alpha_i \ln P_i + 0.5 \sum_i \sum_j \gamma_{ij} \ln P_i \ln P_j \quad (2)$$

w_i = the i -th budget share

P_i = the price of the i -th commodity

X = nominal income ².

Since the budget shares sum to unity by definition, the model parameters must satisfy the following adding-up restrictions:

$$\sum_i \alpha_i = 1 \quad \sum_i \beta_i = 0 \quad \sum_i \gamma_{ij} = 0 \quad (3)$$

Imposing these restrictions results in one equation of the system to become redundant, implying that one equation may be dropped for estimation. Uncompensated price and income elasticities can be derived from (1) and (2) fairly easily. They are listed below:

$$\epsilon_{ij} = \frac{1}{w_i} \left[\gamma_{ij} - \beta_i \left(\alpha_j + 0.5 \sum_{j=1}^n (\gamma_{ij} + \gamma_{ji}) \ln P_j \right) \right] - \delta_{ij}, \quad \delta_{ij} = 1 \text{ if } i = j, 0 \text{ otherwise} \quad (4)$$

$$\eta_i = 1 + \frac{\beta_i}{w_i} \quad (5)$$

² It is customary to refer to X as income, although the variable actually represents total expenditures on all items, i.e. disposable household income minus saving.

It should be noted that these elasticities are not constant, since they depend on the evolution of income and prices.

The theory of the rational consumer implies that demand functions are homogeneous of order zero, ensuring that a proportional change in all prices and nominal income does not affect the quantities demanded. Price effects are also expected to be symmetric. The implications of these restrictions on the elasticities are discussed in the next sections.

3.1.1. Homogeneity restrictions

Imposing homogeneity conditions on model (1) implies the following restrictions on the model parameters:

$$\sum_j \gamma_{ij} = 0 \quad (6)$$

Equations (1) and (2) change accordingly, and the price elasticities now become:

$$\varepsilon_{ij} = \frac{1}{w_i} \left[\gamma_{ij} - \beta_i \left(\alpha_j + 0.5 \sum_{j=1}^{n-1} (\gamma_{ij} + \gamma_{ji}) \ln \left(\frac{P_j}{P_n} \right) \right) \right] - \delta_{ij} \quad (7)$$

The income elasticities remain unchanged.

3.1.2. Symmetry restrictions

Symmetry of the price effects can be imposed by setting $\gamma_{ij} = \gamma_{ji}$. The uncompensated price elasticities then simplify to:

$$\varepsilon_{ij} = \frac{1}{w_i} \left[\gamma_{ij} - \beta_i \left(\alpha_j + \sum_{j=1}^{n-1} \gamma_{ij} \ln \left(\frac{P_j}{P_n} \right) \right) \right] - \delta_{ij} \quad (8)$$

Note that while the homogeneity restrictions apply to each equation separately, the symmetry restrictions are cross-equation restrictions, which can only be imposed when the share equations (1) are estimated simultaneously.

3.1.3. A linear approximation (LA-AIDS)

A disadvantage of system (1) and (2) in empirical modelling is the fact that it is nonlinear in the parameters. Deaton & Muellbauer suggest using a linear approximation to the price index (2), known as Stone's (1953) price index:

$$\ln P = \sum_i w_i \ln P_i \quad (9)$$

The approximation appears to work well when the underlying price variables are highly correlated. The obvious advantage of using (9) is that the price index becomes independent of the model parameters, and the model becomes linear. As a result, the expression for the price elasticities simplifies to:

$$\varepsilon_{ij} = \frac{1}{w_i} (\gamma_{ij} - \beta_i w_j) - \delta_{ij} \quad (10)$$

It is a well-known fact that most early empirical applications of the static AIDS model described in this paragraph have generally failed to confirm the homogeneity and symmetry restrictions, apparently refuting the underlying theoretical model of the rational consumer. This was also the case in the original application of Deaton & Muellbauer (1980), who used post-war British data to test their model. The authors offered several possible explanations for this failure, two of which have proved to be of great importance: (i) the static model implies that consumers adjust their budget allocation in the current period, while it is quite likely that expenditure on several items is relatively inflexible in the short run, implying a dynamic adjustment mechanism; (ii) the use of a ‘representative household’ assumption to ensure exact aggregation over households will be unwarranted when the distribution of household budgets and demographic structure change over time. In subsequent work these complications have led to extensions of the original model, which we discuss in the following paragraphs.

3.2. The dynamic LA-AIDS model

In their 1980 article, Deaton & Muellbauer suggest to include lagged explanatory variables to capture the sluggishness in the adjustment process to the optimal budget allocation. As a result of subsequent developments in time series methods, however, it has become customary to specify the model in terms of a general error correction model (ECM). This approach allows for short-term dynamic adjustments to suboptimal allocations (which occur because of exogenous shocks to the explanatory variables), while preserving a stable long-run relationship between the structural variables. Assuming that the dynamics of the system can be captured with an autoregressive distributed lag model of order one (ADL(1)), the i -th budget share equation in ECM-form has the following specification:

$$\Delta w_{i,t} = \alpha_i + \sum_j \gamma_{ij}^D \Delta \ln P_{j,t} + \beta_i^D \Delta \ln \left(\frac{X_t}{P_t} \right) + \lambda_i \left[w_{i,t-1} - \sum_j \gamma_{ij} \ln P_{j,t-1} - \beta_i \ln \left(\frac{X_{t-1}}{P_{t-1}} \right) \right] \quad (11)$$

where λ_i is the usual error correction adjustment parameter, and the long-term equilibrium relationship can be retrieved from the term in square brackets. Homogeneity and symmetry restrictions can be imposed as before, but it should be noted that the dynamic model allows for these restrictions to hold only in equilibrium (in the levels part of the equations). More concretely, the restrictions may be imposed (and tested) on the γ_{ij} but not on the γ_{ij}^D .

3.3. Heterogeneity in the AIDS model

As pointed out in the previous paragraph, Deaton and Muellbauer (1980) already suggested that the heterogeneity of household characteristics may have been one of the reasons behind the failure of the model to confirm the standard assumptions of microeconomic demand theory empirically. Indeed, the simple AIDS model is only a valid aggregation of underlying household demand functions under rather restrictive conditions about the distribution of household characteristics and their interaction with price and income effects (see Blundell, Pashardes & Weber, 1993). This point can be illustrated easily by considering a simple example: suppose that household spending on, for example, health care increases with the average age of its members, and that this average increases over time due to the ageing of the population. As a result, the aggregate share of health care in the budget will increase over time at given relative prices and income distribution. This uptrend in health spending is likely to be captured by the income variable, whose estimated effect will be biased upward.

Many sources of household heterogeneity are conceivable³, and it goes without saying that it is quite impossible to incorporate them all in the aggregate consumption model. Past research hints at two possible candidate variables: income inequality and demographic composition (Blundell & Stokes, 2005). The former leads to the inclusion of squared income terms, the latter to the inclusion of variables that measure aspects of household composition such as average size and age. Of these candidates, the age composition of the population appears to be a promising choice: not only is there ample evidence of a strong correlation between age and health care spending (see, e.g., European Economy, 2006), it also seems quite likely that age influences many other consumption decisions⁴.

The simplest way to introduce demographic variables in the AIDS model is in log-additive form:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln \left(\frac{X}{P} \right) + \delta_i \ln A \quad (12)$$

with the additional restriction that the δ_i parameters sum to zero. The assumption implicit in this specification is that the demographic variable(s) (denoted as A in (12)) do(es) not influence the income effect β_i . While this assumption is somewhat restrictive, it limits the number of additional parameters to be estimated, a considerable advantage when the model is estimated with annual aggregate data.

The empirical model discussed in the next section is the dynamic (ECM) version of equation (12).

³ For instance, households (and their members) differ in terms of income, educational level, and employment status, to mention only the most obvious sources of heterogeneity.

⁴ Blundell et al. (1993), for example, find significant effects for several age-related variables in their estimated equations for food and alcohol expenditure shares.

4. Estimation of the ECM-LA-AIDS model

Before a model like (12) can be estimated, a decision has to be made about the exact nature of the aggregate demographic variable(s) to be used and about which aggregates of consumption goods and services to consider. The former decision depends on the way in which demographics are assumed to play a role at the micro-level. In the empirical application that we describe in this paragraph, we will use the share of people aged between 65 and 74, and of people 75 years and older in the total population. This corresponds with a micro model in which expenditure equations contain two dummy variables corresponding to each age interval, taking the value of one when a household contains at least one member in the interval.

The decision about the consumption categories depends on the level of aggregation of the available data, and on assumptions about the separability between groups of these basic commodities. Grouping is unavoidable when more than a few basic consumption categories are available, because the number of parameters grows with the square of the number of categories. It imposes an assumption of separability of the underlying utility functions, implying that the choice between members of a group depends only on the relative prices of the group members and on total group expenditures, but not on prices of members of other groups.

In the empirical work presented in the following sections, we consider four broad aggregates: health care, rents, other nondurable goods and services, and consumer durables. The latter category is rather unusual in applied consumption allocation models, which are usually (but not always) restricted to nondurable consumption spending. This exclusion of durables may be based on the assumption that their consumption depends on different factors than the demand for nondurable goods and services. While this may be true to some extent, proceeding without durables amounts to little more than assuming separability between durables and non-durables. In the end, the demand for both aggregates must be modelled as a constrained utility maximization problem subject to the same budget restriction. Following this line of reasoning, we have initially estimated a hierarchical two-step model with the allocation of the total budget between durables and non-durables estimated in the first step, and spending on non-durables allocated to health care, rents and other nondurable goods and services in the second step. As this approach resulted in rather unrealistic implied income and price elasticities for the durables, presumably because of the lumping together of very heterogeneous consumption categories in the broad 'non-durables' aggregate, we have proceeded by estimating the allocation system with the four aggregates on one level.

To estimate the AIDS model described in the previous sections, we have followed a 'general-to-specific' modelling strategy as advocated by David Hendry and others (see for example, Charemza & Deadman, 1992). Taking the general dynamic AIDS model as the starting point (the

'maintained hypothesis'), we have tested the validity of the following sequence of simplifying restrictions on the model parameters:

- using the linear approximation to the overall price index;
- homogeneity of the demand equations;
- symmetry of the cross-price effects;
- exclusion of non-significant effects.

These restrictions, except the first one, lead to simpler models which are nested in the more general specifications that precede them, so they can be tested with the familiar likelihood ratio (LR) test. The linear price index model, however, cannot be derived from the nonlinear one by imposing restrictions on the latter, nor can both models be conceived as special cases of a common 'parent' model, so neither the LR test nor Hausman's J-test can be used to test the linear approximation. Consequently, either another non-nested formal test should be carried out (such as Vuong's test, 1989; see Greene 2008), or the validity of the approximation should be judged more informally from the estimated log-likelihoods of the alternative models. Before we present the results of these tests, a final observation is in order. The linear approximation based on the Stone price index, while being the specification commonly used in applied work, is by no means the only possible one. Indeed, recent work (Ogura, 2006) suggests that the Paassche price index may perform just as well, or possibly even better, than the Stone index.

The results of the tests of the restrictions listed above are presented in Table 1.

Table 1 Likelihood ratio tests of restrictions on the general AIDS model

Model	LogL	LR statistic (against previous model)	Chi-sq df	p-value	LR statistic (against general linear model)	Chi-sq df	p-value
General ECM-AIDS	440.34	-	-	-	-	-	-
General ECM-LA-AIDS	439.47	-	-	-	-	-	-
Stone index							
Homogeneity	412.71	53.52	6	0.00	53.52	6	0.00
Symmetry	408.43	8.58	6	0.20	62.09	12	0.00
Exclusion	407.77	1.31	7	0.99	63.40	19	0.00

The values of the log-likelihood functions of the general and the linear models suggest that using the Stone index hardly affects the model's fit to the data. Similar results were obtained with the Paassche index. Imposing homogeneity, unfortunately, is strongly rejected by the data, while subsequently adding symmetry and exclusion restrictions does not deteriorate the results any further. The rejection of the homogeneity restriction (even when it is imposed only on the long-run parameters) is a disturbing but not uncommon finding in applied work, as explained above. While this result is hard to reconcile with rational consumer behaviour, it should be noted that a host of other reasons can be responsible for it. First, there may be sources of heterogeneity at the individual household level that cause shifts in aggregate consumer spending that

are not captured by the demographic variables. Second, the historical data used may be of poor quality. For instance, the data predating 1995, when the Belgian national accounts have been drawn up according to the new ESR standard, can be suspected to be less reliable than the subsequent data. Finally, and maybe more importantly, the current definition of the four consumption categories may be inadequate. The 'durable' goods, for instance, contain items which are not strictly durable, but rather complementary to actual durables (like gasoline). Redefining the aggregates is a potential remedy to the homogeneity problem which we envisage to undertake in future research. For the time being, we will stick to the current definition, with the homogeneity restriction imposed on the model parameters.

The estimation results of the restricted model are presented in the following tables. Table 2 contains the overall results per equation. The implied own and cross-price elasticities are listed in Table 3. Table 4 presents the income and demographic elasticities.

Table 2 Estimation results for the restricted ECM-LA-AIDS model

Equation 1: Health care		Equation 2: Rent		Equation 3: Non-durables	
α_1	-0.0904 c	α_2	0	α_3	1.27208 ^a
γ_{11}^D	0.020551 a	γ_{12}^D	0.017555 a	γ_{13}^D	0
γ_{12}^D	0.017555 a	γ_{22}^D	0.126431 a	γ_{23}^D	-0.09772 ^a
γ_{13}^D	0	γ_{23}^D	-0.09772 a	γ_{33}^D	0.19386 ^a
β_1^D	0	β_2^D	-0.07993 a	β_3^D	0
δ_1^D (65-74)	-0.05378 a	δ_2^D (65-74)	0	δ_3^D (65-74)	0
δ_1^D (75+)	0	δ_2^D (75+)	-0.05958 a	δ_3^D (75+)	0.184878 ^a
λ_1	-0.88232 a	λ_2	-0.92839 a	λ_3	-0.60362 ^a
γ_{11}	0.018694 a	γ_{12}	0.025967 a	γ_{13}	0
γ_{12}	0.025967 a	γ_{22}	0.136758 a	γ_{23}	-0.15224 ^a
γ_{13}	0	γ_{23}	-0.15224 a	γ_{33}	0.17092 ^a
β_1	-0.01738 c	β_2	-0.05718 a	β_3	0.146334 ^a
δ_1 (65-74)	0	δ_2 (65-74)	-0.03845 a	δ_3 (65-74)	-0.03363 ^b
δ_1 (75+)	0.024087 a	δ_2 (75+)	-7.89E-03 a	δ_3 (75+)	-0.09904 ^a
R ²	0.663	R ²	0.950	R ²	0.74
DW	2.55	DW	1.86	DW	1.75

a, b and c superscripts refer to 1%, 5% and 10% significance levels respectively (two-sided tests).

Table 3 Estimated own and cross-price elasticities (2005)

	P ₁	P ₂	P ₃	P ₄
P ₁ (Health care)	-0.453 ^b	0.808 ^a	0.303 ^c	-1.167 ^a
P ₂ (Rent)	0.200 ^a	0.028	-0.826 ^a	0.003
P ₃ (Non-durables)	-0.016 ^a	-0.469 ^a	-1.702 ^a	-0.125
P ₄ (Durables)	-0.231 ^a	0.070	0.359	-1.326 ^a

a, b and c superscripts refer to 1%, 5% and 10% significance levels respectively (two-sided tests).

The price elasticities in the AIDS model depend on the values of the budget shares. The values reported in Table 3 were computed using the long-run parameters and the 2005 values of the budget shares. Their standard errors were estimated with the ‘delta’ method (Greene, 2006) ⁵. The results are plausible: the own price elasticities are significantly negative for health, non-durables and durables, and essentially zero for rents. Note that health care consumption is price inelastic, as expected, while demand for durables and non-durables is price elastic. The price elasticity of private health care demand is higher in absolute value than the figure reported by Cockx & Basseur (2003) (around -0.08 on average for men and women) and by Van de Voorde et al. (2001) (-0.39 to -0.28 for GP home visits, -0.16 to -0.12 for GP office visits and -0.10 for specialist visits). It should be noted, however, that these elasticities apply only to GP and specialist visits. Our estimates are comparable to those obtained by Newhouse (1993) for outpatient services in the U.S. (-0.31).

Table 4 Estimated income elasticities (2005)

	Health	Rents	Non-durables	Durables
Income elasticity	0.509 ^c	0.596 ^a	1.393 ^a	0.155

a, b and c superscripts refer to 1%, 5% and 10% significance levels respectively.

The income elasticities, again evaluated at the 2005 values for the budget shares, are positive and significant, except for the durables. The rather low income elasticities for health and rents seem plausible, while the results for durables (income inelastic) and (other) non-durables (income elastic) are somewhat counterintuitive. The complete income inelasticity of durables is probably the most unexpected result. A possible explanation is again the definition of the aggregate, but this remains to be investigated.

Table 5 Estimated demographic elasticities (2005)

	Health	Rents	Non-durables	Durables
Age 65-74	0	-0.272 ^a	-0.034 ^c	0.509 ^a
Age 75+	0.680 ^a	-0.056 ^a	-0.266 ^a	0.761 ^a

a, b and c superscripts refer to 1%, 5% and 10% significance levels respectively.

The elasticities with respect to the demographic variables confirm a priori expectations: a growing share of elderly people in the population leads to increased consumption of private health services (only for the 75+ group) and durables, and a decrease for rents and non-durables. It is possible, of course, that the age 75+ variable captures a pure age effect, a ‘proximity-to-death’ effect, or both. This cannot be inferred from the results (see Zweifel et al., 1999).

⁵ The delta method is a convenient way to estimate standard errors of nonlinear functions of model parameters. It is based on a first-order Taylor expansion of the nonlinear function in a neighbourhood of the estimated parameter values.

5. Projections of expenditure shares 2006-2050

The consumption allocation model described in this paper is meant to be integrated in the HERMES model, a model developed and used at the FPB to make medium-term macroeconomic projections of the Belgian economy. While the primary focus of HERMES is on the medium term, with projections to 2012 (and sometimes to 2020), we will extend the simulation horizon in this paper to 2050 for several reasons ⁶. First, a long simulation period provides a check that the model is well-behaved, i.e. that it does not produce nonsensical results. Second, given reasonable assumptions about the exogenous variables, the model in principle offers a plausible estimate of future private health spending as a share of the household budget. Third, a long-run simulation is best suited to assess the impact of demographic ageing on the budget allocation decision.

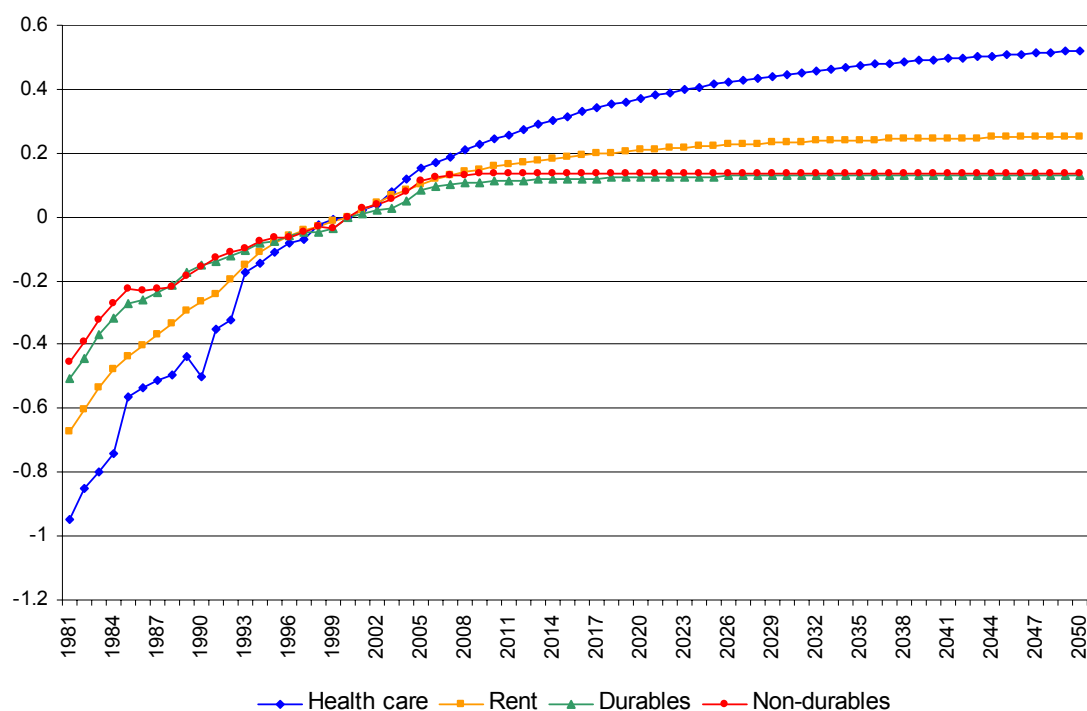
5.1. Assumptions about the future evolution of the exogenous model variables

The simulations reported in the next sections are based on extrapolations of the budget and price variables, and on available demographic projections. The latter are assumed to be reliable forecasts, and are used throughout the simulations. The future values of the household budget were either kept constant, or allowed to grow at a constant real growth rate based on the projected long-run growth of GDP per capita implied by the MALTESE model (1.675 percent per year). Prices were either kept constant, or obtained from second-order autoregressive models estimated over the 1981-2005 period. The projected prices obtained from these autoregressive models are shown in Figure 4.

In the next sections we will discuss three different scenarios, based on combinations of assumptions about the future evolution of budget and prices:

- The base scenario: average real budget growth of 1.675%, autoregressive extrapolation of prices;
- The demographic scenario: constant real budget and prices;
- The income scenario: average real budget growth of 1.675%, constant prices.

⁶ The results reported here are obtained from simulations with the allocation model alone, not with the complete HERMES model.

Figure 4 Observed and extrapolated log price indices of four consumption categories (1980-2050)

5.2. Simulation results 2006-2050, base simulation

The simulated budget shares are presented in Table 6 and Figure 5. The projected budget shares extend the trends observed over the historical period to some extent, but not entirely. Indeed, the ageing of the population, which is expected to become most important between 2020 and 2040, exerts a noticeable influence on the projected consumption allocation pattern.

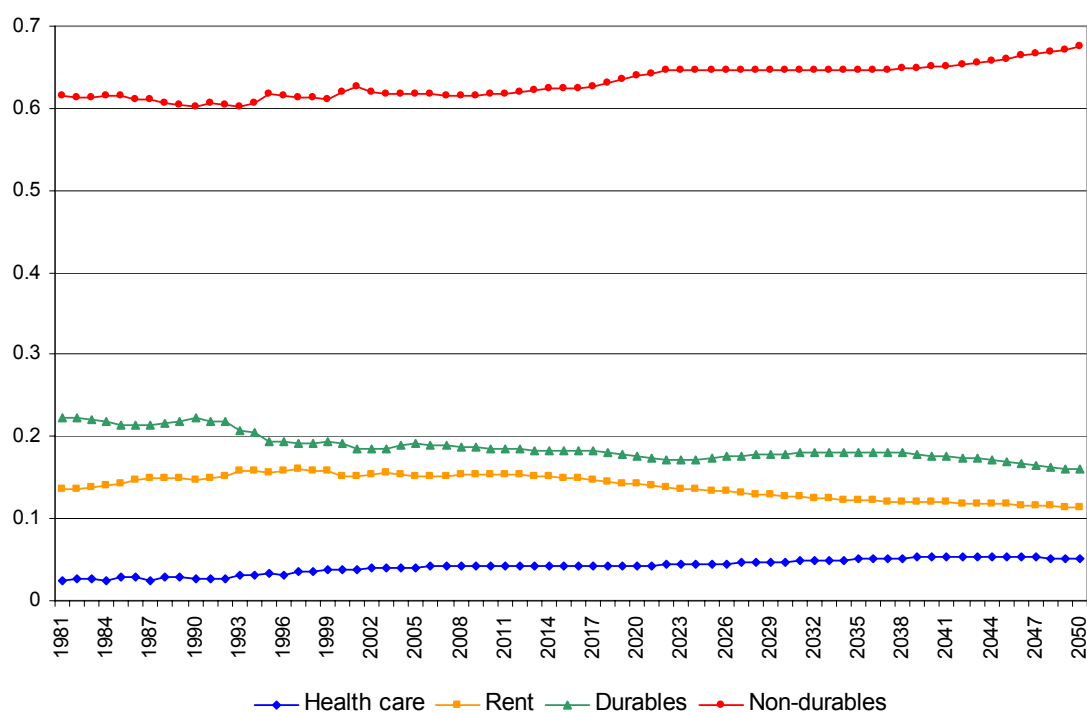
Table 6 Observed and simulated budget shares for selected years, base simulation (1980-2050)

	Health care	Rent	Durables	Non-durables
1980	2.62	12.86	23.17	61.34
1990	2.69	14.76	22.38	60.17
2000	3.80	15.23	19.08	61.89
2010	4.37	15.75	19.01	60.87
2020	4.45	14.83	19.07	61.64
2030	4.99	13.52	19.90	61.59
2040	5.56	12.76	19.83	61.86
2050	5.41	12.19	18.08	64.33

In the case of health care spending, the low income elasticity is compensated by the demographic effect, leading to a maximum budget share of around 5.6% in 2040. The expected decline of the population aged 65-74 from 2030 on, and the end of the growth of the share of the 75+ age group near the end of the simulation period explain the subsequent decrease. For Rents, the low income elasticity combined with a negative demographic elasticity results in a steady decline after 2010. Spending on durables also declines as a percentage of the total budget due to its very low income elasticity, although the trend is tempered by the positive demographic effect. The reverse is true for non-durables, the share of which increases as a result of the high income elasticity and despite the mildly negative demographic effect.

The results obtained in this simulation obviously contain a mix of sometimes compensating effects of the exogenous variables on the budget shares. In the following sections we keep some of these variables constant, in order to gain insight into their separate effects.

Figure 5 Observed and simulated budget shares of four consumption categories, base simulation (1980-2050)



5.3. Simulation results 2006-2050, demographic simulation

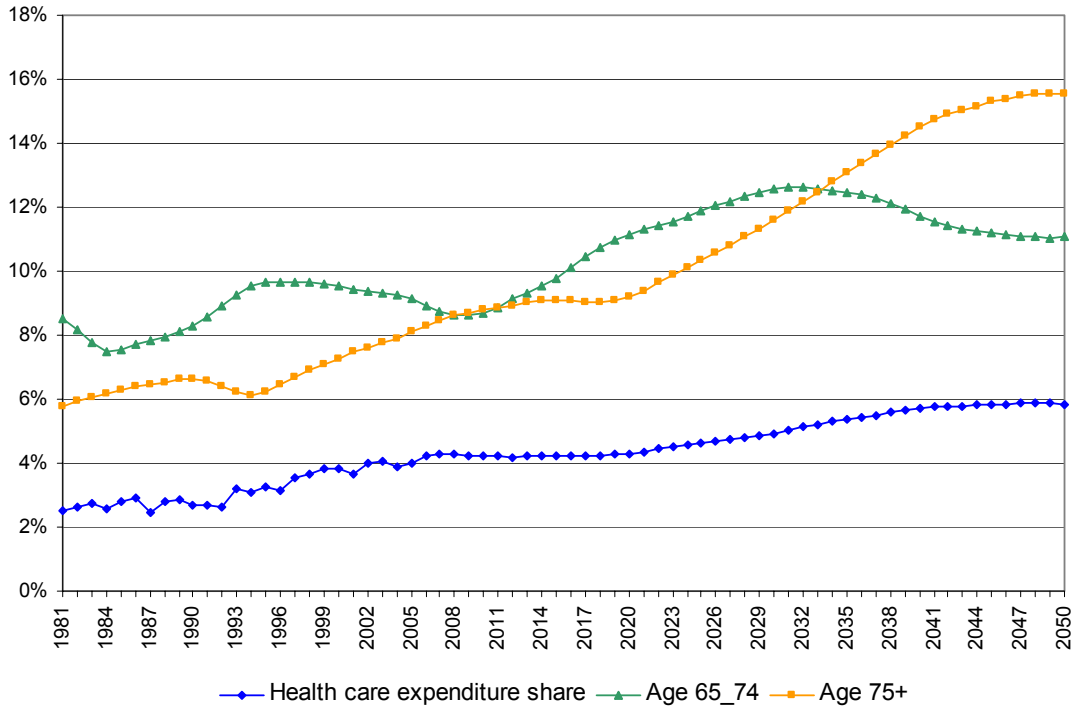
The demographic scenario isolates the effect of the expected demographic evolution, as measured by the share of the population aged 65-74 and 75+, on the budget shares. The results in Table 7 show that in the absence of income growth and at constant prices, the share of private health expenditures in the household budget would increase from around 4 percent in 2005 to almost 6 percent in 2050. This is higher than in the base scenario, mainly because the low income elasticity of health spending is prevented to exert its downward pressure on the health expenditure share. However, the main effect of keeping income constant is on the allocation between durables and non-durables: since consumption of durables was estimated to be income inelastic, and non-durable consumption income elastic, keeping the total budget constant causes a substantial shift from non-durable to durable goods.

Table 7 Observed and simulated budget shares for selected years, demographic simulation (1980-2050)

	Health care	Rent	Durables	Non-durables
1980	2.62	12.86	23.17	61.34
1990	2.69	14.76	22.38	60.17
2000	3.80	15.23	19.08	61.89
2010	4.25	15.54	19.68	60.53
2020	4.29	14.51	22.78	58.43
2030	4.94	13.69	26.67	54.70
2040	5.73	13.70	29.62	50.95
2050	5.85	14.08	30.87	49.20

The relationship between health spending and the age composition of the population is illustrated in Figure 6. The projected share of private health expenditures remains stable until 2020, increases steadily until 2040, and stabilizes again afterwards. This evolution corresponds to the three demographic phases which are apparent from the graph: the declining share of the 65-74 age group compensates for the increasing share of the 75+ age group in the period 2006-2020. Between 2020 and 2040 both age groups increase in relative size, resulting in an accelerating ageing of the population. After 2035 the share of the 65-74 group declines again, while the share of the population aged 75 and older levels off by the end of the simulation period.

Figure 6 Simulated health spending share and projected ageing variables, demographic scenario (1980-2050)



5.4. Simulation results 2006-2050, income simulation

The income scenario adds the effect of real income growth (translated into household budget) to the effect of a changing age composition of the population. This changes the simulated budget shares substantially, since the four consumption categories have quite different estimated income elasticities. Most notable are the low income elasticities of spending on health care and durables, which put downward pressure on their projected expenditures shares. Indeed, as shown in Table 8, the share of private health care in the household budget is projected to be around 4.4 percent in 2050. This compares with 5.85 percent in the demographic scenario, and 5.41 percent in the base scenario. The higher budget share in the base scenario can be explained by the effect of rising relative prices of health care services, combined with a low price elasticity. The income effect also accounts for the substantial differences in projected durable (66.7% versus 49.2% in 2050) and nondurable (19.5% versus 30.9% in 2050) expenditure shares between the income and the demographic scenario.

Table 8 Observed and simulated budget shares for selected years, income simulation (1980-2050)

	Health care	Rent	Durables	Non-durables
1980	2.62	12.86	23.17	61.34
1990	2.69	14.76	22.38	60.17
2000	3.80	15.23	19.08	61.89
2010	4.13	15.00	18.99	61.88
2020	3.84	12.95	19.41	63.80
2030	4.17	11.10	20.63	64.10
2040	4.64	10.09	20.90	64.37
2050	4.44	9.44	19.47	66.65

6. Conclusion

In this paper we have used an extended version of Deaton and Muellbauer's Almost Ideal Demand System to model the allocation of the household budget using Belgian data over the 1981-2005 period. The original static model was modified in two important ways. It was made dynamic using the familiar error correction formulation of a first-order autoregressive specification, and the usual determinants of the budget allocation decision (the total real budget and relative prices) were appended with demographic variables that capture the age-related heterogeneity of household consumption patterns. Despite these extensions, parameter restrictions derived from the theory of consumer behaviour (notably homogeneity and symmetry) were rejected by the data. One possible explanation is that the aggregates studied (which were taken from the existing consumption allocation model) were ill-defined. In subsequent work, we intend to study whether other aggregation schemes of basic goods and services lead to models that are more consistent with consumer theory.

With the restrictions imposed, the model still produces acceptable results: all own price elasticities are significantly negative, except for Rent (which is quasi zero). The income elasticities are all positive as expected, but not significantly so for Durables. The elasticities with respect to the demographic variables are positive for Health Care and Durables and negative for Rent and Non-durables. As a consequence, the projected evolution of the share of the elderly in the population over the coming decades pushes up the projected share of private health expenditures in the household budget from 4.2% in 2005 to 5.4% in 2040 in the base simulation. The health budget share declines again subsequently, following the decline in the share of the population aged between 65 and 74, and the levelling off of the 75+ share.

While the ageing of the population is an important determinant of the projected future household budget allocation, the dominant variable is the total budget. Alternative simulations, in which income and/or relative prices are kept constant, illustrate that the differences in income elasticity between the four aggregates drive their projected expenditure shares.

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