Development of Scenarios for Health and Long-term Care Expenditure in the European Union Member States[*]

Ehsan Khoman and Martin Weale
National Institute of Economic and Social Research
2, Dean Trench Street, London SW1P 3HE

8th October 2007

Abstract

Over the next fifty years, the size and age structure of Europe's population will experience major changes due to low fertility rates, continuous increases in life expectancy due to medical advances and the retirement of the baby boom generation. The main output of this work package is a model which allows the construction of scenarios for health and long-term care expenditure based on the premise that health spending is driven by a number of demographic, economic, social and institutional variables. The projections computed in this study are not forecasts but are instead intended to provide an indication on the potential timing and scale of budgetary challenges that could result from Europe's ageing population.

---

[*] This is the final report of work package 8 of the Ageing, Health Status and Determinants of Health Expenditure (AHEAD) Project, undertaken by the National Institute of Economic and Social Research, under the EC 6th Research Framework Programme.

CONTENTS

Appendices

Appendix B: Country Reports

1. Introduction

One main characteristic of the European Union (EU) member states is the growing share of health and long-term care expenditure in GDP. In consequence, to control, and as much as possible to limit, the increase of those expenditure has become a major issue of European governments. In order to do so, we need to know what the main determinants of health and long-term care expenditure are and what their impact is. In effect, health and long-term care expenditure is usually explained by either a demand or a supply approach. In the former, health and long-term care expenditure depends on the level of GDP per capita and the relative price of health and long-term care, whilst, in the latter, health and long-term care spending depends on technical progress and the general behaviour of medical practitioners through induced demand. Throughout this report the term health care expenditure includes expenditure on long-term care unless explicitly stated that it does not.

Public expenditure on health care comprises a large part of government budgets. Overall health spending, including long-term care for the elderly, already accounts for around 9% of GDP in the EU countries (European Commission, 2006). There is also a question mark over how much funding will be available in the future, given an expected slowdown in GDP growth as the progressive decline in fertility rates since the late 1960s has caused labour supply to expand more slowly. How much health care expenditure might increase is difficult to say as there are numerous factors at play whose impact is quite uncertain. Past studies provide only limited guidance. Key factors that might explain rising expenditure appear to have been rapid introduction of new technologies, and higher demand for health care, itself a reflection of rising incomes and a more educated public. Calculating exactly how much spending will be needed, who will provide it, and the best way to spend it, is as complex a task as it is urgent.

Many EU member states are concerned about the financial sustainability and the efficiency of their national health care systems. They share the collective challenge of discovering ways to deal with issues like the increase of the ageing population, the emergence of new and costly medical innovations, and the public’s growing outlook regarding the quality and availability of health care. The affordability of health care is indeed at great risk.

The main output of this work package is a model built from the results of the earlier work packages in combination, and used to construct scenarios for health care expenditure in the EU. The underlying modelling framework is embedded in a series of EXCEL spreadsheets for subsequent use by policymakers. This makes it possible to explore the implications of changes either to parameters of the model or to underlying drivers such as demographic projections.

2. Data and Methodology

The model is macroeconomic in form and represents the demand and supply side jointly, incorporating factors such demographic variables and the importance of the public sector. The baseline of our calculations is provided by Christiansen *et. al* (2006) who investigate the relationship between ageing and aggregate health care expenditure in the EU countries. We have essentially taken their model and re-estimated it in a form which is convenient for incorporation into a spreadsheet model. Our analysis relates to thirteen "old" EU countries (the EU-15 excluding Greece and Luxemburg) because data for the newer members were not available for long enough for satisfactory estimation to be possible.

2.1 Data

Following from Christiansen *et. al* (2006) the data used in this paper are a balanced panel dataset that covers 13 of the old EU member states (excluding Greece and Luxemburg). We refer to the results as relating to the EU15. The panel spans over a time period of 24 years (1980-2003).[1]

The dependent variable used in this paper is the natural logarithm of total health care expenditure per capita (*THEPC*) measured in US dollars in nominal prices and adjusted for both purchasing power parities (PPP) and inflation. Christiansen *et. al* (2006) make use of data collected from the OECD Health Data 2004 for OECD countries and data from the WHO (European health for all databases, WHO Regional

---

[1] At an early state an attempt was made to estimate a similar model for new and prospective member states but the data were not of suitable quality.

Office for Europe, Copenhagen, Denmark) for non-OECD countries[2]. The OECD's measure of health care expenditure includes important parts of long-term care.

Table 1 Data and Data Sources

Variable	Description	Data Source
THEPC	Total health care expenditure per capita, US$ in nominal prices and adjusted for PPP (in logs).	OECD/WHO
GDPPC	Gross domestic product per capita, US$ in nominal prices and adjusted for PPP (in logs).	OECD
AGE65-74	Population aged 65-74 as a share of the total population.	Eurostat
AGE75+	Population aged 75+ as a share of the total population.	Eurostat
ALE	Average of Life expectancy at aged 65 for males and females.	WHO
FLFPR	Female labour force participation rate (% ratio to active population aged 15-65).	OECD
UNEMP	Unemployed individuals as a share of the total labour force.	OECD
ALCCON	Alcohol consumption, litres per capita (15+) (in logs).	OECD/WHO
MORTALITY	Number of registered deaths/mid-year population (per 100) (in logs).	WHO
PUHES	Public health expenditure in US$ PPP per capita as a share of the total health expenditure in US$ PPP per capita.	OECD/WHO
SALARYGP	Dummy variable for countries with salaried GPs.	Christiansen *et. al* (2006)
CAPGP	Dummy variable for countries with capitation payment GPs.	Christiansen *et. al* (2006)
CASEHO	Dummy variable for countries with case-based reimbursement of hospitals.	Christiansen *et. al* (2006)
COPAYGP	Dummy variable for countries with significant co-payment for GPs.	Christiansen *et. al* (2006)
COPAYHO	Dummy variable for countries with significant co-payment for inpatient hospital treatment.	Christiansen *et. al* (2006)
FREEGP	Dummy variable for countries with free choice of GP or primary care physician.	Christiansen *et. al* (2006)
FREEHO	Dummy variable for countries with overall ceiling of hospitals.	Christiansen *et. al* (2006)
BEDS	Acute care beds per 1,000 inhabitants (in logs).	OECD/WHO

The explanatory variables can be grouped into 3 broad categories. The first group includes the economic variable, the natural logarithm of GDP per capita (*GDPPC*), a behavioural variable (alcohol consumption[3]) and two social variables (female labour force participation and unemployment rate). The age structure variables, life expectancy and mortality rates are included as demographic variables. The mortality rate was included to account for the recent arguments made in the literature that health care spending is more related to the nearness of death than to age (Zweifel *et. al*, 1999; Seshamani and Gray, 2004a; Seshamani and Gray, 2004b). Studies overseas using unit record data have shown than one-quarter or more of lifetime health care

---

[2] More extensive descriptive statistics are reported in work package 6, Part A, see (Schulz, 2005).

[3] We had hoped to include tobacco consumption as well but the data did not seem to be reliable.

expenditure may be consumed, on average, in the last year of life (Miller, 2001; Yang *et. al*, 2003).

The second group includes characteristics of each country’s health care system in the period for which data has been collected. This list includes variables that describe institutional factors assumed to affect utilisation. This second group of institutional variables is included to catch incentives and regulatory factors on the supply side.

Finally, the number of hospital beds reflects a variable which is generally believed to be an important determinant of costs.

2.2 The problem in making cross-country projections

The projections are in general made on the basis of ‘no policy change’, in that they reflect only existing legislation and not possible future policy changes. While these projections can point to key drivers of health care spending, it needs to be noted that they cannot completely model the specific institutional arrangements and policies which exist at the national level. A certain level of caution must be exercised when interpreting the long-run projections and the degree of uncertainty increases the further into the future the projections go.

3. The Model

Since the seminal paper by Newhouse (1977), it has been widely debated whether health care expenditures are a luxury good. Although over time the original empirical model by Newhouse has been improved in several directions in order to obtain a more realistic model, after three decades, the main result that emerges from these studies is that aggregate income appears to be the most important factor explaining health expenditure. Where disagreement occurs, is on the question of whether health care expenditure is either a luxury or a necessary good, i.e. on whether the income elasticity of demand is above or below one.

3.1 Panel unit root tests

Firstly, we check so see if there are unit roots for health care expenditure and the other explanatory variables in our model. Along with the standard augmented Dickey-Fuller (ADF) test (1979) and the Im, Pesaran and Shin (2003) test, **Error! Reference source**

not found. presents four other panel data unit root tests that have been performed for all the variables in question for the EU15. The optimal lag length is selected using the Bartlett kernel and the automatic bandwidth parameter suggested by Newey and West (1994).

The results show that we cannot reject the null hypothesis of the presence of a unit root for health care expenditure and GDP per capita. This hypothesis is only rejected for the female labour force participation rate (*FLFPR*) for the EU15 countries.

Table 2 Panel Unit Root Tests for the EU15

Variable	Lag Order	Levin, Lin and Chu[a] (2002)	Breitung[b] (2000, 2002)	Im, Pesaran and Shin[c] (2003)	Augmented Dickey-Fuller[d] (1979)	Phillips and Perron[e] (1988)	Hadri[f] (2000)
THEPC	6	6.8393	-2.1523	-0.7470	24.1278	251.1278	2.8618
p-value		(1.0000)	(0.0157)	(0.2275)	(0.2275)	(0.0000)	(0.0021)
GDPPC	6	5.8171	-4.1700	-2.1002	38.2773	154.504	0.5577
p-value		(1.0000)	(0.0000)	(0.0179)	(0.1428)	(0.0000)	(0.2885)
AGE65_74	6	4.3733	-2.4932	-0.3544	25.3944	32.6828	2.0804
p-value		(1.0000)	(0.0063)	(0.3615)	(0.7056)	(0.3365)	(0.0187)
AGE75_	6	3.8639	-1.7226	-0.8477	24.1797	48.4834	-0.0752
p-value		(0.9999)	(0.0425)	(0.1983)	(0.7638)	(0.0177)	(0.5300)
ALE	6	3.0061	-1.7951	-1.3904	34.1273	934.556	4.4105
p-value		(0.9987)	(0.0363)	(0.0822)	(0.2758)	(0.0000)	(0.0000)
FLFPR	6	2.3024	-2.2114	-1.7238	29.7737	573.939	3.0968
p-value		(0.9893)	(0.0135)	(0.0424)	(0.2771)	(0.0000)	(0.0010)
UNEMP	6	3.3033	-4.0794	-3.6606	55.1869	350.331	1.0309
p-value		(0.9995)	(0.0000)	(0.0001)	(0.0034)	(0.0000)	(0.1513)
ALCCON	6	3.7001	-3.4188	-0.9583	29.0145	264.818	7.1720
p-value		(0.9999)	(0.0003)	(0.1690)	(0.5168)	(0.0000)	(0.0000)
PUHES	6	5.8974	-1.7204	-0.2598	20.9425	304.899	3.1054
p-value		(1.0000)	(0.0427)	(0.3975)	(0.8897)	(0.0000)	(0.0010)
BEDS	6	11.2182	-1.0813	-0.3283	2.7560	26.8064	-1.4385
p-value		(1.0000)	(0.1398)	(0.3713)	(0.5995)	(0.0000)	(0.9249)
MORTALITY	6	7.2338	-3.5880	-0.5334	27.3345	982.770	4.2770
p-value		(1.0000)	(0.0002)	(0.2969)	(0.6057)	(0.0000)	(0.0000)

Note: Panel unit root tests a, b, c, d and e all assume a null hypothesis of a common unit root process. Test f is the only test that assumes a null hypothesis of no unit root.

3.1 The Co-integration Rank

The presence of unit root variables inevitably mean that we have to consider how many co-integrating vectors may be present in the model. We do this in the context set out by Breitung (2005). He suggests that the co-integrating vectors can be estimated first of all applying the first stage of Johansen's (1988) approach to each member of the panel separately. This allows the data to be purged of dynamic effects and the co-integrating vectors can be estimated by means of a pooled regression based on exactly the same derived variables as is used in Johansen’s approach. He then sets out a test which, given an initial assumption about the number of co-integrating vectors, tests for the significance of at least one extra co-integrating vector. The test is based on orthogonal complements as suggested by Saikonnen (1999). It relies on the fact that, if the rank of the co-integration matrix is sufficient, then linear combinations of the co-integration variables calculated using the orthogonal complement of the assumed co-integrating vector should have no explanatory power in the pooled regression.

With twelve variables apart from the dummies and a short annual series there is a pragmatic question about how to explore the rank of the co-intergrating space. Breitung presents test statistics for co-integrating spaces of up to rank 6 against alternatives of lower rank. The test statistics present mixed messages. GDP per capita is generally believed to be *I(1)* and it would therefore be surprising if health spending were not. Morality rates by age are also often thought to follow *I(1)* processes (Lee and Miller, 2001), and one would therefore expect average life expectancy to be so. For the same reasons we include the population shares aged 65-74 and aged 75+ in the group of variables amongst which we explore co-integration. Finally, we consider also the share of public health expenditure relative to total health care expenditure. This gives us six variables with a maximum of five co-integrating relationships, allowing Breitung’s test to establish whether we can accept the hypothesis that there is no more than one co-integrating relationship between the two. If there is no more than one such relationship we can use standard methods for estimating dynamic equations in panels, with the statistically significant present of lagged variables in levels indicating co-integration. This gives a test statistic of $\lambda = 86.35$ where, with N the number of panel elements and T the sample size, the distribution of

$$\sqrt{N}\,\frac{\lambda-76.94}{119.7} \sim \underset{N\rightarrow\infty}{\overset{Lt}{T\rightarrow\infty}}\; N(0,1)$$

tests the hypothesis that there are *k-5* co-integrating vectors against the null of *k-1*. It is plain that the hypothesis is easily accepted, and we proceed on the assumption that there is at most one co-integrating vector linking the variables in levels.

3.2 Estimation

It has been known for many years that estimation of panel models with lagged dependent variables is subject to biases (Nickell, 1982). One popular means of dealing with this problem is to use the estimation methods described by Arellano and Bond (1991) and Arellano and Bover (1995) using dynamic generalised method of moments (GMM). However, as Nickell shows, the biases fall off rapidly as the sample size increases. For our sample size of over twenty observations it is by no means clear that Arellano and Bond's method is better than more conventional generalised least squares. We did experiment with both methods and found it difficult to identify satisfactory instruments for use with Arellano and Bons' method. Accordingly we have instead relied on generalised least squares estimation with country fixed effects.

We consider the simple autoregressive model

$$THEPC_{it} = \delta THEPC_{i,t-1} + x'_{it}\beta + u_{it} \quad i = 1,...,N;\ t = 1,...,T \tag{1}$$

where x_{it} is a $K \times N$ matrix of covariates, β a $1 \times K$ vector of regression slopes and $u_{it} = \mu_i + \upsilon_{it}$ with $\mu_i \sim \left(0, \sigma_\mu^2\right)$ and $\upsilon_{it} \sim \left(0, \sigma_\upsilon^2\right)$, independent and identically distributed (i.i.d) over the panels. With the hypothesis of a single co-integrating vector accepted we have, provided that the covariates include both current and lagged values of the *I(1)* variables, a satisfactory means of estimating the dynamic relationship.

3.3 Least-squares restriction

From the unrestricted equation we can use least-squares methods to explore various restrictions (Theil, 1971). This can be done following on from the estimation procedure, making it possible to explore the effects of different restrictions in the EXCEL spreadsheet produced as part of this work and allowing users to impose their own structures.

It is assumed that there is a parameter vector $\mathbf{x}$ defined as the unrestricted set of variables, which should satisfy the accounting constraint, $\mathbf{Ax} = \mathbf{r}$, where $\mathbf{r}$ is a vector of accounting residuals. It is also assumed that the observed parameters are distributed without bias around the true parameter values $\mathbf{x}^*$ with known variance matrix, $\mathbf{V}$.

The least-squares problem presented here is then one of finding a vector $\mathbf{x}^*$, i.e. the set of restricted variables, which satisfies the accounting constraints, $\mathbf{Ax}^* = \mathbf{r}$, and is close as possible to the observed parameter vector, $\mathbf{x}$. The problem is that of minimising

$$\left(\mathbf{x}^* - \mathbf{x}\right)' \mathbf{V}^{-1} \left(\mathbf{x}^* - \mathbf{x}\right) \tag{3}$$

subject to the constraint

$$\mathbf{Ax}^* = \mathbf{r} \tag{4}$$

The Lagrangian function takes the form

$$\mathbf{Min}\, L = \left(\mathbf{x}^* - \mathbf{x}\right)' \mathbf{V}^{-1} \left(\mathbf{x}^* - \mathbf{x}\right) - \lambda\left(\mathbf{Ax}^* - \mathbf{r}\right) \tag{5}$$

The first-order conditions are then

$$\frac{\partial L}{\partial \mathbf{x}^*} = 2\mathbf{V}^{-1}\left(\mathbf{x}^* - \mathbf{x}\right) - \mathbf{A}'\lambda = \mathbf{0} \tag{6}$$

$$\frac{\partial L}{\partial \lambda} = \mathbf{Ax}^* - \mathbf{r} = \mathbf{0} \tag{7}$$

Rearranging equation (6) gives

$$\mathbf{VA}'\lambda = 2\left(\mathbf{x}^* - \mathbf{x}\right) \tag{8}$$

Now by premultiplying both sides by $\mathbf{A}$ and rearranging yields

$$\lambda = 2\left(\mathbf{AVA}'\right)^{-1} \mathbf{A}\left(\mathbf{x}^* - \mathbf{x}\right) \tag{9}$$

and given that $\mathbf{Ax}^* = \mathbf{r}$, we have

$$\lambda = -2\left(\mathbf{AVA}'\right)^{-1}\left(\mathbf{Ax} - \mathbf{r}\right) \tag{10}$$

Substituting this into equation [8] yields the constrained least-squares solution

$$\mathbf{x}^* = \mathbf{x} - \mathbf{VA}'\left(\mathbf{AVA}'\right)^{-1}\left(\mathbf{Ax} - \mathbf{r}\right) \tag{11}$$

The estimator is just a linear combination of the unrestricted parameters. That is, we need only run the unrestricted regression and then by performing a few computations we get the restricted estimates. We conclude this least-squares adjustment process by noting that the difference between the constrained and the unconstrained least-squares coefficient vectors is a linear function of the vector $\mathbf{Ax}^* - \mathbf{r}$, which measures the degree to which the unconstrained coefficient vector fails to satisfy the constraints.

The mean of this estimator can be shown to be

$$E\left(\mathbf{x}^{*}\right)=\mathbf{x}-\mathbf{VA}'\left(\mathbf{AVA}'\right)^{-1}\left(\mathbf{Ax}-\mathbf{r}\right) \tag{12}$$

So the restricted least squares estimator is unbiased only when the linear restrictions are identically correct. The restricted least-squares estimator (Equation (11)) does not appear to be affected by premultiplication of the variance matrix $\mathbf{V}$ by any scalar constant. This implies that the balancing process depends on relative but not on absolute data reliability. Restricting the parameters also leads to a reduction in the data variance, which can be seen by considering the restricted variance matrix

$$\mathbf{V}^{*}=\mathbf{V}-\mathbf{VA}'\left(\mathbf{AVA}'\right)^{-1}\mathbf{AV} \tag{13}$$

Given that equation (13) is a positive semi-definite matrix, it follows that the process of least-squares balancing has the effect of not making the data less accurate. The restricted variance matrix has a smaller variance than its unrestricted counterpart since $\mathbf{VA}'\left(\mathbf{AVA}'\right)^{-1}\mathbf{AV}$ is positive definite and by restricting the parameters we enhance their reliability.

4. The Health Care Expenditure Model

The model is built around a macro programme in EXCEL which uses the parameters estimated by GLS for the EU-15 excluding Luxemburg and Greece; we nevertheless refer to the model as a model of the EU-15. It is set up in such a way that users can impose restrictions on the parameters and also restrict the long-run elasticity of health care expenditure with respect to GDP. A set of restrictions has been programmed into the model but users can change any of these by adjusting the number of restrictions in the model. The long-run elasticity can be changed in the same way. An empty box implies that no restriction has been put in place on that parameter. Once the user is satisfied with the restrictions the χ^2 output will present a test for the validity of the restrictions.

Once the restrictions have been imposed the user can select the member states whose health expenditure they wish to project. The spreadsheet for each country contains the data output from Christiansen *et. al* (2006) which is used to estimate the restricted model. For each of the variables, users can select the start and end period of the data in question. Alternatively, a trend growth can be applied to any of the variables. It is important to mention here that the growth rates of the parameters projected may not be entirely logical and users are recommended to change the growth rates for the variables in question accordingly. For example, with the age variables, the proportion of the elderly may be very large the further the projections go and so therefore it is advisable for users to insert their own growth rates.

Finally, users can enter an intercept correction by entering an initial and final years over which the correction is to be calculated. The default of this for the forecasting model is that the results are aligned to the last five years of the data. This avoids sharp jumps between data and forecast periods and is in keeping with common practice among economic forecasters. When users are content with the restrictions in place along with the relevant data selected for the countries in question then the model will compute projections for health care spending between 2004 and 2050 (or up to any other year the user specifies). Each time the model is run, the new projected figures are pasted over the existing ones. In order to show more clearly how to apply the model, appendix A provides a step-by-step guide on how to use the programme to project health care spending.

5. Estimation Results

By using the unrestricted and restricted parameters following from the least-squares estimation method outlined in section 3 we have estimated health care projections for the EU15 excluding Luxemburg and Greece. For an analysis of the descriptive statistics along with the correlation matrix of the variables the reader is referred to Christiansen *et. al* (2006).

5.1 Parameter Estimates for EU15 countries

Table 3 gives the long-run elasticities of the variables in our initial regression analysis.

Table 3 Long-Run Elasticities

Variable	Unrestricted Models
GDPPC	0.9363
AGE65_74	-0.0230
AGE75_	-0.0381
AVELE65	0.0920
FLFPR	0.0253
UNEMP	-0.0082
ALCCON	-0.0006
PUHES	0.0125
SALARYGP	0.1212
CAPGP	0.2013
CASEHO	0.0079
COPAYGP	0.0812
COPAYHO	-0.1409
FREEGP	0.2458
FREEHO	0.0690
BEDS	0.0369
MORTALITY	0.2152

As we can see from Table 3, the age effects have negative long-run semi-elasticities while the effects of mortality and average life expectancy are positive. Since the variables are not independent of each other such a structure need not be inconsistent with the idea that the partial effect of each demographic term should be positive. However we are able to accept a set of restrictions which set the long-run age effects to zero and which also limit the effect of mortality to zero, so that the only age effect is associated with rising life expectancy. We impose these restrictions jointly with others on insignificant variables giving the base restrictions for model 0 shown in Table 4. If we restrict only the population structure terms to zero the mortality effect becomes negative and for this reason it too is restricted to zero.

Table 4 Unrestricted and Restricted Regression Results from EU15

	Unrestricted		Restricted Model 0	
	Coeff	z-stat	Coeff	z-stat
LOGTHEPC(-1)	0.712597	14.75834	0.7001	22.4300
LOGGDP	0.286783	2.266419	0.3021	10.8121
LOGGDP(-1)	-0.01768	-0.14216	0.0000	Rest*
AGE65_74	0.023154	1.99257	0.0338	5.0139
AGE65_74(-1)	-0.029777	-2.729757	-0.0338	-5.0139
AGE75_	0.038199	1.904183	0.0311	3.3023
AGE75_(-1)	-0.049141	-2.26814	-0.0311	-3.3023
AVELE65	-0.008697	-0.582769	-0.0163	-1.8821
AVELE65(-1)	0.035151	2.510683	0.0288	2.5109
FLFPR	0.005525	1.982653	0.0084	7.3622
FLFPR(-1)	0.001753	0.720535	0.0000	Rest*
UNEMP	-0.002544	-0.917307	-0.0019	-3.2634
UNEMP(-1)	0.000201	0.083806	0.0000	Rest*
ALCCON	-0.012096	-1.768828	-0.0058	-1.1924
ALCCON(-1)	0.011911	1.846001	0.0032	0.6695
PUHES	0.004087	1.831964	0.0028	4.9738
PUHES(-1)	-0.000487	-0.198353	0.0000	Rest*
SALARYGP	0.024331	1.369935	0.0000	Rest*
SALARYGP(-1)	0.010513	0.729624	0.0000	Rest*
CAPGP	0.036716	3.136739	0.0220	4.5991
CAPGP(-1)	0.021145	1.849732	0.0201	5.6771
CASEHO	-0.038563	-3.436662	-0.0496	-6.9427
CASEHO(-1)	0.040823	3.760246	0.0447	5.6206
COPAYGP	0.038339	1.553251	0.0472	4.7847
COPAYGP(-1)	-0.014997	-1.140861	0.0086	1.5641
COPAYHO	-0.024313	-2.015252	-0.0199	-3.2467
COPAYHO(-1)	-0.01619	-0.972756	0.0000	Rest*
FREEGP	0.007112	0.441763	0.0000	Rest*
FREEGP(-1)	0.06352	3.966351	0.0429	3.8931
FREEHO	0.052506	4.974856	0.0541	8.1592
FREEHO(-1)	-0.032686	-2.76244	-0.0329	-4.1439
BEDS	0.011626	0.890551	0.0187	5.8882
BEDS(-1)	-0.001009	-0.096272	0.0000	Rest*
MORTM	-0.107016	-0.668941	-0.2128	-2.0307
MORTM(-1)	0.168854	1.190521	0.2128	2.0307
Test of Restriction			$\chi^2_{13}=12.90$	

The long-run coefficients of the restricted model are compared with the earlier unrestricted model in Table 5.

Table 5 The Impact of Restrictions on the Long-Run Coefficients

	Unrestricted	Model 0
GDPPC	0.9363	1.0071
AGE65_74	-0.0230	0.0000
AGE75_	-0.0381	0.0000
AVLE65	0.0920	0.0419
FLFPR	0.0253	0.0281
UNEMP	-0.0082	-0.0065
ALCCON	-0.0006	-0.0087
PUHES	0.0125	0.0094
SALARYGP	0.1212	0.0000
CAPGP	0.2013	0.1405
CASEHO	0.0079	-0.0162
COPAYGP	0.0812	0.1862
COPAYHO	-0.1409	-0.0662
FREEGP	0.2458	0.1429
FREEHO	0.0690	0.0707
BEDS	0.0369	0.0622
MORTM	0.2152	0.0000

While income is the main driving force in most studies of health care expenditure, there is little consensus regarding the elasticity with respect to per capita health care spending (McGuire *et. al*, 1993). Herwartz and Theilen, 2003 argue that estimated elasticity seems to have decreased since the beginning of the 1980s, possibly reflecting cost-containment policies. Earlier studies using cross-sectional data found elasticities greater than one (Gerdtham *et. al*, 1998), suggesting that health care expenditure is a luxury good. More recent studies using pooled time-series data and a wider range of explanatory variables suggest elasticities near or less than one (Hitiris and Posnett, 1992). Though, for time-series data, it is difficult to separate demand from supply related factors, since supply side factors are often not available, and those that are show little variance or are correlated with the income variable. With the restrictions in place which are easily accepted model 0 delivers an elasticity very close to 1.

Among the social and demographic variables, alcohol consumption might be thought to have an incorrect sign. However, there is little consensus about how far alcohol consumption is harmful and we have therefore not tried to restrict this variable. There is an expected positive sign on public health care expenditure (*PUHES*); high public provision raises total expenditure. The positive term in acute beds is not a surprise.

The dummy variables merit particular discussion. They arise from an attempt to identify the characteristics of the health care systems of the different countries at different times. There is an obvious question how well they do this, since, for example, one might expect a country with small co-payments to be more like one without copayments than like one with large copayments. The supply-side dummy variables tend to have positive signs apart for case-based remuneration of hospitals (*CASEHO*) and co-payments to hospitals (COPAYHO). The demand-side dummy variables show a mixture of positive signs for co-payment for visiting a GP (*COPAYGP*), free choice of GP (*FREEGP*) and free choice of hospitals (*FREEHO*) but a negative sign for co-payment for using hospitals (*COPAYHO*).

Of these variables one in particular, the positive sign on copayments to GPs is of some concern. One might expect that copayments to GPs would reduce rather than increase health spending for any given share of public spending in the total. Since our model includes country fixed effects, the dummies affect our projections only if they change in the projection period. This happens only to Austria where the change is the removal of co-payments for visiting GPs. This has a powerful effect in depressing expenditure. Since there are obvious questions whether the dummy might actually represent a combination of characteristics rather than just the characteristic attributed to it, there are grounds for doubting that the impact of that single change would actually be what our model shows. In the report on Austria we therefore also present a projection on the assumption of no change.

The large impact of the dummy variables suggests that institutional arrangements are an important influence on costs. However it is hard to be precise about exactly what characteristics of institutional arrangements do in fact have this influence.

6. Hypotheses about Determinants of Health Care Spending

The model allows us to explore the implications of basic scenarios about the determinants of health spending in the context of the richer framework provided by regression analysis. We can explore hypotheses about the long-run elasticity of health spending with respect to GDP, that spending is closely related to the age structure of the population and that it is substantially driven by death-related costs.

With the equation given as

$$THEPC_{it} = \delta THEPC_{i,t-1} + \beta_{11} \ln GDP_{it} + \beta_{12} \ln GDP_{it-1} + \ldots + u_{it} \quad i = 1,\ldots,N;\ t = 1,\ldots,T \quad (14)$$

The long-run elasticity with respect to GDP is

$$\varepsilon_{GDP} = \frac{\beta_{11} + \beta_{12}}{1-\delta} \quad (15)$$

For a given value of ε_{GDP} this defines a linear restriction linking β_{11}, β_{12} and δ. Equation (15) shows the long-run elasticities which result from imposing various restrictions on long run income elasticity. We can see in table 5 that, while an elasticity of 1.1 is accepted by the data, one of 1.2 is firmly rejected. Raising the elasticity affects the other coefficients. Most notably it reduces the coefficient on life expectancy. This explains why we find, in our country studies, that when the elasticity is raised, projected expenditure may fall. The impact of the reduced weight put on life expectancy more than compensates for the effect of a greater than unit elasticity on GDP with a rising GDP.

Table 6 Long-Run Coefficients with Different GDP Elasticities

GDPPC	1.0071	1.0000	1.1000	1.2000
AGE65_74	**0.0000**	**0.0000**	**0.0000**	**0.0000**
AGE75_	**0.0000**	**0.0000**	**0.0000**	**0.0000**
AVELE65	0.0419	0.0431	0.0244	0.0029
FLFPR	0.0281	0.0282	0.0273	0.0264
UNEMP	-0.0065	-0.0066	-0.0059	-0.0059
ALCCON	-0.0087	-0.0089	-0.0068	-0.0055
PUHES	0.0094	0.0094	0.0101	0.0104
SALARYGP	0.0000	0.0000	0.0000	0.0000
CAPGP	0.1405	0.1405	0.1460	0.1628
CASEHO	-0.0162	-0.0161	-0.0149	-0.0107
COPAYGP	0.1862	0.1856	0.1929	0.1982
COPAYHO	-0.0662	-0.0647	-0.0845	-0.1017
FREEGP	0.1429	0.1459	0.1088	0.0805
FREEHO	0.0707	0.0702	0.0788	0.0895
BEDS	0.0622	0.0628	0.0547	0.0465
MORTM	**0.0000**	**0.0000**	**0.0000**	**0.0000**
	$\chi_{12}^2=12.90$	$\chi_{13}^2=12.93$	$\chi_{13}^2=16.42$	$\chi_{13}^2=24.6$

The model also allows us to explore the hypothesis that spending is age-related, or death-related. The first of these hypotheses implies that it changes as the age structure of the population changes while the second implies that it responds to movements in the mortality rate. As the population ages through increased longevity the proportion of old people in the population is likely to rise, while at the same time the mortality rate will decline. Thus the two hypotheses may have rather different implications for the evolution of health spending.

We consider the long-run model in schematic form as

$$THEPC = \alpha_1 GDPPC + \alpha_2 AGE65-74 + \alpha_3 AGE75 + \alpha_4 MORTALITY + etc \qquad (15)$$

It is important to recall here that the dependent variable, *THEPC*, used is defined in natural logarithms. The coefficients α_2 to α_4 show the semi-elasticities of the population share age 65-74, the population share aged 75 and over and the mortality rate on health spending. If health spending is driven only by population structure and the amount spent per person under 65 is β_1, per person aged 65-74 is β_2, and per person aged 75+ is β_3 with π_1, π_2, π_3 being the number of people in each of the three categories, then total spending per capita is

$$THEPC = \log\left[\frac{\beta_1\pi_1 + \beta_2\pi_2 + \beta_3\pi_3}{\pi_1 + \pi_2 + \pi_3}\right] + GDPPC + constant \tag{16}$$

The effect on the proportion of 65-74 year olds of a change in π_2 is

$$\frac{\partial \dfrac{\pi_2}{\pi_1 + \pi_2 + \pi_3}}{\partial \pi_2} = \frac{1}{\pi_1 + \pi_2 + \pi_3} - \frac{\pi_2}{(\pi_1 + \pi_2 + \pi_3)^2} = \frac{\pi_1 + \pi_3}{(\pi_1 + \pi_2 + \pi_3)^2} \tag{17}$$

and the effect of the same change given the model of health spending is

$$\frac{\partial THEPC}{\partial \pi_2} = \frac{\beta_2}{\beta_1\pi_1 + \beta_2\pi_2 + \beta_3\pi_3} - \frac{1}{\pi_1 + \pi_2 + \pi_3} \tag{18}$$

Thus the semi-elasticity with respect to the proportion is given as

$$\begin{aligned} \frac{\partial THEPC}{\dfrac{\partial \pi_2}{\pi_1 + \pi_2 + \pi_3}} &= \frac{\dfrac{\beta_2}{\beta_1\pi_1 + \beta_2\pi_2 + \beta_3\pi_3} - \dfrac{1}{\pi_1 + \pi_2 + \pi_3}}{\dfrac{\pi_1 + \pi_3}{\left(\pi_1 + \pi_2 + \pi_3\right)^2}} \\ &= \frac{\dfrac{\beta_2\left(\pi_1 + \pi_2 + \pi_3\right)}{\beta_1\pi_1 + \beta_2\pi_2 + \beta_3\pi_3} - 1}{\dfrac{\pi_1 + \pi_3}{\left(\pi_1 + \pi_2 + \pi_3\right)}} \end{aligned} \tag{19}$$

Here the numerator is the ratio of what health spending would be if it were β_2 per capita for the whole population to actual spending less 1, divided by 1 minus the proportion of people aged 65-74 in the actual population. Thus by restricting α_2 to this value we can impose the hypothesis that health spending is driven in this precise way by population structure. Obviously the effect of the population aged 75+ can be derived in the same way. Note that the coefficient actually changes as the population numbers change. We impose it using the most recent information available. Since the equation is estimated for the EU15 as a whole, with country-specific effects dealt with by means of country dummy variables, we base the restrictions on the EU15 average and impose the same restrictions for all countries.

We have used age profiles for health and long-term care supplied by the European Commission. While health profiles are available for all countries, the long-term care profiles are not available for Austria, Eire, France, Greece and Spain, Eire. We have used the *per capita* expenditure average for the other countries to substitute for these missing data. Table 7 shows the derivation of the restrictions to be imposed on the long-run coefficients if health spending is taken to be age-related.

Table 7 Derivation of the Restrictions of the Long-Run Values of the Age Terms when Health Expenditure is Age-Related

Country	Health spending as of GDP	GDP (2003)	Health and Long-term Care Spending	Proportion of Health and Long-term Care Expenditure by Age Group			Health and Long-term Care Expenditure by Age Group		
				0-64	65-74	75+	0-64 spend	65-75 spend	75+ spend
Austria	8.65%	226243	19570	0.468	0.124	0.408	9162	2422	7986
Belgium	9.28%	274658	25495	0.396	0.134	0.470	10089	3412	11994
Denmark	8.68%	188500	16363	0.430	0.108	0.462	7031	1774	7558
Finland	6.48%	145938	9463	0.385	0.096	0.518	3646	911	4906
France	9.58%	1594814	152734	0.450	0.125	0.425	68708	19049	64977
Germany	11.37%	2161500	245799	0.461	0.154	0.385	113310	37861	94628
Greece	10.22%	155543	15892	0.447	0.130	0.423	7100	2064	6728
Eire	7.47%	138941	10378	0.464	0.127	0.408	4820	1320	4239
Italy	8.50%	1335354	113504	0.464	0.167	0.369	52699	18964	41841
Luxemburg	5.94%	25607	1522	0.411	0.129	0.460	626	197	699
Netherlands	8.71%	476945	41539	0.432	0.105	0.462	17951	4381	19207
Portugal	9.60%	137523	13198	0.468	0.124	0.408	6179	1633	5385
Spain	6.91%	782531	54073	0.442	0.164	0.393	23922	8876	21274
Sweden	9.01%	269548	24292	0.339	0.069	0.592	8234	1679	14380
U.K	7.76%	1604497	124549	0.407	0.119	0.474	50685	14822	59041
Total	9.10%	9518142	868369				384162	119365	364844
Number of people							318998600	35344285	45546619
Share of spending by age								0.442	0.137
Spend per person							1204	3377	8010
Population shares				0.798	0.088	0.114			
Coefficients								**0.006**	**0.030**

Data Source. Ageing Working Group. European Commission

We can similarly impose the restriction that a proportion of health spending is determined by the number of deaths. If

$$THEPC = \log \gamma_1 + \gamma_2 MORTALITY \qquad (20)$$

then

$$\frac{\partial THEPC}{\partial MORTALITY} = \frac{\gamma_2}{THEPC} = \exp(THEPC) \qquad (21)$$

Thus if spending per death (or spending in the last year of life) is known the associated semi-elasticity can be imposed.

Here there are two data problems. First of all data on death-related costs are not available for all countries. This means that we have to work out the relevant restriction for those countries for which we have data. Secondly, while we can identify expenditure on health care in the year prior to death, at least for some countries, it is much less clear how to handle long-term care costs. These undoubtedly increase with age, but at the same time mortality rates of people receiving long-term care are probably higher than those not receiving it. Unfortunately, mortality rates for people in receipt of long-term care are not available and it is therefore impossible to establish this. *Faut de mieux* we simply use the information on death related health costs and assume that the same proportion applied to long-term care. The calculation of the EU15 share of mortality-related costs in the total is shown in Table 8.

Table 8 Mortality-Related Costs as a Proportion of Total Health Expenditure

Country	Mortality-related costs (% of total)	Health spending	Mortality-related spending
Austria	24.0%	19570	4697
Belgium	28.0%	25495	7139
Denmark	23.0%	16363	3770
France	43.0%	152734	65675
Germany	25.3%	245799	62070
Italy	28.0%	113504	31781
Netherlands	27.0%	41539	11216
Portugal	36.8%	13198	4853
Spain	45.4%	54073	24529
Sweden	23.0%	24292	5587
EU as a whole: based on countries reporting results		706575	221318
Mortality-related share Coefficient restriction			**0.313**

Data Source. Ageing Working Group. European Commission

Given these calculations we are able to explore a range of scenarios summarised in Table 9. Model 0 is our starting point. We next look at the effect of restricting the mortality coefficient both without and then with the coefficient on life expectancy restricted to zero. We repeat the process with the ageing coefficients taking their restricted values but with the mortality coefficient set at zero. Thus models 2 and 4 have demographic influences restricted to mortality and populations structure respectively, while models 1 and 4 are closer to the original model. The GDP elasticity moves as a consequence of the effects of the restrictions on unrestricted coefficients of the model

We repeat the exercise with the GDP elasticity set to 1.

Table 9 Scenarios of Different Restrictions

On the Demographic Parameters

Model	GDP Elasticity	AGE65-74	AGE75+	AVELE65	MORT
0	1.0071	**0**	**0**	0.0419	**0**
1	1.0151	**0**	**0**	0.0538	**0.313**
2	1.1738	**0**	**0**	**0**	**0.313**
3	0.9653	**0.006**	**0.030**	0.0227	**0**
4	1.0403	**0.006**	**0.030**	**0**	**0**
5	**1**	**0**	**0**	0.0431	**0**
6	**1**	0	0	0.0564	**0.313**
7	**1**	**0**	**0**	**0**	**0.313**
8	**1**	**0.006**	**0.030**	0.0163	**0**
9	**1**	**0.006**	**0.030**	**0**	**0**

The impact of these restrictions on the long-run coefficients is shown in Table 10 and Table 11.

Table 10 Long-run Coefficients with Demographic Restrictions. GDP Elasticity Unrestricted

	Unrestricted	Model 0	Model 1	Model 2	Model 3	Model 4
GDPPC	0.9363	1.0071	1.0151	1.1738	0.9653	1.0403
AGE65_74	-0.0230	**0.0000**	**0.0000**	**0.0000**	0.0060	**0.0060**
AGE75_	-0.0381	**0.0000**	**0.0000**	**0.0000**	0.0300	**0.0300**
AVELE65	0.0920	0.0419	0.0538	**0.0000**	0.0227	**0.0000**
FLFPR	0.0253	0.0281	0.0321	0.0323	0.0322	0.0308
UNEMP	-0.0082	-0.0065	-0.0034	-0.0054	-0.0055	-0.0061
ALCCON	-0.0006	-0.0087	-0.0144	-0.0142	-0.0156	-0.0148
PUHES	0.0125	0.0094	0.0138	0.0136	0.0103	0.0102
SALARYGP	0.1212	0.0000	0.0000	0.0000	0.0000	0.0000
CAPGP	0.2013	0.1405	0.1539	0.1937	0.1615	0.1728
CASEHO	0.0079	-0.0162	-0.0144	-0.0132	-0.0196	-0.0080
COPAYGP	0.0812	0.1862	0.2572	0.3042	0.2610	0.2965
COPAYHO	-0.1409	-0.0662	-0.0663	-0.0736	-0.0677	-0.0821
FREEGP	0.2458	0.1429	0.0858	0.0599	0.0928	0.0951
FREEHO	0.0690	0.0707	0.0872	0.1130	0.0766	0.0869
BEDS	0.0369	0.0622	0.0775	0.0554	0.0807	0.0715
MORTM	0.2152	**0.0000**	**0.3130**	**0.3130**	**0.0000**	**0.0000**
		$\chi_{12}^2=12.9$	$\chi_{12}^2=21.2^*$	$\chi_{14}^2=34.4^{**}$	$\chi_{12}^2=23.5^*$	$\chi_{14}^2=27.5^*$

Table 11 Long-run Coefficients with Demographic Restrictions. GDP Elasticity Restricted to One

	Unrestricted	Model 5	Model 6	Model 7	Model 8	Model 9
GDPPC	0.9363	**1.0000**	**1.0000**	**1.0000**	**1.0000**	**1.0000**
AGE65_74	-0.0230	**0.0000**	**0.0000**	**0.0000**	**0.0060**	**0.0060**
AGE75_	-0.0381	**0.0000**	**0.0000**	**0.0000**	**0.0300**	**0.0300**
AVELE65	0.0920	0.0431	0.0564	**0.0000**	0.0163	**0.0000**
FLFPR	0.0253	0.0282	0.0322	0.0349	0.0319	0.0314
UNEMP	-0.0082	-0.0066	-0.0035	-0.0094	-0.0052	-0.0070
ALCCON	-0.0006	-0.0089	-0.0148	-0.0233	-0.0148	-0.0164
PUHES	0.0125	0.0094	0.0137	0.0099	0.0105	0.0095
SALARYGP	0.1212	0.0000	0.0000	0.0000	0.0000	0.0000
CAPGP	0.2013	0.1405	0.1539	0.2401	0.1630	0.1774
CASEHO	0.0079	-0.0161	-0.0144	-0.0027	-0.0193	-0.0065
COPAYGP	0.0812	0.1856	0.2560	0.3380	0.2636	0.3108
COPAYHO	-0.1409	-0.0647	-0.0631	-0.0125	-0.0747	-0.0688
FREEGP	0.2458	0.1459	0.0921	0.1921	0.0795	0.1241
FREEHO	0.0690	0.0702	0.0861	0.1159	0.0795	0.0870
BEDS	0.0369	0.0628	0.0787	0.0588	0.0780	0.0717
MORTM	0.2152	**0.0000**	**0.3130**	**0.3130**	**0.0000**	**0.0000**
		$\chi_{13}^2=12.9$	$\chi_{13}^2=21.4$	$\chi_{15}^2=48.6^{**}$	$\chi_{13}^2=24.0^{*}$	$\chi_{15}^2=28.7^{*}$

* Significant at 5%
** Significant at 1%
Restricted demographic coefficients are shown in bold type.

A conclusion from tables 9 and 10 is that simple demographic hypotheses- that spending is driven by the age structure of the population, or by death-related costs, in a manner connected with observed spending on different age categories or in the year before death- are rejected by the data at a 5% level. The rejection is relatively marginal, with only the hypothesis that mortality is the sole demographic influence being rejected at the 1% level; on the other hand the increase in the χ^2 statistic between model 0 and the models with the demographic restrictions in place points to these restrictions being strongly rejected. While we noted earlier the difficulty in determining the appropriate restriction, it is unlikely that the error is so large as to affect this conclusion.

We present scenarios for the countries to which our model is fitted with the various restrictions imposed above in place. This allows us to explore what would happen if such models were true despite the statistical evidence against them.

7. Simulation Results

The results for each country are presented in the appendix (to be completed). We show a summary of these in Table 12. The results are generated using the unrestricted model, model 0. Some general points emerge from these figures for model 0. Increases in the share of health spending in GDP are expected everywhere except in Denmark and Sweden where a reduction in the share of health spending which is publicly funded is expected to offset demographic effects. Austria manages to keep its rise in spending modest on account of a change in the structure of co-payments to GPs.

Table 12 Summary Results of Health Care Projections for the EU15

Health Care Expenditure as % of GDP

		2050 Projected Value					
Country	2003 Value	Model 0	Model 2 Mortality Restrictions	Model 5 ε_{GDP}=1	Model 7 ε_{GDP}=1 Mortality Restrictions	Model 4 AGE65-74 and AGE75+ restricted	Model 9 ε_{GDP}=1 AGE65-74 and AGE75+ restricted
Austria	8.7%	9.0%	9.1%	9.0%	7.8%	9.9%	9.5%
Belgium	9.3%	11.6%	11.6%	11.6%	10.5%	13.0%	12.7%
Denmark	8.7%	8.6%	9.0%	8.6%	8.3%	9.8%	9.6%
Finland	7.4%	9.2%	9.5%	9.2%	8.7%	10.1%	9.8%
France	9.6%	11.3%	11.3%	11.3%	10.1%	13.4%	13.0%
Germany	11.4%	12.9%	14.2%	12.9%	13.1%	16.0%	15.7%
Eire	7.5%	12.1%	15.1%	12.1%	13.6%	14.5%	14.0%
Italy	8.5%	10.0%	10.2%	10.0%	9.7%	11.6%	11.5%
Netherlands	8.7%	9.9%	12.5%	9.9%	10.4%	12.2%	11.8%
Portugal	9.6%	13.8%	13.0%	13.8%	11.9%	15.9%	15.5%
Spain	7.7%	11.1%	12.9%	11.1%	12.6%	14.8%	14.5%
Sweden	9.0%	8.7%	9.0%	8.7%	8.3%	9.3%	9.1%
United Kingdom	7.8%	9.9%	9.3%	9.9%	8.6%	10.8%	10.5%

The individual country reports show, in addition the effects on the outcome of individual variables remaining constant instead of changing as specified in our projections.

8. Comparison with Ageing Working Group Results

These results naturally invite comparison with the findings of the Ageing Working Group (European Commission, 2006). However, such a comparison is fraught with difficulties. An initial difficulty is that the data provided by the OECD plainly differ from those used by the Ageing Working Group. There are two factors behind this. First of all, the OECD figures include all spending while the AWG figures include only spending by the public sector. In principle it ought to be possible to correct for this because the OECD also provides data on the share of total health and long-term care expenditure paid for by the public sector. We therefore show in Table 13 the AWG figures for the pure ageing scenario plus the long-term care figures. This represents core projection in the AWG Report, scaled up to expand from the public sector to the whole economy and the OECD figures side by side. Ageing Working Group figures are available for 2004 but not for 2003. We do not regard this as an important influence on the comparison.

Table 13 The Ageing Working Group and the OECD Data

	Ageing Working Group 2004					**Ahead**
	Health	Long-term Care	Total Public	Public Share	Total	OECD 2003
Austria	5.3%	0.6%	5.9%	70.3%	8.4%	8.65%
Belgium	6.2%	0.9%	7.1%	71.6%	9.9%	9.28%
Denmark	6.9%	1.0%	7.9%	82.9%	9.5%	8.68%
Finland	5.6%	1.7%	7.3%	73.8%	9.9%	7.39%
France	7.7%	0.0%	7.7%	76.1%	10.1%	9.58%
Germany	6.0%	1.0%	7.0%	79.4%	8.8%	11.37%
Eire	5.3%	0.6%	5.9%	77.5%	7.6%	7.47%
Italy	5.8%	1.5%	7.3%	75.3%	9.7%	8.50%
Netherlands	6.1%	0.5%	6.6%	63.0%	10.5%	8.71%
Portugal	6.7%	0.0%	6.7%	69.7%	9.6%	9.60%
Spain	6.1%	0.5%	6.6%	71.2%	9.3%	7.68%
Sweden	6.7%	3.8%	10.5%	84.3%	12.5%	9.01%
United Kingdom	7.0%	1.0%	8.0%	82.2%	9.7%	7.76%

Source: European Commission(2006). Table 4-8 p. 128 (Health Expenditure). Table 5-13. p.157 (Long-term Care)

The correlation between the two sets of data in the last two columns is 0.11 suggesting that, at least in some countries, there are serious differences of definition between them. On its own this might be thought to render comparison of the projections pointless.

A second substantial point affects our projections. As we have discussed, the share of public spending in the total can be an important influence on total spending. Countries with a high public share tend to have a high total level of spending. In our core projections country authors have generally assumed that trends in the share of public spending are likely to continue while the AWG figures can be presumed to be calculated on the assumption that the share is constant since, as far as we are aware the projection methods used do not consider the issue.

A declining public sector share has two impacts. First of all as noted, it depresses the projected value generated by our model for 2050. Secondly, if we gross up the AWG projections for 2050 using the projected public sector share figures for 2050, public spending lower in 2050 than in 2004 raises the grossing up factor applied to the AWG figure. Thus a decline the public sector share reduces the estimate of total spending generated by our model and raises the grossed up figure computed from the AWG figures. For this reason we present two sets of comparisons. The first is with our projections from model 0 using the values assumed there for the public sector share in 2050. The second is an alternative projection with the results generated on the assumption that the share of public sector spending in the total remains constant. We show in Table 14 the implications of these two assumptions for the interpretation of the AWG figures for 2050.

Table 14 Ageing Working Group Projections for 2050 and the Public Sector Share

	Ageing Working Group 2050						
	Health	Long-term Care	Total Public	Base Public Share	Total	Constant Public Share	Total
Austria	6.9%	1.5%	8.4%	59.9%	14.0%	70.3%	11.9%
Belgium	7.7%	2.1%	9.8%	70.6%	13.9%	71.6%	13.7%
Denmark	8.0%	2.3%	10.3%	82.9%	12.4%	82.9%	12.4%
Finland	7.0%	4.0%	11.0%	73.8%	14.9%	73.8%	14.9%
France	9.5%	0.0%	9.5%	76.1%	12.5%	76.1%	12.5%
Germany	7.3%	2.3%	9.6%	79.4%	12.1%	79.4%	12.1%
Eire	7.3%	1.3%	8.6%	69.9%	12.3%	77.5%	11.1%
Italy	7.2%	2.4%	9.6%	70.0%	13.7%	75.3%	12.7%
Netherlands	7.4%	1.2%	8.6%	75.0%	11.5%	63.0%	13.7%
Portugal	7.3%	0.0%	7.3%	61.4%	11.9%	69.7%	10.5%
Spain	8.3%	0.8%	9.1%	63.9%	14.2%	71.2%	12.8%
Sweden	7.8%	6.3%	14.1%	70.3%	20.1%	84.3%	16.7%
United Kingdom	9.3%	2.0%	11.3%	69.4%	16.3%	82.2%	13.7%

In Table 15 we compare the figures produced on the two assumptions. Moving to the assumption that the public sector share is held constant reduces the gap between the AHEAD projections and those from the AWG. The sum of squared deviations falls from 128.9 to 69.0 showing the importance of the issue.

Table 15: Comparison of AWG and Ahead Project Projections

	Ahead		**Ahead**		**AWG**	
	Model 0		Increase 2003 to 2050 Percentage Points		Increase 2004 to 2050 Percentage Points	
	Base Public Share	Constant Public Share	Base Public Share	Constant Public Share	Base Public Share	Constant Public Share
Austria	9.0%	8.7%	0.3	0.1	5.6	3.5
Belgium	11.6%	11.7%	2.3	2.5	4.0	3.8
Denmark	8.6%	9.3%	-0.1	0.7	2.9	2.9
Finland	9.2%	9.2%	1.8	1.8	5.0	5.0
France	11.3%	11.4%	1.7	1.8	2.4	2.4
Germany	12.9%	12.7%	1.6	1.4	3.3	3.3
Eire	12.1%	12.9%	4.6	5.5	4.7	3.5
Italy	10.0%	10.5%	1.5	2.0	4.0	3.0
Netherlands	9.9%	8.9%	1.2	0.2	1.0	3.2
Portugal	13.8%	13.8%	4.2	4.2	2.3	0.9
Spain	11.1%	11.9%	3.4	4.2	4.9	3.5
Sweden	8.7%	10.0%	-0.3	0.9	7.6	4.2
United Kingdom	9.9%	11.1%	2.1	3.4	6.6	4.0

This comparison is still open to the objection that we have used our core model, with public sector shares adjusted while the AWG uses an ageing scenario. We address this final issue in Table 16. Here we draw on our simulations of model 9, where the demographic effects are limited to those arising from the changing age structure of the population and the income elasticity of health spending is held at one. We also hold the share of public spending in the total at the level identified in 2003, so as to remove the influence of this.

Table 16 Comparison with Ageing Working Group Projections with Constant Public Sector Share and Similar Demographic Effects

	AWG	**Ahead**	**Percentage Point Increase 2003/4 to 2050**	
			AWG	Ahead
Austria	11.9%	9.6%	3.5	1.0
Belgium	13.7%	13.2%	3.8	3.9
Denmark	12.4%	10.7%	2.9	2.0
Finland	14.9%	10.1%	5.0	2.7
France	12.5%	13.5%	2.4	4.0
Germany	12.1%	15.7%	3.3	4.3
Eire	11.1%	15.6%	3.5	8.1
Italy	12.7%	12.3%	3.0	3.8
Netherlands	13.7%	10.8%	3.2	2.1
Portugal	10.5%	15.9%	0.9	6.3
Spain	12.8%	15.9%	3.5	8.2
Sweden	16.7%	10.7%	4.2	1.7
United Kingdom	13.7%	12.1%	4.0	4.4

Source: European Commission(2006). Table 4-8 p. 128 (Health Expenditure). Table 5-13. p.157 (Long-term Care)

In fact this change serves to widen the gap between the two sets of estimates further. The sum of squared deviations rises to 96.6. It can be seen that there are very substantial differences in Eire, Spain and Portugal. One further point is of importance. We have already noted that for Austria our projections are depressed by the change in copayments to GPs in 2050; with this change we would find a figure of 12.6% for 2050 in this simulation, giving an increase of 3.9 percentage points which is close to the AWG figure of 3.5 percentage points.

9. Discussion and Conclusions

The aim of this work package is to present projections of health care expenditure in order to assess the impact of ageing populations on future spending levels. Projections of public expenditure on health are required to inform the debate on the future impact of ageing populations for the overall sustainability of future EU public finances. The expenditure projections modelled in this work package for the EU member states have attempted to measure the impact of health care expenditure in the first half of the current century.

Health care spending is to a large extent determined by the policy decisions of national governments, for example, whether specific treatment are provided by public health systems, the coverage of individuals eligible for public health services, the ‘quality’ of public health care (policy choices/ preferences for waiting lists, size of hospital wards, etc.). The different institutional arrangements of health care systems across member states imply that these factors cannot be taken into account in projections made at a multilateral level, although they can be included in national projections when clear policy targets exist (Wanless, 2004).

In general, the health of the public in EU countries has improved significantly in recent years. Though, all member states face problems with the affordability and efficiency of the provision of health care, as well as with the realisation of good quality health care for all individuals. There are many lessons to be learned about good and bad practices where effective and ineffective health care policy is concerned. Finally, there tends to be a general consensus within the EU member states that there is no ideal system to project health care expenditure. There are indeed trade-offs between various government objectives. Every member state attempts to reconcile social and economic goals and makes its own balance of trade-offs, reflecting different national values, traditions and institutions. There is therefore no ‘one size fits all’ approach to projecting health care expenditure.

Nevertheless, perhaps the most important message which emerges from this work is that a variety of variables seems to influence health spending- and the influence of factors such as the share of the public sector in the total could easily be omitted from more mechanical calculations. Thus the results from this study provide a valuable insight into influences on health spending and also shed some light on the policy structures which governments can adopt to keep health spending in check.

Our results suggest that the share of GDP spent on health is likely to increase by more than four percentage points in Eire and Portugal, with a slightly smaller increase in Spain. Other countries should expect increases of the order of 1 to 2 ½ percentage points with the exception of Austria where only a small increase is anticipated and Denmark and Sweden where slight declines are expected. These figures are generally below those found by the Ageing Working Group, but the comparison is affected by the assumption made about the size of the public sector. If we compare our projections on the assumption that spending is driven by demographic effects with those of the Ageing Working Group we find substantial differences for Eire, Portugal and Spain, for which we project increases substantially larger than those of the Ageing Working Group.

The study suggests that institutional variables are of great importance. Finland is an acknowledged success story in having limited its health spending over the last ten years or so by means of institutional change and this may provide an example to other countries. However, the use of dummy variables to represent institutional differences is not completely satisfactory since a number of countries reported that they did not see institutional structures being as clear cut as the dummy variables themselves suggested. Thus, if institutional change is to be used as a means of limiting spending, careful case studies will be needed to identify more precisely the effects of different arrangements.

Nevertheless, one institutional issue does stand out unambiguously. Total spending on health is significantly and positively related to the share of health spending paid for by the public sector. This result is extremely intuitive and is likely to be of considerable importance in any future discussion of budgetary pressures associated with population ageing.

10. References

Ahn, S.K. and Reinsel, G.C. (1990). Estimation for partially nonstationary multivariate autoregressive models, *Journal of the American Statistical Association*, Vol. 85, pp 813-823.

Arellano, M. and Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equation, *The Review of Economic Studies*, Vol. 58, No. 3, pp 277-297.

Arellano, M. and Bover, O. (1995). Another look at the instrumental-variable estimation of error-components models, *Journal of Econometrics*, Vol. 68, pp 29-52.

Banerjee, A. (1999). Panel data unit roots and cointegration: An overview, *Oxford Bulletin of Economics and Statistics*, Vol. 61, pp 607-629.

Boswijk, H.P. (1996). Testing identifiability of cointegrating vectors, *Journal of Business and Economic Statistics*, Vol. 14, No. 2, pp 153-160.

Breitung, J. (2000). The local power of some unit root tests for panel data, in Baltagi, B. (ed.), Nonstationary panels, panel cointegration, and dynamic panels, *Advances in Econometrics*, Vol. 15, JAI: Amsterdam, pp 161-178.

Breitung, J. (2002). Nonparametric tests for unit roots and cointegration, *Journal of Econometrics*, Vol. 108, pp 343-363.

Breitung, J. (2005). A parametric approach to the estimation of cointegration vectors in panel data, *Econometric Reviews*, pp 151-174.

Busse, R. and Wismar, M. (2002). Health target programmes and health care services any link? A conceptual and comparative study, *Health Policy*, Vol. 59, No. 3, pp 209-221.

Christiansen, T., Bech, M., Nielsen, P. and Lauridsen, J. (2006). Demographic changes and aggregate health care expenditure in Europe, *Final draft of the Ageing, Health Status and Determinants of Health Expenditure (AHEAD) Project under the EC 6th Research Framework Programme*.

Dickey, D.A. and Fuller, W.A. (1979). Distribution of the estimates for autoregressive time series with a unit root, *Journal of the American Statistical Association*, Vol. 74, pp 427-431.

Engle, R.F. and Granger, C.W.J. (1987). Co-integration and error correction: Representation, estimation, and testing, *Econometrica*, Vol. 55, pp 251-276.

Engle, R.F. and Yoo, B.S. (1991). Cointegrated economic time series: An overview with new results, in: Fomby, T.B. and Rhodes, G.F. (eds.), *Advances in Econometrics*: Co-integration, Spurious Regression, and Unit Roots, Greenwich: JAI Press, pp 237-266.

European Commission (2006). The impact of ageing on public expenditure: projections for the EU25 member states on pensions, health care, long-term care, education and unemployment transfers (2004-2050), *Report prepared by the Economic Policy Committee (EPC) and the Directorate General Economic and Financial Affairs*, pp 1-406.

Fries, J.F. (1980). Aging, natural death and the compression of morbidity, *The New England Journal of Medicine*, Vol. 303, pp 130-135.

Fries, J.F., Green, L.W., Levine, S. (1989). Health promotion and the compression of morbidity, *The New England Journal of Medicine*, Vol. 321, pp 481-483.

Gerdtham, U., Jonsson, G., MacFarlan, B. and Oxley, H. (1998). The determinants of health expenditure in the OECD countries: A pooled data analysis, *Development of Health Economics and Public Policy*, Vol. 6, pp 113-134.

Gerdtham, U-G, Lothgren, M. (2000). On stationarity and cointegration of international health expenditure and GDP, *Journal of Health Economics*, Vol. 19, pp 461-475.

Gerdtham, U-G, Lothgren, M. (2002). New panel results on cointegration of international health expenditure and GDP, *Applied Economics*, Vol. 34, pp 1679-1686.

Gruenberg, E.M. (1977). The failure of success, *Milbank Quarterly*, Vol. 55, pp 3-24.

Hadri, K. (2000). Testing for stationarity in heterogeneous panel data, *Economic Journal*, Vol. 3, pp 148-161.

Herwartz, H. and Theilen, B. (2003). The determinants of health care expenditure: Testing pooling restrictions in small samples, *Health Economics*, Vol. 12, No. 1, pp 113-124.

Hitiris, T. and Posnett, J. (1992). The determinants and effects of health expenditure in developed countries, *Journal of Health Economics*, Vol. 11, No. 2, pp 173-181.

Im, K.S., Pesaran, M.H. and Shin, Y. (1995). Testing for unit roots in heterogenous panels, *Journal of Econometrics*, Vol. 115, pp 53-74.

Johansen, S. (1988). Statistical analysis of cointegrating vectors, *Journal of Economic Dynamics and Control*, Vol. 12, pp 231-254.

Johansen, S. (1991). Estimation and hypothesis testing of cointegrating vectors in Gaussian vector autoregressive models, *Econometrica*, Vol. 59, pp 1551-1580.

Jones, C.I. (2003). Why have health expenditures as a share of GDP risen so much?, *CEDA papers*, University of California, Berkeley and NBER, pp 1-36.

Kao, C. and Chiang, M.-H. (2000). On the estimation and inference of a cointegrated regression in panel data, *Advances in Econometrics*, Vol. 15, pp 179-222.

Kramer, M. (1980). The rising pandemic of mental disorders and associated chronic diseases and disabilities, *Scandinavian Supplement*, Vol. 62, pp 282-297.

Lee, R. and T. Miller. (2001). Evaluating the Performance of the Lee-Carter Method for Forecasting Mortality. *Demography*. Vol 38. pp 537-549.

Levin, A. and Lin, C.-F. (1992). Unit root tests in panel data: Asymptotic and finite-sample properties, *University of California San Diego Working Paper*.

Levin, A., Lin, C. and Chu, C.J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties, *Journal of Econometrics*, Vol. 108, pp 1-24.

Lubitz, J. and Riley, G.F. (1993). Trends in Medicare payments in the last year of life, *The New England Journal of Medicine*, Vol. 328, No. 15, pp 1092-1096.

McGuire, T.G., Parkin, D., Hughes, D. and Gerard, K. (1993). Econometric analyses of national health expenditures: Can positive economics help to answer normative questions?, *Health Economics*, Vol. 2, No. 1, pp 113-126.

Miller, T. (2001). Increasing longevity and medicare expenditures, *Demography*, Vol. 38, No. 2, pp 215-226.

Newhouse, J.P. (1977). Medical-care expenditures: A cross-national survey, *Journal of Human Resources*, Vol. 12, No. 1, pp 115-125.

Newey, W. and West, K. (1994). Automatic lag selection in covariance matrix estimation, *Review of Econometric Studies*, Vol. 61, pp 631-653.

Pedroni, P. (1995). Panel cointegration: Asymptotic and finite sample properties of pooled time series test with an application to the PPP hypothesis, *Indiana University Working Papers in Economics*, No. 95-013.

Pedroni, P. (2000). Fully modified OLS for the heterogeneous cointegrated panels, *Advances in Econometrics*, Vol. 15, Amsterdam: JAI Press, pp 93-130.

Phillips, P.C.B. and Hansen, B.E. (1990). Statistical inference in instrumental variable regression with I(1) processes, *Review of Economic Studies*, Vol. 57, No. 1, pp 99-125.

Phillips, P.C.B. and Moon, H.R. (1999). Linear regression limit theory for nonstationary panel data, *Econometrica*, Vol. 67, pp 1057-1111.

Phillips, P.C.B. and Perron, P. (1988). Testing for a unit root in time series regression, *Biometrika*, Vol. 75, pp 335-346.

Saikkonen, P. (1992). Estimaton and testing of cointegrated systems by an utoregressive approximation, *Econometric Theory*, Vol. 8, No. 1, pp 1-27.

Schultz, E. (2006). How do supply and demand factors influence aggregate health care expenditure with specific focus on age composition, *Final draft of the Ageing, Health Status and Determinants of Health Expenditure (AHEAD) Project under the EC 6th Research Framework Programme*.

Serup-Hansen, N., Wickstrom, J., Sonbo Kristiansen, I. (2002). Future health care costs: Do health care costs during the last year of life matter?, *Health Policy*, Vol. 62, No. 2, pp 161-172.

Seshamani, M. and Gray, A. (2004a). Ageing and health-care expenditure: The red herring argument revisited, *Health Economics*, Vol. 13, No. 4, pp 303-314.

Seshamani, M. and Gray, A. (2004b). A longitudinal study of the effects of age and time to death on hospital costs, *Health Economics*, Vol. 23, No. 2, pp 217-235.

Theil, H. (1971). *Principles of Econometrics*, North-Holland Publishing Company, Amsterdam-London, John-Wiley & Sons, Inc.

Wanless, D. (2004). *Securing good health for the whole population*, Final report, HM Treasury.

Weisbrod, B.A. (1991). The health care quadrilemma: An essay on technological change, insurance, quality of care, and cost containment, *Journal of Economic Literature*, Vol. 29, No. 5, pp 523-552.

Yang, Z., Norton, E.C., Stearns, S.C. (2003). Longevity and health care expenditures: The real reasons older people spend more, *Journal of Gerontology*, Vol. 58, No. 1, pp 2-10.

Zweifel, P., Felder, S. and Meiers, M. (1999). Ageing of population and health care expenditure: A red herring?, *Health Economics*, Vol. 8, No. 5, pp 485-496.