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Modelling health care expenditures

Overview of the literature and evidence from a panel time series model

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Abstract in English

Health care expenditures in industrial countries have been growing rapidly over the past forty years. This rapid growth jeopardizes the sustainability of public budgets and causes an increasing interest in the determinants of health care expenditures. The first purpose of this paper is to give an up to date overview of the literature on health care expenditures. Secondly, this paper tries to contribute to the existing literature by investigating the impact of several factors on health care expenditures in an empirical analysis using an error-correction model. Additional to the 'usual suspects' for rising health care expenditures, we pay attention to a somewhat neglected driving factor, which is the increase in the relative price of health care compared to other goods and services. We find that the increasing price of health care helps to explain the increase in real health care expenditures. However, the use of health care in volume terms is negatively affected by the increasing price. This effect seems to be stronger in periods of cost containment policy. Consistent with most recent findings in the literature, we find that income and ageing are important drivers of health care expenditures.

Key words: health care expenditures, error-correction model

JEL code: I100, H510

Abstract in Dutch

De zorguitgaven in de industriële landen zijn de afgelopen veertig jaar sterk gegroeid. Deze sterke groei vormt een bedreiging voor de houdbaarheid van de publieke budgetten en veroorzaakt een toenemende belangstelling voor de determinanten van de zorguitgaven. Dit paper geeft ten eerste een up-to-date overzicht van de bestaande literatuur over zorguitgaven. Daarnaast beoogt dit paper een bijdrage te leveren aan deze literatuur door het effect van verschillende factoren op de zorguitgaven in een empirische analyse te onderzoeken met behulp van een error-correctiemodel. Naast de bekende determinanten van stijgende zorguitgaven richten we ons hierbij op de invloed van de relatieve prijs van zorg. We vinden dat de stijgende relatieve prijs van zorg bijdraagt aan de stijgende zorguitgaven. Het effect van de relatieve prijs op de volumes van zorggebruik is echter negatief. Dit effect lijkt sterker te zijn in een periode van kostenbeheersing. In overeenstemming met recente onderzoeksresultaten vinden we dat inkomen en vergrijzing belangrijke determinanten zijn van de stijgende zorguitgaven.

Steekwoorden: zorguitgaven, error-correctiemodel

Contents

Summary

Health care expenditures in industrial countries have been growing rapidly over the past forty years. This rapid growth jeopardizes the sustainability of public budgets and causes an increasing interest in the determinants of health care expenditures. In the literature many factors are proposed as possible drivers of health care expenditures. The first purpose of this paper is to give an up to date overview of the literature on health care expenditures. From this we conclude that income, ageing and some institutional variables are important in explaining health care expenditures growth.

Secondly, this paper tries to contribute to the existing literature by investigating the impact of several factors on health care expenditures in an empirical analysis using an error-correction model. Additional to the common factors that are proposed in the literature, we pay attention to a somewhat neglected driving factor, which is the increase in the relative price of health care compared to other goods and services.

The estimation results suggest that there is a stable long run relationship between health care expenditures on the one hand and GDP, age structure of the population and the relative price of health care on the other hand. The relative price has a significant impact on health care expenditures in the long run and for most countries -among which the Netherlands - also in the short run. We find coefficients which imply that an increase in price decreases volume and increases real health care expenditures in the long run. Furthermore, the estimation results, though uncertain, suggest that the impact of the price was larger (in absolute value) during the period 1980-2003. This could be explained by the strong cost containment policy during this period, in which budgets are fixed and prices have less influence on expenditures.

Consistent with most recent findings in the literature, we find that income and ageing are important drivers of health care expenditures. The income elasticity is significantly positive and just below unity. It takes values of 0.93 and 0.96, which corresponds well to the existing literature. Ageing turns out to have a positive impact on health care expenditures, while both the coefficients of the population aged between 65 and 74 and the population aged above 75 are significantly positive.

1 Introduction

Health care expenditures (HCE) in industrial countries have been growing rapidly over the past forty years. In most countries expenditures on medical treatment tend to increase faster than gross domestic product (GDP). This rapid growth brings an improvement in life expectancy and quality of life, but also jeopardizes the sustainability of public budgets.[1] A particular concern for the next decades is that the ageing of the population may increase the expenditures on health care even more. This causes an increasing interest in the determinants of health care expenditures. Interestingly, the impact of ageing as such on health care expenditures is the subject of considerable debate. For example, the proponents of the cost of dying-hypothesis maintain that the last period of life is expensive in terms of health care, not so much ageing as such.

The research for this paper was carried out mostly as part of the AHEAD project (Ageing, Health Status and Determinants of Health Expenditure). This is a research project commissioned by the European Commission and carried out in the Enepri-network which focuses on the future evolution of health care expenditures in the European Union. This paper investigates the determinants of health care expenditures by both collecting recent insights from the existing literature and by carrying out an empirical analysis.

In the literature, many factors are proposed as possible drivers for health care expenditures. Gerdtham and Jönnson (2000) provide an overview of the literature on international comparisons of health care expenditures. They conclude that income is the most important variable. Other factors which are often used to explain health care expenditures are ageing, medical technology, health status of the population and some institutional variables.

The first purpose of this paper is to provide an up to date overview of the literature on international comparisons of health care expenditures. This gives an insight in the most important variables to be used in estimating and projecting health care expenditures. The selection of papers to review is based on the choice of explanatory variables, econometric methods used (especially regarding stationarity and cointegration issues), theoretical insights and recentness.

Furthermore, this paper aims to contribute to the existing literature by investigating the determinants of health care expenditures in an empirical analysis. We focus on a not commonly used variable: the relative price of health care. This price tends to increase over time because of the Baumol effect. This may decrease the demand for health care in terms of volume. Omitting the relative price in the set of explanatory variables may lead to biased coefficients for the other variables. Therefore, taking the relative price into account can be a valuable extension to most research done so far. Due to a lack of good data available, relative prices are constructed out of a series of prices and wages.

[1] See for example Cutler (2004) for the benefits of health care expenditures.

Many health economists use a fixed effects model for panel data analyses of health care expenditures. In the recent literature more attention is paid to topics like structural breaks and cointegration. Some drivers of health care expenditures are likely to have a unit root which may cause spurious regressions. To deal with non-stationarity of the variables we therefore adopt an error correction model.

The structure of this paper is as follows. Chapter 2 provides an overview of the literature on international health care expenditures. Chapter 3 introduces the variables to be studied and describes the data. It addresses the construction of data on the relative price. Chapter 4 discusses the research methodology and the model choice. The estimation results are presented in chapter 5. Chapter 6 summarizes the main findings and concludes.

2 Overview of the literature

2.1 Introduction

In one of the first cross section analyses of macro expenditures, Newhouse (1977) found that 92% of the variance in health care expenditures between countries could be explained by gross domestic product and that the income elasticity was larger than one. Since then, much research along those lines has been done, using cross-sectional data as well as time series and panel data. Gerdtham and Jönsson (2000) present an overview of the extensive literature on international comparisons of health care expenditure. They find that the most important factor explaining variations in health care expenditures is aggregate income. The effect of gross domestic product is positive and significant and close to unity or higher than unity. The effect of the population age structure is usually insignificant. The same holds for the less frequently used variables as unemployment rate and female labour participation. A number of institutional variables seem to be important too. For example, when the primary care sector acts a gatekeeper, the expenditures are lower. They also claim that the many macro-econometric analyses of health care expenditures lack a solid theoretical foundation.

There are several reasons why one should be careful in interpreting the results of macro analyses. First of all, there are data problems. Despite the effort put into it, time series are usually not fully comparable between countries, especially regarding the definition of long term care. A more basic problem is the difficulty of reliably measuring the volume of health care. Usually there are no market prices that can be used, only regulated or constructed prices. It is very difficult to properly correct for quality advances and improvements in the organisation of care. Secondly, there is the question whether pooling of countries or states is acceptable. There are many indications that the relevant restrictions will be rejected, if tested (see Roberts (1999), Ariste and Carr (2003), Murillo et al. (1993), O'Connell (1996), Clemente et al (2004).) On the other hand, in making projections the results on pooled data may still be superior. Baltagi and Griffin (1997) show for gasoline consumption that pooling leads to higher quality long-run forecasts. They conclude: 'Using a root mean square error criterion, the efficiency gains from pooling appear to more than offset the biases due to intercountry heterogeneities.'(p. 317).

Finally, the stationarity of the data is questioned. With non-stationary data spurious results may be found. Roberts (2000) remarks on this point: 'In summary the regression of non-stationary variables is likely to result in a spurious regression problem, by which the apparent close correlation between health care expenditure and, for example, per capita income is the result of common trends rather than evidence of any real economic relationship. ….. In the special case where a linear combination of non-stationary variables is itself stationary, then this combination represents the cointegrating, or long-run, relationship, which can be specified in levels, with short-run dynamics modelled via an error correction process.' The issue of the best possible analysis of most likely non-stationary data in this area has not yet been settled.

In the past 10 years, many researchers carried out different tests for stationarity and cointegration (see for example Gerdtham and Jönsson (2000) for an overview of earlier results, Dreger and Reimers (2005), Okunade and Murthy (2002), Gerdtham and Löthgren (2002), Clemente et al (2004), Jewell et al (2003)and Okunade et al (2004)). Some of these researchers allowed for the possibility of structural breaks in the data which appears to give different results on stationarity. Below we will give much attention to the creation of a useful time series model for health care expenditures.

2.2 Important drivers of health care expenditures

Table 2.1 gives a brief summary of estimation results of various studies for a number of important variables or groups of variables. In accordance with Gerdtham and Jönsson (2000) we find gross domestic product per capita to be an important explanatory factor in these analyses, but unlike these authors we find many income elasticities to be lower than one, especially in recent studies. Also, in contrast to their findings, ageing was associated with higher health care expenditures in many recent studies. Proxies for the introduction and diffusion of new medical technology (mostly simple trends) usually have a positive significant effect on health care expenditures. Some researchers also use institutions and the relative price of health care in their attempts to explain the development of health care expenditures.

Table 2.1	**Summary of parameters estimation results (across various models with different specifications)**						
	GDP	Ageing	Relative price health	Technology	Trend	Share of public financing	Other insti-tutions
Christiansen et al (2006)	0.56	not significant in the final specification		positive significant	1,5%	0.009	significant
OECD (2006)	0.87	significant positive			2% for 70's 1.3 and 1% for 80s and 90s		
Ligthart (2006)	0.72 - 0.99	significant positive			0.6 - 1.5%		
Dreger and Reimers (2005)	0.68 - 0.84	significant positive		proxies e.g. share of the elderly			
Okunade et al (2004)	0.86 (growth)	significant positive (growth)	0.41 (growth) HCE in real terms			– 0.13	significant
Clemente et al (2004)	1.4 - 3.65 before break (individual countries)				different constant and income el. in most countries after break		
Ariste and Carr (2003)	0.88	not significant			2%		
Okunade and Murthy (2002)	1.56 - 1.64			positive significant effect of R&D			
Roberts (1999)	1.25 - 2.04	not significant	– 0.43 - 0.47 (HCE in real terms)		– 2,4%	– 0.13 - 0.76	
Gerdtham et al (1998)	0.66 - 0.82	negative, not very significant		positive significant			significant
Barros (1998)	0.62 - 0.92 (growth)	not significant			growth HCE lower in 1980-1990	not significant	not significant
O'Connell (1996)	0.53	significant positive			HCE in 1990 26% higher than 1975	– 0.11	
Murthy and Ukpolo (1994)	0.77	significant positive	– 0.22 HCE in real terms			0.78	
Murillo et al (1993)	1.13 - 2.17		– 0.43 - – 1.11 HCE in volume				

The relative price of health care has generally been increasing in the past decades. This may be one of the factors underlying the increase in real health care expenditures, unless the higher relative price was offset by lower volumes. We start by discussing the role of the relative price. After that, income, ageing, technology and institutions will be discussed.

Relative prices

The health care sector is labour-intensive and it is possible that labour productivity thus increases less fast than it does in other sectors of the economy (Baumol, 1967). However, wages in the health care sector have to be in line with the rest of the economy over the longer run in order to be able to attract enough labour. Therefore, it likely that health care becomes relatively more expensive over time. Okunade et al (2004) show that the relative prices of health care, for a large number of OECD countries, increased in every sub-period from 1968 till 1992. Only in the period 1993-1997 it decreased. This increase in the relative price of health care may affect the volume of health care demand and the real health care expenditure. The volume can be expected to decrease. The real expenditures may increase if health care is a (relatively) price-inelastic good. There may be differences in the relative price of health care between countries (at the same moments in time), due to differences in policies with respect to the regulation of prices, or differences in labour supply.

In many studies, the relative price is not included in the set of explanatory variables. This means that other estimated coefficients may be biased if the series are correlated with the relative price. Murillo et al (1993) express health care expenditures in volume terms and find negative price-elasticities for nine European countries in practically all of their estimated models. Most of the estimated elasticities are smaller than 1 in absolute sense. This means that real health care expenditures (deflated by the price of GDP) increase when the relative price increases. This is also what Okunade et al (2004) find for the growth of real health care expenditures for OECD countries. Murthy and Ukpolo (1994) on the other hand find a long-run negative effect of the relative price on real health care expenditures for the USA, A 1% increase in relative price leads to a -0.22 % decrease in real health care expenditures. This means that the volume of health care expenditures is decreased by about 1.2% and it seems to indicate that the volume of health care expenditures is price-elastic. It is possible that the macro-price elasticity is larger (in absolute terms) in the USA than in Europe. Roberts (1999) finds positive long-run elasticities for real health care expenditures smaller than one for relative prices in 4 out of 5 estimated models for 20 OECD-countries. In a cross-section analysis of OECD countries, Gerdtham and Jönsson (1991) find a price-elasticity of -0.84 for the volume of health care (and an income elasticity of 1.43). The available evidence for OECD-countries seems to suggest that an increase in the relative price of health care causes larger real health care expenditures and a lower volume of health care.

The role of income

The overview of Gerdtham and Jönsson (2000) shows that gross domestic product is the single most important variable used to explain health care expenditures in macro-studies. We could ask ourselves why that would be the case. As national income increases we want to have nicer houses, better holidays, more new clothes and perhaps better public services. But we might not become ill more often, so why would we want to have more health care? Health care is not a service that we consume because it is fun to consume. We just want to become healthy or stay healthy. One possible explanation for the effect of income is that we would have liked to have more health care before but decided we could not afford it with a lower national income. In other words, there was an unmet need for health care.

Another explanation is that we wish to spend more on health care because new technology opens up wonderful new possibilities. Hall and Jones (2004) expand on this explanation. They study the share of health care in income with the help of a theoretical model in which utility depends upon consumption and health status and they formulate a health production function. They conclude that technological development alone is not enough to explain *an increasing share* of health care in income. The technology not only has to be available to buy, but people should also want to buy it. The reason that they might want that is that the marginal utility of consumption decreases as they get richer. The marginal utility of spending extra money on health care may also decrease, but not as fast. There are indications that the value of a statistical life increases over time at a faster rate than the growth of gross domestic product. Their estimation results indicate that the marginal costs of saving a life also increase over time (from 1950 to 2000). Technological progress in itself is not a crucial factor in explaining a rising share of health care in their model, as in the simple version of the model progress may even decrease the optimal health share depending on the form of the health production function. A relatively fast decrease of the marginal utility of consumption is crucial. Hall and Jones (2004) formulate it as follows: 'In summary, our basic model suggests that the health share rises over time as income grows if the joy associated with living an extra year does not diminish as quickly as the marginal utility of consumption (p. 11).' Their model might help to explain why a large effect of income on health care expenditures may be found.

All the studies summarized in table 2.1 find a significant positive effect of income. However, some estimation results may be biased because of omitted variables that may be correlated with gross domestic product. Researchers who ignore the influence of technological change or positive trends in general may overestimate the income elasticity. Hence, a proper econometric model linking health care expenditures with income should cover the trend in the right way. The same applies to studies where relative prices from the equation are omitted as long as the relative price for health care increases and the price-elasticity of real health care expenditures is positive.

Usually researchers who include a trend or some proxy for technological development find income elasticities lower than one. Exceptions are Roberts (1999) and Okunade and Murthy

(2002). Roberts finds high income elasticities, mostly positive price elasticities and a negative trend. The negative trend is surprising. Okunade and Murthy (2002) include health R&D or total R&D as an indication for technological development but still find high income elasticities for the USA. Their estimate of the income elasticity may be biased upwards because they omit the relative price.

The evidence might indicate that the 'true' income elasticity, that would be found when all relevant explanatory variables are included, is smaller than one. Another explanation for the recent results is that the income elasticity decreased over time. An interesting question in the light of the discussion above is whether larger health care expenditures are actually caused by higher gross domestic product. Devlin and Hansen (2001) test for Granger-causality between gross domestic product and health care expenditures for 20 OECD-countries. For 6 countries health care expenditures 'cause' gross domestic product[2], for 6 countries gross domestic product causes health care expenditures and for 2 countries the causality works both ways. For 6 countries no causality is found. They warn that this result is dependent on the choice for bivariate equations; multivariate equations might give different results. It is remarkable that the causality from gross domestic product to health care expenditures that is implicitly assumed in many analyses is only found for 6 countries.

Ageing

Gerdtham and Jönsson (2000) conclude that generally not much effect of ageing is found in international comparisons of health care expenditures. In contrast to their findings, many of the studies summarized in table 2.1, especially the most recent ones, do find a significant and positive effect of ageing on health care expenditures.

At first sight, one would expect a positive effect of ageing on health care expenditures as older people use much more health care than younger people. However, Zweifel (1999) has tried to show that this pattern is mostly associated with the high cost of dying and the fact that older people have a larger probability of dying. An overview of the literature on death related costs is given in Raitano (2005). His findings can be summarized as follows. Health care costs of decedents are much higher than those for survivors. Costs in the last period of life decrease with age. The age pattern for long term care is different than that for health care. Econometric studies show for people over 65 that proximity to death has a larger effect on health care expenditures than age. There is still uncertainty about the residual influence of age once proximity to death is taken into account. Projection studies that distinguish between decedents and survivors all find a lower increase in health care expenditures, but the reduction differs significantly among studies. Raitano's final conclusion is that 'age alone is not a good predictor of health spending growth, and that proximity to death must also be used as a predictor of health care expenditure.' (p. 19).

[2] Health care expenditures can increase human capital.

Hence, a positive effect of ageing on health care expenditures is not inconsistent with the literature on death-related costs. But in making projections the effect of proximity to death should not be ignored.

Christiansen et al. (2006) find different effects for both the proportion of the population aged 65-74 and the proportion aged 75+ for the 15 old EU countries, depending on the model specification. In the most extensive model, in which country fixed effects, a time trend and many institutional variables are included the effect of the age structure is insignificant. Dreger and Reimers (2005), Okunade et al. (2004) and O'Connell (1996) find a positive and significant effect for the share of the population over 65 for OECD countries. Ligthart (2006) shows a similar result for the old EU countries. Murthy and Ukpolo (1994) find a large positive effect of the share over 65 for the USA. In contrast, Gerdtham et al (1998) find a positive effect on health care expenditures for the share of ages 0-4 and a slight negative effect for people over 75. The OECD (2006) finds a positive effect of the average population age on health care expenditures.

Influence of technology/trends

The results of Gerdtham and Löthgren (2002) indicate that a trend should be included in the long term relation between health care expenditures and gross domestic product. Given the chosen variables their model cannot explain the growth of health care expenditures without an independent trend. Researchers who allow for trends in real health care spending over time practically always find a positive trend despite the fact that gross domestic product is included as an explanatory variable (see OECD(2006), Ligthart (2006), Ariste and Carr (2003), Freeman (2003) and O'Connell (1996)), where Roberts (1999) is an exception. The cost-increasing effect of technological change in health care is often given as an explanation (see Weisbrod, 1991). Technological change in health care may have cost-saving effects as in many other sectors. However, an important effect is that conditions become treatable that were previously not or badly treatable or not treatable for frail patients. New treatment options may be added to the old ones instead of substituted. Patients who would have died earlier are kept alive, but often not completely cured. Their chronic conditions have to be treated for a long time. New drugs are often very expensive. The consensus seems to be that technological change brings us saved life-years and improved quality of life, but also on balance increases in the costs of health care (see Cutler, 2004).

The role of technology may become clearer by including proxies for technological development in the model instead of just trends. Okunade and Murthy (2002) include health R&D or total R&D as proxies for technological development in a time series analysis for the USA (cointegration estimation). R&D has a positive and significant effect on health care expenditures. They state (p. 157): "Our findings confirm, econometrically for the first time in this line of inquiry, the untested conjecture that changes in R&D spending, a proxy for changes in technology, is a statistically significant long-run driver of rising health care expenditure." Dreger and Reimers (2005) consider life expectancy, infant mortality and share of the elderly as

possible proxies for medical progress. Their cointegration analysis yields the expected signs for these variables, which are included in the equation for health care expenditures one by one. However, their role as proxies for medical progress seems to be not beyond doubt, especially for the share of the elderly. This is probably in many countries influenced more by the post war baby boom and the drop in fertility than by medical progress. Infant mortality and life expectancy are not just influenced by medical progress, but also by health behaviour, environmental factors, hygiene, and so on. Gerdtham et al (1998) include the number of renal dialyses per million of the population as a proxy and find a positive significant effect. Christiansen et al (2006) also find a positive effect of such proxies. All in all there seems to be some evidence that technological progress can explain the positive trends in health care expenditure. This explanation seems to be plausible. The complementary view of Hall and Jones (2004) on the role of technology was discussed in the section on income. Their model suggests that technological progress by itself is not enough to explain a rising share of health care in GDP. It has to be combined with a relatively fast decrease of the marginal utility of consumption.

Institutions and supply of health care

Christiansen et al (2006), Gerdtham et al (1998), Roberts (1999), Murthy and Ukpolo (1994), O'Connell (1996) and Okunade et al (2004) all find a significant effect of institutions on health care expenditures. Barros (1998) finds no significant results. In some analyses only the share of public financing in health care is included. It is not a priori clear which sign this variable should have. Leu (1986) expected a positive sign because bureaucrats try to maximize their budgets and there is less competition in the public sector. An alternative explanation is that a larger share of public financing makes it possible to increase the number of people insured or the coverage which will lead to higher health care expenditures because of moral hazard effects. On the other hand, competition in the private sector may not be very successful in controlling cost growth because of large information asymmetries and the presence of health insurance. It may be easier to contain costs in the public sector and there may also be a larger incentive because of worries about an increase of government share in gross domestic product.

The empirical work does not give a clear answer as positive as well as negative signs are found in different studies. Okunade et al (2004) find a negative sign for the share of public financing not only for their panel data estimates but also for about every sub-period, except 1973-1977.

Okunade et al (2004) and Gerdtham et al (1998) classified health systems as public integrated, public contract or public reimbursement. In a public integrated system, one organisation controls funding as well as the provision of care (for example the NHS in the United Kingdom). In a contract system, third party payers negotiate with health care providers and patients should in principle use providers that are under contract with their insurer. In a reimbursement system, consumers have free choice of providers and providers are reimbursed

by patients or their insurers. One would expect that it is easiest to control the growth of costs in a public integrated system and a public contract system after that. Gerdtham et al (1998) find lower health care expenditures under public reimbursement than under public integrated systems in all of their estimated models, which is surprising. They find their results for public reimbursement systems difficult to explain. A possible explanation is that public integrated systems have higher shares of in-patient care, which is expensive, and they also have fewer gate-keeping arrangements. Okunade et al (2004) find for four of the six sub-periods that a public integrated system lowered the growth of health care expenditures, but the overall effect in the panel data models is positive and significant. The public reimbursement system is associated with a higher growth of health care expenditures, not just for the whole period, but also for every sub-period.

The effect of overall ceilings for hospitals on health care expenditures is positive in Gerdtham et al (1998). This may be a selection effect. Countries with high growth of health care expenditures may decide to maximize hospital costs. Gerdtham et al. (1998) find a positive effect of the share of in-patient care in total health care on health care expenditures and a positive effect of public insurance coverage. For gate keeping, a negative effect was found. Okunade et al (2004) find different effects for different sub periods for gatekeeping. Gerdtham et al (1998) find a negative effect for capitation and for capitation in combination with wages and salaries compared to fee-for-service systems. In Christiansen et al. (2006), salaried general practitioners (GP's) and GP's with capitation payment are associated with lower health care expenditures compared to GP's under a fee-for-service system. According to Okunade et al (2004) capitation in the primary care sector leads to higher health care expenditures growth over the whole period (significantly lower in 1988-1992). According to Christiansen et al. (2006) case-based reimbursement of hospitals leads to lower health care expenditures.

All in all, institutions seem to matter for health care expenditures but the evidence on the precise effect of institutions is confusing and inconclusive.

In a market where demand is formulated independently from supply, one would expect that an increase in supply decreases the price and -in case of an inelastic good- decreases expenditures. However, in the health care market supplier-induced demand is a possibility that is extensively discussed in the literature. If the supplier-induced demand hypothesis is valid (or health care is elastic) a positive sign for the number of doctors per capita may be found. The evidence from macro studies on this point is conflicting. Okunade et al (2004) find a positive effect of the number of physicians on health care expenditures, while Christiansen et al (2006) find a negative effect. Murthy and Ukpolo (1994) find an important negative effect of the number of doctors and advise policy makers to train more doctors. Gerdtham et al (1998) find a negative effect of the supply of physicians in itself, but a positive effect in combination with a fee-for-service system. Christiansen et al (2006) find a positive sign for the number of acute care beds.

Health and behaviour

A more healthy behaviour may lower the growth of health care expenditures over the long run, but this does not necessarily have to be the case. For example, not-smoking might keep people from dying from lung cancer at a comparatively young age, with as a consequence that they have a larger probability of suffering from chronic diseases associated with ageing. Taking health behaviour into account is difficult with commonly available data, as lags between behaviour and health effect may be very long. A person who starts smoking now, may get lung cancer in 30 years from now. Christiansen et al (2006) and Gerdtham et al (1998) both find that tobacco consumption is associated with higher health care expenditures. In addition, they both find no significant effect of alcohol consumption.

2.3 Conclusions from the literature

Income and technology are both important drivers of health care expenditure. The influence of these two factors is difficult to unravel. Without an increase in income it is difficult to spend more on new medical technology, but without new technology in the end there will be no reason to want more health care per capita, unless morbidity is increasing.

The effect of ageing is significant in many recent studies. Despite the high cost of dying, ageing as such also seems to increase health care expenditures over time. This seems especially likely for the costs of long-term care. However, institutions are also important for these costs. In countries with a traditionally high institutionalisation rate costs increases may be curbed by a new organisation of long term care. With respect to institutional variables we generally conclude that they seem to matter, but their effect is not a priori clear. The rise in relative prices of health care may help to explain the increase in health care expenditure.

3 Data

From the literature review, we conclude that more attention should be paid to the relative price of health care as driver for health care expenditures. This section discusses the data we will use in our empirical analysis below, where we pay particular attention to the construction of relative prices.

To study which factors affect health care expenditures and to what extent, we make use of a macro panel data set. The main data source used for this research is the OECD Health Data 2005. At our disposal we have (unbalanced) panel data on health care expenditures, income, ageing, and the public share of health care expenditures of the old 15 EU countries for the period 1970-2003. We analyse health care expenditures for the 8 countries for which the data are most extensive and these are Austria, Finland, Ireland, Luxembourg, the Netherlands, Portugal, Spain and the United Kingdom.

An overview of all variables used in the models can be found in Appendix A. We will use real health care expenditures as the dependent variable. Note that for the estimation results it makes no difference whether this variable is used or the purchasing power parity- and inflation corrected health care expenditures (see box at the end of this section).

The OECD Health Data set does not provide data on the relative price of health care. To analyse the influence of the relative price, we have constructed series for the relative prices of health care out of series of wages and a consumer price index. This construction method is discussed in appendix B. We have added these constructed series of the relative price for each country to the OECD data to complete our data set.

To verify the constructed price of health care we have compared it with the available CPI-health data from the OECD Health Data. This source contains CPI-health data for three of the countries under consideration. Figure 3.1 presents the CPI-health for the available countries and our constructed prices (price indices with base year 2000).

Figure 3.1 Constructed prices and CPI-health per country

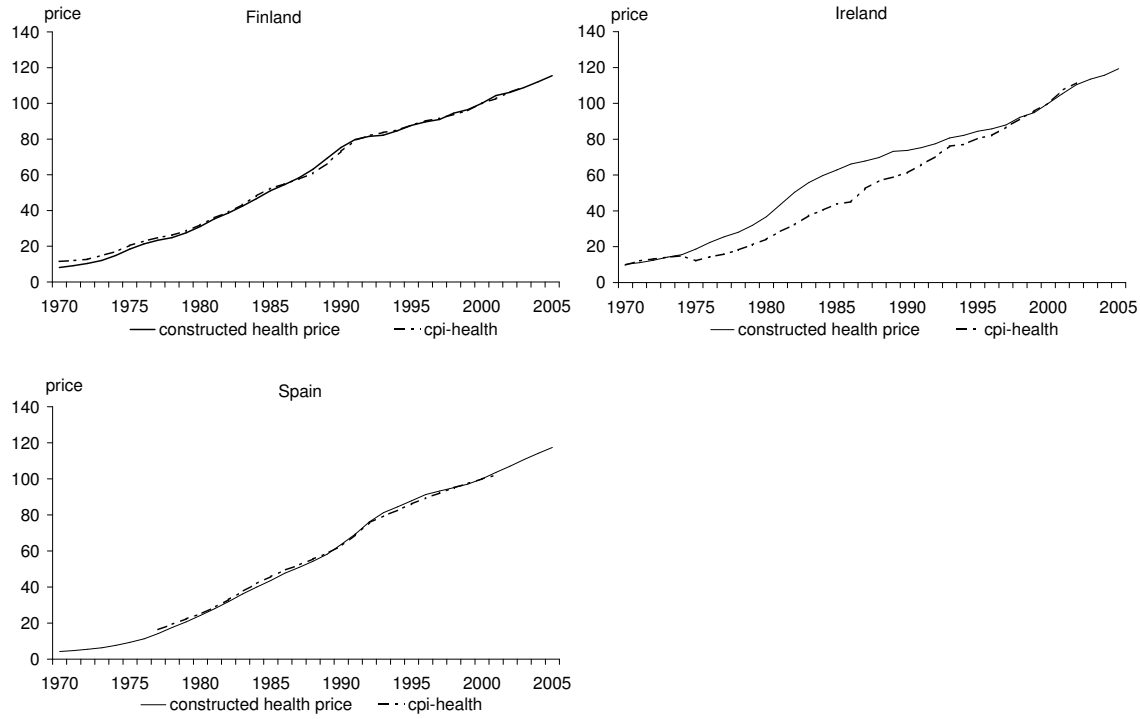
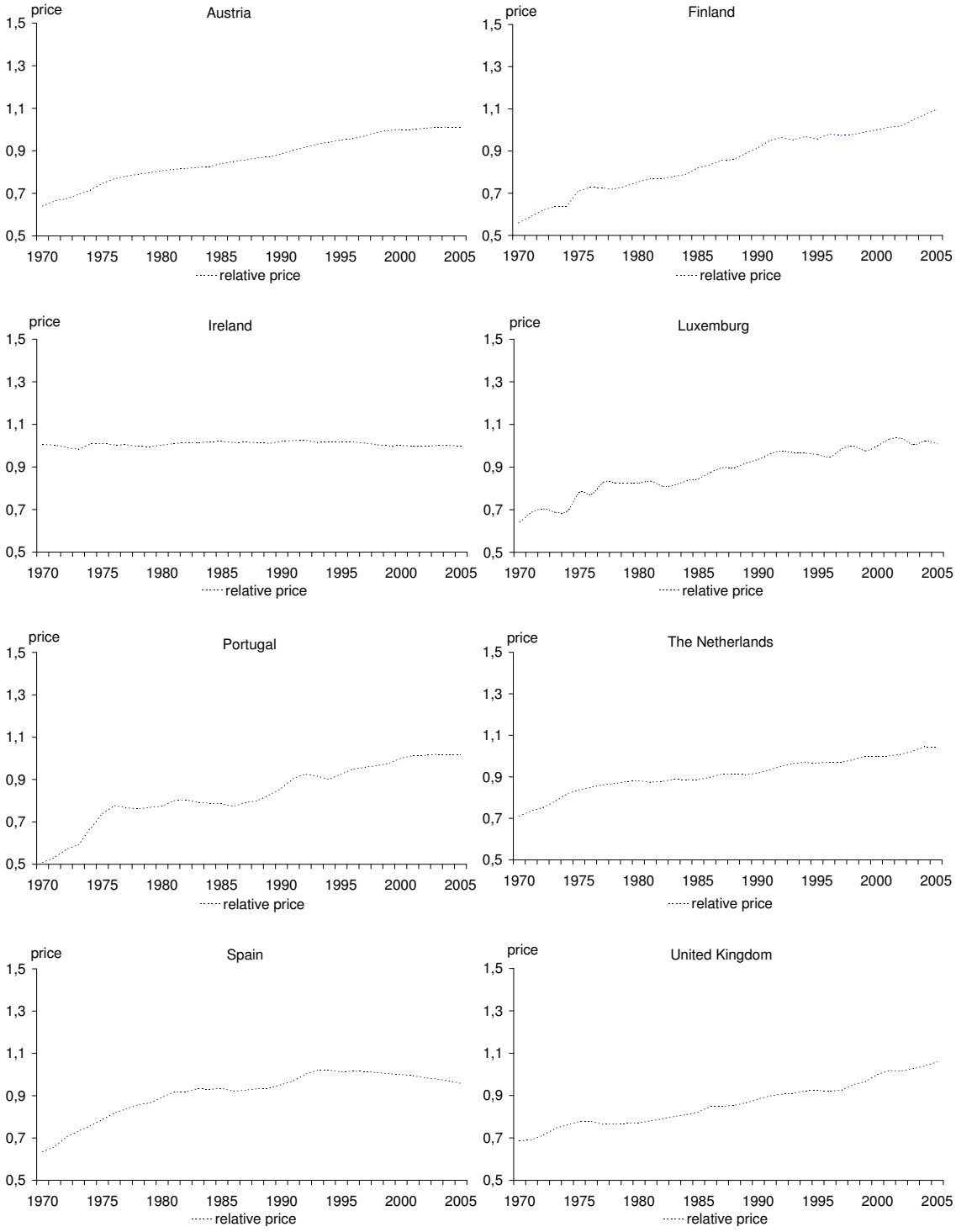


Figure 3.1 shows that our constructed prices are reasonably close to the health CPI data. This gives confidence about the reliability of our data on relative prices.

By deflating all constructed prices for health care by the GDP price, we obtain the relative health care prices for each country. The developments of the relative prices per country for each of the 8 countries under consideration are displayed in figure 3.2. For about all countries, the constructed relative price of health care has increased between 1970 and 2003. Only Ireland is an exception.

Figure 3.2 Constructed relative prices for the EU-15 countries (base year = 2000)



The use of purchasing power parities

In order to find out which factors influence health care expenditures, most studies make use of a macro data set and estimate various linear models. Total health care expenditures are almost always used as the dependent variable. These expenditures can be decomposed in volumes of demand and prices. Basically, we are interested in the impact of various variables on the volume.

Unfortunately, however, because of a lack of good data on volumes and prices we cannot directly distinguish between them. Hence, confusion between prices and quantities may easily arise, for example because of the use of market exchange rates to convert HCE and GDP into a common unit, like Newhouse (1977) did. This inadequate distinction between volumes and prices could be the explanation for the high income elasticity he found. Often, researchers use purchasing power parities (PPP's) to partly avoid this problem and convert the expenditures into a common unit.

The overall price level as well as the price level for health care (a basket of health care goods and services) can differ across countries and fluctuate over time. PPP's correct for differences in overall price levels between countries. To adjust PPP-corrected expenditures for overall price levels over time, one has to deflate with GDP prices of the reference country. For example, if health care expenditures for a number of countries are given in US $ PPP's (after correction for inflation differences between countries), they have to be deflated with the US GDP price to correct for inflation over time. This PPP-corrected and inflation-corrected health care expenditure is frequently used by researchers as a dependent variable. Notice that with respect to the estimation results it makes no difference whether PPP- and inflation-corrected expenditures are taken as dependent variable or just real health care expenditures for each country (expenditures of each country deflated with its own GDP price). The only use of PPP's is to convert the expenditures to a common currency which makes series comparable across countries. For the estimation results there is no additional use in converting expenditures to PPP's.

Differences in real health care expenditures (or PPP-corrected and inflation-corrected health care expenditures) between countries or over time still reflect not only differences in the volume of health care but also differences in the relative price of health care.[a] As discussed in section 2.2, the relative price of health care compared to other goods and services, defined as the price of health care deflated with the GDP price, can vary over time and across countries. Therefore, including the relative price of health care in the set of explanatory variables makes it possible to make a clear distinction between prices and volumes.

[a] A possible solution to avoid this is to use a basket of health care goods and services to determine PPP's. In that case the PPP-corrected values have to be deflated with the price of health care in the reference country to correct for differences in health care prices over time. Then, differences in the 'health PPP'-corrected and 'inflation in health care' corrected HCE reflect only differences in volumes. However, reliable health PPP's are difficult to construct and are rarely used in analyses.

4 Method and model

We have annual time series data for 8 countries and these data concern:

$HCE_{i,t}$ = real health care expenditure per capita for country i at time t
$GDP_{i,t}$ = real gross domestic product per capita for country i at time t
$POP65\_74_{i,t}$ = proportion of population aged 65-74 for country i at time t
$POP75_{i,t}$ = proportion of population aged above 75 for country i at time t
$PUBLIC_{i,t}$ = public share of total health care expenditures for country i at time t
$PRICE_{i,t}$ = relative price of health care in country i at time t.

Tests for unit roots on the individual series indicate that for most series we cannot reject the relevant null hypothesis.[3] Most series show an upward trending pattern and it is now of interest to see if these trends are somehow similar, or put otherwise, whether there is cointegration across these variables.

The sample size is too small to perform a 6-variable multivariate test for cointegration. The power of such a test in this case is extremely low. Hence, we do not pursue along these lines. Another issue is that we are basically interested in the properties of a single cointegration relationship (should one exist), and this concerns the long-term link between expenditures and the other five variables. So, our model below shall contain a single variable linking the levels of the data. In addition, as we have annual data, current growth rates of the explanatory variables are likely to be correlated with current growth rates in expenditures. Finally, to increase the power of the statistical analysis on the long-run relationship, and also following the suggestions of Baltagi and Griffin (1997), we impose that it is the same across the 8 countries under scrutiny. Together this leads to the 8-equation model:

$$\log(HCE_{i,t}) - \log(HCE_{i,t-1}) = \beta_{i1} + \beta_{i2}[\log(HCE_{i,t-1}) - \beta_3 \log(GDP_{i,t-1}) - \beta_4 \log(POP65\_74_{i,t-1}) - \beta_5 \log(POP75_{i,t-1}) - \beta_6 \log(PUBLIC_{i,t-1}) - \beta_7 \log(PRICE_{i,t-1})] + \beta_{i8}(\log(GDP_{i,t}) - \log(GDP_{i,t-1})) + \beta_{i9}(\log(POP65\_74_{i,t}) - \log(POP65\_74_{i,t-1})) + \beta_{i10}(\log(POP75_{i,t}) - \log(POP75_{i,t-1})) + \beta_{i11}(\log(PUBLIC_{i,t}) - \log(PUBLIC_{i,t-1})) + \beta_{i12}(\log(PRICE_{i,t}) - \log(PRICE_{i,t-1})) + \varepsilon_{i,t} \quad (4.1)$$

for i = 1,2,..,8.

To examine if there is a relevant cointegration relation in this so-called conditional error correction model, one can test the significance of the adjustment parameters β_{i2}, see Boswijk (1994). This means that one tests for the joint significance of $\log(HCE_{i,t-1})$, $\log(GDP_{i,t-1})$, log

[3] Details can be obtained from the authors.

($POP65\_74_{i,t-1}$), log ($POP75_{i,t-1}$), log ($PUBLIC_{i,t-1}$) and log ($PRICE_{i,t-1}$) in the linearized version of model (4.1).

After estimation of model (4.1) with seemingly unrelated regression (SUR), we proceed by dropping all statistically insignificant current growth rates of the explanatory variables to obtain our final model.

5 Estimation Results

This section presents the results of the cointegration test and the estimation results of the error correction models for two different time periods.[4]

The results for the Wald test for cointegration and the estimated adjustment parameters β_{i2} are given in table 5.1.

Table 5.1 Wald test results and adjustment parameters ECM by country, 1970-2003

Country	Wald test	Coefficient	Standard Error	Number of periods T after which 95% of shock has died out
Austria	39.34	– 0.205	0.083	13
Finland	28.44	– 0.051	0.023	57
Ireland	65.99	– 0.318	0.055	8
Luxemburg	37.95	– 0.504	0.098	4
Netherlands	33.13	– 0.254	0.053	10
Portugal	17.54	– 0.317	0.100	8
Spain	32.90	– 0.516	0.101	4
United Kingdom	10.84	– 0.206	0.070	13

The critical value of the Wald test is 25.66 at the 5% level and 20.19 at the 20% level.

For Austria, Finland, Ireland, Luxemburg, Netherlands and Spain we find clear evidence of cointegration. For the United Kingdom and Portugal the evidence is less clear. However, given the limited number of observations we choose to leave these countries in our pooled model. Clearly, the estimated adjustment parameters have the proper sign and, assuming that there is a single cointegration relation for all 8 countries, the parameters are all unequal to zero. The adjustment parameters can be interpreted in terms of the number of periods it takes before a shock has died out to a certain extent. Table 5.1 presents the number of periods T, which is defined as the 95% duration interval of a shock to the equilibrium relation (due to for example increased income or higher prices). In other words, after T periods 95% of the shock has died out. The table shows that there is a wide variation in the 95% duration interval among the countries considered. In reality of course we never observe a new long run equilibrium because the driving factors keep on changing.

The long-run cointegration relation parameters are given in table 5.2.

[4] We have also examined the 8 series of estimated residuals, but find no signs of serious misspecification.

Table 5.2 Estimation results ECM long run 1970-2003

Variable	Coefficient	Standard Error	T-statistic
Log (GDP)	0.934	0.039	24.14
Log (POP65_74)	0.267	0.085	3.16
Log (POP75)	0.472	0.078	6.06
Log (PUBLIC)	– 0.191	0.124	– 1.54
Log (PRICE)	0.684	0.133	5.15

The t-statistic of these parameters is not distributed as standard t, but still, the obtained values suggest confidence in the relevance of all but one variable (log(PUBLIC)) in the long-run relation. The coefficient of GDP is close to but less than unity. The age composition of the population is also important with a larger impact of the older population group (over 75) on the development of expenditures. An increase in the relative price of health care is associated with a less than proportionate increase in real expenditures. This means that, in the long run, part of the increase in relative prices is "compensated" by a decrease in the volume of health care consumed.

Table 5.3 Estimation results ECM short run by country, 1970-2003

	Log(PRICE)	Log(POP75)	Log(PUBLIC)
Austria	3.687		– 1.029
Finland	1.204	0.574	0.762
Ireland			
Luxemburg	0.540	0.203	
Netherlands	0.869		
Portugal	0.997		– 0.286
Spain			– 0.308
United Kingdom			1.180

Another interesting question is which factors influence health care expenditures in the short run. Table 5.3 presents the estimation results of the short run coefficients that are part of our final model for each of the countries. All of these coefficients are significant at a 5% level. From the estimation results it follows that especially changes in the relative price of health care and the share of public financing are important in the short run. The large positive effect of changes in the relative price seems to suggest that in the short run these changes mostly lead to an increase in real health care expenditures. For Austria, Finland, Portugal and the Netherlands the short run impact of price changes is somewhat larger than the long run impact.

For the Netherlands, the direct effect of a temporary 1% increase in the relative price of health care is an increase in real health care expenditures of 0.87%. In the next period and the periods after real health care expenditures are somewhat decreased because of the error correction mechanism. After 10 periods the cumulative effect of a 1% increase in the relative price is 0,69% increase in real health care expenditures. After an infinite number is periods the

cumulative effect would be equal to the long run parameter: 0,68%. So the long run effect is somewhat smaller than the direct effect for the Netherlands. For most other countries (except Luxemburg) the difference between short and long run effects of a change in relative price is much larger.

From 1980 on, in many countries a more severe cost containment policy was followed in health care as a reaction to rapidly increasing health care expenditures. In table 5.4 the results of the conditional ECM are given for the period 1980-2003. The impact of GDP and the age structure of the population do not differ much compared to 1970-2003. The impact of the oldest age group seems somewhat higher. Because of the limited number of observations we have to be careful drawing conclusions about the difference in periods. The results seem to suggest that an increase in the relative price of health care has somewhat less long-run impact on real health care expenditures in the period of cost containment. A possible explanation for decreasing the volume of health care to a larger extent is that more emphasis will be put on staying within a budget. If relative price increases can not be prevented, decreasing the volume of care can serve as an alternative in a period where cost containment is an important policy goal.

Developments in the public share of financing on the other hand have an almost significant positive effect on real health care expenditures in the cost containment period, while for 1970-2003 no significant effect could be found. In 6 of the 8 countries under consideration the share of public financing decreased between 1980 and 2003. Possibly this decrease in the share of public financing is only partly compensated by an increase in private expenditures on health care, meaning that total health care expenditures drop.

Table 5.4 Estimation results ECM long run 1980-2003

Variable	Coefficient	Standard Error	T-statistic
log (GDP)	0.961	0.053	18.05
log (POP65_74)	0.297	0.115	2.57
log (POP75)	0.583	0.095	6.15
log (PUBLIC)	0.220	0.120	1.82
log (PRICE)	0.431	0.214	2.01

6 Conclusions

Based on a study of the literature on international health care expenditures we extend the macro-model with the factor relative prices of health care. In order to test the impact of relative prices we construct a time series. Furthermore, we use an error correction model to gain more insight into short run and long run dynamics of the driving factors of health care expenditures. The estimation results suggest that there is a stable long run relationship between health care expenditures on the one hand and GDP, age structure of the population and the relative price of health care on the other hand. In the short run, the growth of health care expenditures is mainly affected by changes in the relative price and changes in the share of public financing. The speed of adjustment to the long run equilibrium differs considerably among the countries considered. For some countries the effects of a temporary shock in one of the drivers of the health care expenditures takes a long time to die out. Given the direct and long run effects, the conclusion seems justified that the effect of the relative price should be taken into account in modelling health care expenditures.

For the relative price of health care our conclusions are the following. The relative price has a significant impact on health care expenditures in the long run and for most countries -among which the Netherlands - also in the short run. We find coefficients which imply that an increase in price decreases volume and increases real health care expenditures in the long run. Furthermore, the estimation results, though uncertain, suggest that the impact of the price was larger (in absolute value) during the period 1980-2003. This could be explained by the strong cost containment policy during this period, in which budgets are fixed and prices have less influence on expenditures. As more observations are needed to draw robust conclusions, further research is needed on this point.

It is conceivable that price elasticities will change when health care markets develop to more demand-driven systems. Moreover, a more competitive health care market will lead to market prices instead of the current mostly regulated prices. These market prices of health care may contribute to the reliability of future research on relative prices. Another possible future development is that the Baumol effect will become less important in the health care sector as incentives for efficiency and shortages in the labour market start to play a larger role. These shortages will presumably lead to greater effort to increase labour productivity, since additional personnel is difficult to find.

With respect to the other explanatory variables used in our models, we briefly summarize the long run results. Consistent with most recent findings in the literature we find that income and ageing are important drivers of health care expenditures. The income elasticity is significantly positive and just below unity. It takes values of 0.93 and 0.96, which corresponds well to the existing literature. Estimating models for the time period 1980-2003 instead of 1970-2003 results in comparable income elasticities. Ageing turns out to have a positive impact on health care expenditures, while both the coefficients of the population aged between 65 and 74

and the population aged above 75 are significantly positive. This may partly be explained by the high costs of dying, which is proxied by the age composition. For the public share of health care the results are more uncertain.

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Appendix A List of variables

HCE : real health care expenditures per capita

GDP : real gross domestic product per capita

PRICE : relative price of health care

POP65_74 : population aged 65-74 as share of total population

POP75 : population aged 75+ as share of total population

PUBLIC : public share of total health care expenditures.

Appendix B Construction of relative prices

To create time series for the relative price of health care for the old EU-15 countries, we need series for the price of health care and series for the gdp-price. However, there is a lack of good data concerning the price of health care. Therefore we have constructed the price of health care from macro series for wages and prices (a consumer price index), in the following way[5]:

Price health = wages^α * prices^(1-α) (b.1)

Hence, the price of health care can be said to be constructed as a weighted average of wages and prices. We have determined the weights making use of the national accounts for all countries. From the national accounts we have collected data on the total production, total intermediate consumption (supplied by other sectors), total value added and compensation for employees of the health and social work services sector.[6] For each country the weight for wages is determined as[7]:

α = (wages + social premiums + 2/3* total intermediate consumption) / production (b.2)

Hence, the weight is defined as the compensation for employees in the health care sector plus the estimated compensation for employees in the intermediate consumption part (for this we use an estimated wage share of 2/3) divided by total production.
After determining the weights in this way, we have calculated the price of health care for all countries, making use of formula b.1. For wages we have used the nominal compensation per employee index and for prices we haven taken the national consumer price index (cpi), both from the AMECO database.[8] Hence, equation (b.1) can be written as

price health=(nominal compensation per employee index)^α *(national consumer price index)^(1-α)

[5] We implicitly assume that labour productivity growth in health care is 0.
[6] Total production consists of the intermediate consumption and total value added.
[7] We have decided to keep α constant for each country, since this parameter hardly changes over time.
[8] http://europa.eu.int/comm/economy_finance/indicators/annual_macro_economic_database/ameco_en.htm