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Review of the literature on the determinants of healthcare expenditure

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This study reviews the literature on determinants of healthcare expenditure for the period 1998 to 2007. The methodology combines searches in the MesH database of PubMed with the search in the principal journals of *Health Economics*. 20 primary studies were found that met the criteria for inclusion. No single pattern of results is clearly identified. Among the 20 articles, four consider income to be the principal determinant of healthcare expenditure, two of them jointly with population ageing. Six highlight population ageing, as against six others that emphasize the proximity to death. The remaining six do not focus on a specific variable, or focus on another variable, e.g. technological progress or territorial decentralization. 11 of the 20 articles calculate the income elasticity of demand, only two of them obtaining a value greater than 1, thus cataloguing healthcare expenditure as a luxury good. There is, therefore, no unanimity in the variables and econometric regressions of healthcare expenditure in Organization for Economic Cooperation and Development (OECD) countries. No solid empirical evidence exists that population ageing is one of the principal determinants of healthcare expenditure, and factors such as technological progress, closeness to death and territorial decentralization of healthcare are increasingly seen as important in the development of explanatory models of healthcare expenditure.

I. Introduction

The course of the debate on the determinants of the growth of healthcare expenditure goes from the consensus as to a country's level of income as its principal explanatory variable, identifying it as a luxury good, to the increasing fragmentation regarding the most significant variables, which would include ageing, the proximity of death, the incorporation of technologies, the degree of decentralization of the healthcare system or the remuneration of healthcare suppliers among others. The notable improvements in the econometric methods used, the increase in the databases available and the

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drastic reduction of the transaction costs of carrying out studies, propitiated by the revolution in information technologies, have illuminated a much more complex and indeterminate scenario. As usually occurs in social sciences, the improvements in the instruments of analysis, and in the empirical evidence available, lead to a greater complexity and obscurity of explanation.

The first study on the determinants of healthcare expenditure identified the wealth of a country as the main determinant of healthcare expenditure. The seminal work by Newhouse (1977) found an income elasticity of healthcare services between 1.15 and 1.31 for 13 Organization for Economic Cooperation and Development (OECD) countries with data from 1970, the variation of per capita Gross Domestic Product (GDP) explaining around 90% of the variation in real per capita healthcare expenditure.

Other subsequent studies, also with cross-sectional data, from the 1980s and 1990s, confirmed this result. Leu (1986) carried out a study of 19 OECD countries for the year 1974 and obtained an income elasticity of the demand for healthcare services between 1.18 and 1.36. Likewise, Parkin *et al.* (1987), with the data for 1980 from the OECD, obtained an income elasticity between 1.12 and 1.18. Brown (1987), with the data from a group of 20 OECD countries for 1978, estimated an income elasticity of demand for healthcare services of 1.39. Gerdtham *et al.* (1992) carried out a multivariate study of 19 countries of the OECD for 1987, including in addition to the GDP, other variables such as healthcare expenditure as a percentage of (total) public expenditure and dichotomous variables such as the payment of physicians' fees per service. The results of this study showed an income elasticity of the demand for healthcare services of 1.33.

These results endorsed Wagner's Law (Wagner, 1883), or 'Law of hundred-year growth of the public sector', according to which the increase in public spending is even faster than the country's increase in production.[1]

However, in the 1990s, the use of time series and panel data placed estimations of the income elasticity of demand at close to one, implying considering healthcare as a normal good (Culyer, 1990; Hitiris and Posnett, 1992), a result that is confirmed in the study by Hitiris (1997), who estimates an income elasticity of between 1.0 and 1.2. Panel data permit the size of the sample to be increased and constant effects to be included for a specific country, monitoring a wide range of characteristics that vary over time, the absence of which can distort the relationship between healthcare expenditure and GDP.

Also in the 1990s, several studies analysed the impact of population ageing on healthcare expenditure. Getzen (1992), combining time series with cross-sectional studies in 20 OECD countries for the period 1960–1988, finds that population ageing is not associated with higher healthcare expenditure. Gerdtham (1993) analysed the impact of the ageing of the population of Sweden from 1970 to 1985, with cross-sectional data, finding that demographic changes explain only 13% of the total increase in healthcare expenditure in the period considered.

Blomqvist and Carter (1997), however, obtain contrary results when they analyse the time series of 24 OECD countries for the period 1960–1991, considering as explanatory variables the level of income, population ageing and technological progress. Their results indicate that the number of persons aged over 65 is a predominant factor in the increase in healthcare expenditure.

The impact of technology comes into prominence as an explanatory variable of the growth of healthcare expenditure with the study by Newhouse (1992) which cross-sectionally analysed healthcare expenditure in the US from 1960 to 1987, finding a strong positive relationship between expenditure and healthcare technologies.

Methodological issues have also occupied an increasingly important place in published studies, particularly those referring to the stationariness of the random disturbances of time series.[2] For example, Hansen and King (1996) consider inadequate the studies by Culyer (1990) and Hitiris and Posnett (1992), pointing out that the time series observed by both are not stationary, due to the presence of spurious noncausal relationships among them.

During recent years, the studies on the determinants of healthcare expenditure have increased, both in methodological complexity and in the identification of its causal variables.

The objective of this study is to review the state of the art, i.e. the empirical evidence on the determinants of healthcare expenditure in the health economics literature in recent years (1998–2007), particularly that which uses regressional methods as

[1] *Wagner's Law* or *Law of secular growth of the public sector* was formulated by its author in 1883, and subsequently in 1911, though it began to arouse interest among economists of the public sector after its rediscovery through the digest *Classics in Public Finance* by Musgrave and Peacock (1958).

[2] A disturbance is said to be second-order stationary, if its first- and second-order moments are constant over time. This requires the disturbance to have a constant variance (Guisán, 2002).

Table 1. Methodology of the review of the determinants of healthcare expenditure (1998–2007)

Phases
(a) Establishment of the criteria for selection of studies
(b) Independent Boolean searches combining the following MeSh terms[a]:
– Health expenditures AND aged
– Health expenditures AND technology, high-cost
(c) Search for articles in Health Economics Journals
Selection criteria
(a) Analyse one or more factors that directly affect healthcare expenditure
(b) Use quantitative and econometric methods
(c) Consider healthcare expenditure at aggregate level
(d) Publication in the period 1998–2007
(e) Analysis in the countries belonging to the OECD
Exclusion criteria
(a) Publication outside the period 1998–2007
(b) Studies in developing countries
(c) Publications of international agencies or grey literature
(d) Partial studies explaining some item of healthcare expenditure
(e) Analyses of the impact of a particular technology on healthcare expenditure
(f) Methodological studies

Source: Authors' own preparation.
Note: [a]MeSh, medical subject headings.

the methodological approach to testing the statistical relationship between variables. Section II presents the methodology used. Section III describes the results and finally, the text closes with the discussion and a brief section of conclusions.

II. Methodology

Table 1 shows the systematic review strategy used and the criteria for selection and exclusion. As can be observed, the studies of a methodological character have been excluded, as have those carried out with data from non-OECD countries.

In order to carry out the systematic review, a search was carried out in the MesH database of PubMed.[3] It was found that a MesH term for the determinants of healthcare expenditure ('Determinants of health expenditure' or 'Health expenditure determinants') did not exist. In view of this limitation, a search was made 'by subject' in the PubMed database, combining MesH terms directly related to the determinants of healthcare expenditure of greatest impact, such as aged, health expenditure, health expenditures, health care cost, humans, health services for aged and health services and demand.

After seeking different combinations among these MesH terms in PubMed with the Boolean logical operators 'AND' and 'OR', two independent Boolean searches[4] were made, limited to the period 1998–2007, combining the following MesH terms:

- health expenditures AND aged
- health expenditures AND technology, high cost

Simultaneously, a search was carried out for articles 'by words of text', in six Health Economics journals: *Journal of Health Economics*, *Health Economics*, *Health Policy*, *The American Journal of Managed Care*, *Applied Economics* and *Applied Economics Letters*.

III. Results

20 articles that met the methodological criteria were found.[5] Four consider income to be the main determinant of healthcare expenditure, two of them together with population ageing. In total, six highlight population ageing and six others focus on proximity to death. The remaining six do not focus on a specific variable, or focus on another variable, such as technological progress. Table 2 reflects the main characteristics of the studies.

We synthesize the studies below in terms of their origin, the objective, the quantitative and econometric method, the variables, the determinant or determinants of healthcare expenditure on which emphasis is placed and the results and conclusions.[6]

[3] In the medical area, the different databases generally use the MeSH descriptive terms (controlled vocabulary of the United States National Library of Medicine, which is continually revised and updated). The MesH database includes the ordering of descriptors by major groups of subjects or categories in turn subdivided into more specific subjects or areas (www.pubmed.gov).
[4] The Boolean search allows complex searches to be created by combining concepts using the Boolean operators 'OR', 'AND' and 'NOT'. It is a powerful tool for creating specific searches, and particularly useful when it is desired to expand or limit the search.
[5] Barros (1998), Di Matteo and Di Matteo (1998), Zweifel *et al*. (1999), Felder *et al*. (2000), Karatzas (2000), Roberts (2000), Gianoni and Hitiris (2002), Okunade and Murthy (2002), Herwartz and Theilen (2003), Koening *et al*. (2003), Clemente *et al*. (2004), Stearns and Norton (2004), Seshamani and Gray (2004a,b), Di Matteo (2005), Breyer and Felder (2006), Crivelli *et al*. (2006), Dormont *et al*. (2006), Mosca (2007), Werblow *et al*. (2007).
[6] The Appendix contains a table of these characteristics.

Table 2. Studies analysing the determinants of healthcare expenditure (1998–2007)

Principal determinant	Studies	Healthcare expenditure variable	Income elasticity	Against the ageing hypothesis	Analysis of the series
Income	Barros (1998)	Increase per capita	0.62–0.92	X	
	Roberts (2000)[a]	Per capita and growth	1.21–1.25 and 0.864		Stationary[b]
	Giannoni and Hitiris (2002)[a]	Per capita	0.33		
	Clemente *et al*. (2004)	Utility	>1		Structural breaks
Ageing	Di Matteo and Di Matteo (1998)	Per capita	0.77		
	Karatzas (2000)	Public per capita	0.578		Stationary series
	Di Matteo (2005)	Per capita	0.15, 0.01, 0.73 and 0.5		Exogeneity test
	Crivelli *et al*. (2006)	Per capita	−0.082		
Proximity to death	Zweifel *et al*. (1999)	Healthcare expenditure		X	
	Felder *et al*. (2000)	Healthcare expenditure		X	
	Seshamani and Gray (2004a)	Healthcare expenditure		X	
	Seshamani and Gray (2004b)	Per capita		X	
	Breyer and Felder (2006)	Per capita			
	Werblow *et al*. (2007)	Healthcare expenditure		X	Endogeneity
Unclear or others	Okunade and Murthy (2002)	Per capita			Stationariness and no breaks
	Herwartz and Theilen (2003)	Healthcare expenditure	0.74	X	Stationariness
	Koening *et al*. (2003)	Healthcare expenditure	0.760 and 0.312		
	Stearns and Norton (2004)	Per capita hospital cost			
	Dormont *et al*. (2006)	Healthcare expenditure		X	Endogeneity of closeness to death
	Mosca (2007)	Per capita	0.682		

Source: Authors' own preparation.
Notes: [a]Also belong to those that consider ageing as the principal determinant of healthcare expenditure.
[b]A time series is stationary if it is a stochastic process whose distribution of probability presents a cyclical pattern.

Income as the main determinant of healthcare expenditure

Although, as can be seen from Table 2, 11 of the 20 studies calculate the income elasticity of demand, only in four does it emerge as the principal determinant of healthcare expenditure, and only in two of them is healthcare considered to be a luxury good (Roberts, 2000; Clemente *et al*., 2004). The range of variation of income elasticity of demand is very wide, from slightly negative values (−0.082 in Crivelli *et al*., 2006) to values clearly greater than unity as in one of the models in Roberts (2000) with coefficients of 1.25.

Barros (1998) analyses the divergence in the evolution of healthcare expenditure in the countries of the OECD between 1960 and 1990 with panel data on 24 countries of the OECD for five scenarios, the result of combining the different independent variables. The main results are an income elasticity of demand between 0.62 and 0.92 according to the model used, and the lack of significance of population ageing in the countries of the OECD, with coefficients contained within a negative interval close to zero (−0.27 and −0.31), as well as the type of funding system of the healthcare system (−0.02 and −0.07) and the existence of primary care physicians (−0.36 and −0.71).

Roberts (2000), in a critical analysis of Hitiris (1997), points out that a study of the stationariness of the time series of the OECD for the period 1960–1991 must be carried out. According to Roberts, the time

series of the population dependence ratio and inflation included in Hitiris were not stationary, and should not be included in the model nor estimated by Ordinary Least Squares (OLS). Roberts (2000) includes the stationary variable percentage of the population aged over 65, which explains 21.1% of healthcare expenditure. The income elasticity of demand of this model varies between 1.21 and 1.25. The coefficient of determination of the model is 0.9, as in the model of Hitiris (1997). Another model developed by the author, employing the growth of healthcare expenditure as the dependent variable, obtains an income elasticity of demand for healthcare services of 0.864 and a coefficient of the population aged over 65 of 0.049 (4.9%).[7]

Giannoni and Hitiris (2002) estimate a model to explain the determinants of healthcare expenditure and its disparities among the regions of Italy in the period 1980–1995, finding that the level of income with an elasticity of 0.33 and population ageing with a coefficient of 0.16 are the principal variables explaining the expenditure. Other variables considered, such as the number of hospital beds with a coefficient of −0.07, seem to point to the existence of economies of scale at regional level, as well as the positive contribution to the expenditure of healthcare and nonhealthcare personnel per hospital with a coefficient of 0.05.

Clemente *et al*. (2004), though they find a close long-term relationship between total healthcare expenditure and GDP when analysing 22 countries of the OECD separately, maintain that this relationship cannot be considered stable for the countries of the OECD as a whole, due to the presence of structural breaks in the time series. They suggest that this may be the cause of the close dependency that other studies find between GDP and healthcare expenditure.[8] Estimating the model after including the presence of structural breaks in the time series, they find an income elasticity of the demand for healthcare services greater than unity.

Other studies for which income is not the principal determinant of healthcare expenditure provide the income elasticity of demand for healthcare services. For example, among those included in the following section for which ageing is the main determinant, Di Matteo and Di Matteo (1998) obtain a value of 0.77; Karatzas (2000) shows that GDP presents an elasticity of demand of 0.578; Di Matteo (2005) calculates it as 0.15 and 0.01 for Canada and 0.73 and 0.50 for the USA; and Crivelli *et al*. (2006) calculate an elasticity of −0.082.

Among those who do not find a clear determinant of the increase in healthcare expenditure, Herwartz and Theilen (2003) show an income elasticity of the demand for healthcare services of 0.74; Koening *et al*. (2003) calculate it as 0.760 in one model and 0.312 in another, and Mosca (2007) as 0.682.

Population ageing as the principal determinant of healthcare expenditure

Seven of the 20 studies find that population ageing is not important as a determinant of healthcare expenditure: Barros (1998), Zweifel *et al*. (1999), Felder *et al*. (2000), Herwartz and Theilen (2003), Seshamani and Gray (2004b), Dormont *et al*. (2006) and Werblow *et al*. (2007).

Di Matteo and Di Matteo (1998) analyse the determinants of real per capita healthcare expenditure in the Atlantic and Prairie provinces of Canada, Quebec, Ontario and British Columbia between 1965 and 1991. The authors identify population ageing as principal determinant of healthcare expenditure of the provinces, which would explain 92% of the variation of real per capita healthcare expenditure, indicating federal transfers in second place, which in the period considered covered 48% of total healthcare expenditure. As has been mentioned, the authors obtain an income elasticity of demand of 0.77, cataloguing it therefore as a normal good.

Karatzas (2000) analyses the primary and secondary determinants of healthcare expenditure in the USA between 1962 and 1989, developing four scenarios that combine different economic, healthcare and demographic variables to explain per capita public, private and total healthcare expenditure, respectively. The results indicate an elasticity of demand characteristic of a normal good of 0.578, a strong influence of the percentage of the population aged over 65 (2.552) and a coefficient close to unity for the number of active nurses adjusted for population. The results of the unit root test show that the series are stationary.

The aforementioned studies by Roberts (2000) and Giannoni and Hitiris (2002) also indicate that population ageing is responsible for the increase in healthcare expenditure, jointly with the level of income.

Di Matteo (2005) examines the impact of demographic change and technological change on the

[7] Regarding the low value of the coefficient of ageing of the population, the author supposes that it may be because the short-term changes in the proportion aged over 65 years are not detected by the model, or because its goodness-of-fit is not good enough.

[8] See McCoskey and Selden (1998), Karatzas (2000), Roberts (2000) and Herwartz and Theilen (2003).

increase in healthcare expenditure in Canada (1975−2000) and the USA (1980–1998) estimating two models for each country. The first includes the percentage of the population aged over 65 and the second disaggregates the population by age groups. The principal results for Canada show a low value (0.15 and 0.01, respectively) of income elasticity of demand for healthcare services at regional level, and a value slightly greater than unity (1.07) with respect to the proportion of the population aged over 65 (model 1). In model 2, only the age groups of the population between 18 and 44, 45 and 64 and over 74 years have a positive relation to healthcare expenditure, the population over 74 being mainly responsible for the increase in healthcare expenditure.

For the USA, the author finds an income elasticity of demand for healthcare services of 0.73 and 0.50, respectively, the percentage of the population older than 65 explaining 94% of the healthcare expenditure in model 1. In model 2, only the age groups of the population between 0 and 24, 25 and 44, 65 and 84 and over 85 years have a positive relation to healthcare expenditure.

The objective of Crivelli *et al*. (2006) is to analyse the determinants of healthcare expenditure in the 26 cantons of Switzerland (1996–2002). They estimate a model with a single equation in a sample of patients in terms of economic and demographic variables and structural factors. The determinants of the increase in healthcare expenditure are the proportion of elderly persons and payment by fee for service. They refer to the greater risk of illness and proximity to death of those over 75 years of age. In this study, the income elasticity is negative and close to zero (−0.082), probably due to the high degree of territorial decentralization of healthcare in Switzerland.

Closeness to death as principal determinant of healthcare expenditure

The study by Zweifel *et al*. (1999) is the precursor of a series of investigations that include the proximity to death as an explanatory variable of healthcare expenditure.[9] Zweifel *et al*. (1999) estimate models in two healthcare insurance companies. One of them, 'KKB', covers the rural population in 1983–1992. The other company, called 'Helvetia' (the biggest in Switzerland), covers the urban population in 1983–1994. They estimate one model for all the individuals covered by each company and another for those aged over 65. The last 2 years of life (eight quarters) of the individuals are taken into account. The study is repeated again for individuals' last 5 years of life (20 quarters), taking only those over 65 years of age.

According to their results, age is a weakly significant variable in the regression of sample 1 and only when considering all individuals, with a coefficient of 0.062. For individuals aged over 65, in sample 1 and in sample 2, age presents a negative coefficient close to zero, implying that population ageing does not explain healthcare expenditure. However, the coefficient of the 4-month period just before death varies between 1.888 (sample 1, individuals aged over 65) and 0.610 (sample 2, individuals over 65). The further we get from the 4 months preceding death, the lower the coefficient, showing that a higher healthcare expenditure is concentrated in the 4 months prior to death independently of the individual's age. Other results of the authors are the importance of the sex and the possession of a supplementary insurance.[10]

Felder *et al*. (2000) estimate two models explaining healthcare expenditure in Switzerland in 1986–1992. One of the models includes all individuals (without discriminating by age cohorts) and the other, only those over 65. They first take into account the last 2 years of an individual's life (eight quarters) and then the study is repeated for the last 5 years of the individuals' life (20 quarters), only for over-65s. Their results, similar to those of Zweifel *et al*. (1999) indicate that age is only a significant variable when all individuals are considered, with a coefficient of 0.066. However, for individuals aged over 65, age presents a negative coefficient close to zero (−0.015). Furthermore, the coefficient of the 4 months just before death is 1.944 for individuals aged over 65 years and 1.939 when all individuals are taken into account. The coefficient decreases for the 4-month periods before death further from it. According to their study, healthcare expenditure decreases as the individual's age increases, though it increases as death approaches, healthcare costs prior to death being higher for young individuals than for over-65s.[11]

[9] Zweifel *et al*. (1999) introduce the term *red herring* for the phenomenon that age does not have a significant impact on healthcare expenditure.

[10] In sample 1, for individuals aged over 65, the sex has a coefficient of 1.632, implying that women aged over 65 spend more than men. Having supplementary insurance is significant in both samples, between 0.239 and 0.761, the latter coefficient corresponding to individuals over 65 of sample 1.

[11] Other results of the study are as follows: (1) For individuals aged over 65 years, the sex has a coefficient of 1.324. Women aged over 65 years spend more than men. (2) The state subsidy has an indirect relationship with the increase in healthcare expenditure, presenting a coefficient of −0.109 for people over 65 years. (3) Having supplementary insurance is fairly significant, between 0.806 and 0.762 (the latter coefficient corresponding to individuals aged over 65 years).

Seshamani and Gray (2004a) repeat the methodology of Zweifel *et al*. (1999) for data from Oxfordshire (England), in 1970–1999. According to Seshamani and Gray (2004a), the model developed by Zweifel *et al*. (1999) suffers from the problems of multicollinearity among its variables. For this reason, they include new variables to explain healthcare expenditure, as well as positing a probit model with the aim of avoiding the possibility that any individual should not incur any hospital cost. Their results nevertheless confirm those of Zweifel *et al*. (1999); thus, although age and the proximity of death influence healthcare expenditure, the influence of the latter is much greater, since there is an increase in the probability of being in hospital (incurring a healthcare expenditure greater than zero) with closeness to death.

In another later study Seshamani and Gray (2004b), using the same database, establish various age cohorts corresponding to the population aged over 65, 75, 85 and 95, respectively, and estimate a model that analyses the healthcare expenditure incurred by said patients in the 24 years preceding their death. Their results point out the lack of significance of age and sex, with coefficients of 0.027 and 0.014, respectively, while the coefficients of the variables referring to the 15 years prior to death show a rising trend, up to a value of 0.571 in the year just before death.

Breyer and Felder (2006) calculate the demographic impact on German healthcare expenditure for 2050 from a database of 91 237 individuals of a Swiss health insurance in 1999. They use a two-stage method to estimate the expenditure in the Swiss population by age and sex for individuals in their last 4 years of life and for survivors. First, they estimate the probability that expenditure will be made and second, the level of expenditure. When these data are used to estimate the impact of demographic change on healthcare expenditure in Germany, the authors point out that taking into account the costs of the last years of life causes the demographic impact of the per capita expenditure to decrease.

In a recent study, Werblow *et al*. (2007) with microdata in Switzerland (1999) estimate a model in two parts, first the probability that healthcare expenditure will be greater than zero and in that case this value is estimated. To avoid the effect of age on the endogenous variables, it is included raised to the cube, and the terms of interaction with sex and death are also included. The proximity to death is included squared, and also interacting with sex. The results indicate that age is of very little significance when proximity to death is controlled for.

Among the authors for whom proximity to death is the principal determinant of healthcare expenditure, both Zweifel *et al*. (1999) and Felder *et al*. (2000) take into account all individuals in the regression of the explanatory model of healthcare expenditure, irrespective of whether or not they are hospitalized. For this reason, Seshamani and Gray (2004a, b) and Stearns and Norton (2004) eliminate from their study those individuals who have not generated any healthcare expenditure, through discrete choice models.[12] On the one hand, Seshamani and Gray (2004a, b) model healthcare expenditure through probit models, while Stearns and Norton (2004) opt for a logit model.

Other determinants of healthcare expenditure

The only article included in the review in which technological progress is the main determinant of healthcare expenditure is Okunade and Murthy (2002). The existence of a single reference in this category may be due to the criteria for selection of articles in the review, which do not incorporate articles focussing on the valuation of the cost of adoption and diffusion of specific healthcare technologies, which would impair the methodological coherence of the review.

Starting from the study by Newhouse (1992), Okunade and Murthy (2002) analyse the relationship between real per capita healthcare expenditure, real per capita incomes and spending on R&D in 1969–1999. The results of the unit root test show that these series are stationary and their dynamic evolution does not present structural breaks. As for the results of the cointegration test, we observe a strong relationship, stable in the long term, between per capita GDP, per capita healthcare expenditure and expenditure on R&D by the healthcare sector. Okunade and Murthy (2002) conclude that technological progress is the main determinant of healthcare expenditure in the USA in the period considered.

[12] The discrete, binary and multiple choice models consider the decision-making process as an indirect comparison of utility functions. Two of the models most widely used in the analysis of the demand for healthcare assistance have been the *probit* and *logit* models, in which, assuming individuals to be maximizers of their utility, they will choose between two alternatives the one which provides them with the greatest utility. The observed decision reveals which of the alternatives provides most utility, but not their utilities, which are unobservable. For example, let UB_{oB}, be the utility afforded to the individual by the decision not to demand assistance and UB_{1B}, the utility of requesting assistance. The probability that $Y = 1$, i.e. that the individual will decide to demand assistance, will be given by the expression: $\Pr(Y = 1/x) = \Pr(UB_{1iB} > UB_{oiB})$ (Clavero and González, 2005).

The objective of Herwartz and Theilen (2003) is to analyse the variation of healthcare expenditure in the countries of the OECD in the period 1961–1979.[13] According to the analysis of stationariness, the time series corresponding to the level of income and to the population aged over 65 years, they converge towards the same value in the long term. The results of the regression show an income elasticity of the demand for healthcare services of 0.74. Regarding the population over 65 years of age, no strong relationship to the increase in healthcare expenditure is observed, as it presents a coefficient equal to 0.095.

Koening *et al*. (2003) identify and classify the factors contributing to the increase of healthcare expenditure and to the increased demand for healthcare services in the US from 1990 to 2000 by means of the regression of two models in two US databases: *State Health Expenditure* (SHE; 1990–1998) and *Large National Group Health Insurer* LNGH (1998–2000). In both, healthcare expenditure is explained by 41 dependent variables grouped into the following categories: demographic and general economic conditions; health status; payment to suppliers; healthcare insurance; supply of physicians and specialists; market structure of providers; running costs; regulation of healthcare and treatment guidelines and technology.

The results obtained with the SHE model database establish that healthcare expenditure is a normal good, presenting an income elasticity of demand for healthcare services equal to 0.760, and that the population aged over 65 years influences the increase in healthcare expenditure with a coefficient of 0.67. Other results indicate that an increase of 10% in the Hispanic and coloured population is associated with a fall in spending on healthcare services of 39% and 21%, respectively, and that an increase of 10% in physicians' salaries is associated with an increase in the expenditure on healthcare services of 2.2%.

In relation to the model with the LNGH database, the principal results are an income elasticity of demand of 0.312 and the demographic structure of the population as the driving element of healthcare expenditure. Other results indicate that an increase of 10% in the immigrant population is associated with a rise in expenditure on healthcare services of 91% and the influence exercised on expenditure by different healthcare technologies such as magnetic resonance, CAT, and catheterization.

Stearns and Norton (2004) compare future healthcare costs of the population between 66 and 99 years of age in England (1992–1998) with two models, including or not including the proximity to death as a dependent variable. The model that includes proximity to death is estimated with and without inclusion of the survivors at the end of the study period. The most important results are:

- Gender and geographical location present negative coefficients in both parts of the simple and expanded model, so they cannot be considered significant variables of healthcare expenditure.
- The coefficients of the different age groups are positive, except for the age group [90, 95) in the expanded model.
- The interaction of the quarter prior to death and the age presents a nonsignificant coefficient in the expanded model, all the coefficients having a negative sign.
- The regression of the *logit* model shows that the adjusted coefficient of determination of the simple and expanded model is 0.038 and 0.0514, respectively, implying that the inclusion of the proximity to death increases the power to explain healthcare expenditure.

Dormont *et al*. (2006) analyse the determinants of healthcare expenditure in France (1992–2000). They estimate a two-part model on the basis of microdata from random samples of patients. They first estimate the decision to use healthcare services and next the level of expenditure incurred.

The expenditure due to population ageing is relatively small. The impact of the change on practice – influence of morbidity on use – is 3.8 times higher. The changes in morbidity act in the opposite direction, cancelling out the changes due to ageing. The consideration of the variable 'risk of death', together with a detailed set of indicators of morbidity for each individual, is preferable to the proximity to death, which can present problems of exogeneity in the estimations (Salas and Raftery, 2001).

Finally, the study by Mosca (2007) indicates that decentralization influences the increase in healthcare expenditure. With a sample of 20 countries of the OECD for which sufficient information is available in 1990–2000, he formulates a log–log in which he estimates the Total Healthcare Expenditure per capita (THE) by OLS. All the variables included, except beds, are statistically significant, and have a positive effect on per capita healthcare expenditure, except the percentage of population aged under 19 years. The increase of 10% in the percentage of over-80s implies an increase in healthcare expenditure of 1.4%. Healthcare services are seen to be a normal good, with an elasticity of less than one (0.682).

[13] Except Greece, Luxembourg, New Zealand, Portugal and Turkey, as no data exist for these countries.

Decentralized Social Health Insurance (SHI) systems ($\beta_8 = 0.246$), decentralized National Health Systems (NHSs) ($\beta_7 = 0.116$) and centralized SHI systems ($\beta_9 = 0.006$) have higher expenditures than centralized NHSs.

IV. Discussion

As can be observed in this literature review, as well as in earlier studies, there is little consensus regarding the value of the income elasticity of demand for healthcare services. According to Getzen (2000), this elasticity varies according to the level of analysis (individual, regional or aggregate) of the study. Most studies before 1998 that analyse healthcare expenditure in the OECD at aggregate level obtain values for income elasticity greater than one (Newhouse, 1977; Leu, 1986; Brown, 1987; Parkin *et al*., 1987; Gerdtham *et al*., 1992). However, the articles identified in the review find an income elasticity with values between zero and one (Barros, 1998; Di Matteo and Di Matteo, 1998; Karatzas, 2000; Giannoni and Hitiris, 2002; Herwartz and Theilen, 2003; Koening *et al*., 2003; Di Matteo, 2005). Only Roberts (2000) and Clemente *et al*. (2004) determine an income elasticity greater than unity.

A noteworthy point is the values of income elasticity of the demand for healthcare services presented by Di Matteo (2005) and Gianoni and Hitiris (2002), close to zero. This may be due to the territorial decentralization of healthcare as existing in Canada and Italy, where these studies were made. This is reinforced in the results of Crivelli *et al*. (2006), in which the income elasticity is negative and close to zero (−0.082), probably due to the strong territorial decentralization of healthcare in Switzerland.

Another interesting contribution related to the value of the income elasticity of demand for healthcare services is that by Ariste and Carr (2003).[14] The results of this study show that the income elasticity of demand for healthcare services in Canada is 0.88. However, because the sign of the variation in the relative price of such services is uncertain, it cannot be concluded whether healthcare services are a luxury good or a normal good. Ariste and Carr (2003) show that it is necessary to separate the *Baumol* effect characteristic of the public sector from the increase in the price of healthcare services caused by economic growth in general, to be able to state whether healthcare services are a normal or a luxury good.[15]

The results of this review do not offer sufficient evidence to consider population ageing to be a significant variable of healthcare expenditure. As posited by Barer *et al*. (1994), it is difficult to attribute healthcare expenditure to population ageing, since fortunately the ageing process more closely resembles the slow flow of a glacier than the deadly speed of an avalanche. Zweifel *et al*. (1999), Felder *et al*. (2000), Seshamani and Gray (2004a, b), Stearns and Norton (2004), Breyer and Felder (2006) and Werblow *et al*. (2007) maintain that closeness to death, rather than population ageing, is the variable that explains the increase in healthcare expenditure. Evans *et al*. (2001) and Gornemann and Zunzunegui (2002) posit that population ageing is not synonymous with the growth of healthcare expenditure, but that the latter is concentrated in the 4 months, or the year, prior to death, independently of the individual's age, as to the extent that people who would have died if they had received the old treatments are kept alive, the use of healthcare services increases. This empirical evidence contrasts with the results of Di Matteo and Di Matteo (1998), Karatzas (2000), Roberts (2000), Giannoni and Hitiris (2002), Di Matteo (2005) and Crivelli *et al*. (2006), who consider the percentage of the population aged over 65 years to be a key variable in the estimation of healthcare expenditure. Recently, Dormont *et al*. (2006) or Werblow *et al*. (2007) insist on the irrelevance of age to the increase of healthcare expenditure.

Reinhardt (2003), in a review of the principal results obtained in the United States by the different studies that have assessed the effect on healthcare expenditure of population ageing, finds that the diffusion of healthcare technologies, the asymmetry of healthcare market power, favourable to supply rather than demand, and the scarcity of healthcare professionals are the true drivers of the spectacular growth of American healthcare expenditure, and not the slow advance of the glacier of ageing. A recent study by the OECD (2006) goes into the same question: only 10% of the growth in healthcare

[14] Not included in the review because it is a working paper on the Canadian healthcare system and therefore does not meet the criteria for inclusion.

[15] To support the thesis of an inefficient use of resources in the public sector, it is mentioned that it is increasingly necessary to devote more resources to this sector without any adequate correlation between the quantity or quality of the services. This phenomenon responds to the so-called 'Baumol effect': social sectors are labour-intensive and any increase in productivity in them is therefore lower than in the rest of the economy. In this framework, it is logical to find a growing increase in relative costs.

expenditure in recent decades (1970–2002) can be attributed to population ageing, nondemographic factors including technological change being those with most important influence.

As to technological progress, once its direct relationship to the increase in healthcare expenditure has been demonstrated, the review reveals the need for future studies that will investigate more about the conceptualization, measurement and incorporation of the effects of technological progress on the econometric models used to explain healthcare expenditure, and on the analysis of the overall impact of healthcare technologies on healthcare expenditure, as in Newhouse (1992) and Okunade and Murthy (2002).

The analysis of the determinants of healthcare expenditure at the regional level highlights the heterogeneity of the results depending on the country of origin of the study. Di Matteo and Di Matteo (1998) maintain that federal transfers to the Canadian provinces explain a considerable percentage of the increase in healthcare expenditure in that country. However, Di Matteo (2005) does not place special emphasis on the importance of such transfers because of their reduction in recent years. According to Giannoni and Hitiris (2002), in Italy, the territorial decentralization of healthcare does not increase healthcare expenditure, the level of income and population ageing being the main determinants. Likewise, Crivelli *et al*. (2006) do not allege that territorial decentralization is increasing healthcare expenditure, though they do affirm that it is causing the emergence of socio-economic inequalities among the Swiss cantons. In Spain, Costa-Font and Pons-Novell (2007) develop an econometric model that includes as independent variables political ideology, spatial interaction among the different autonomous communities and a variable that identifies the regions benefitting from a unique statutory regime. The results of this study reveal that the development of political and fiscal decentralization in a context of interjurisdictional competition tends to increase public healthcare expenditure.

Some of the articles included in the review, Karatzas (2000), Roberts (2000), Herwartz and Theilen (2003) or Clemente *et al*. (2004), place more emphasis on the methodological justification than on the search for explanatory variables of the increase in healthcare expenditure. McCoskey and Selden (1998) focus on the formalization of the unit root statistical test, concluding that the time series that contain the dynamic evolution of healthcare expenditure and GDP are stationary and converge to the same value in the long term. In the same line of research as Clemente *et al*. (2004), Carrion-i-Silvestre (2005) shows that the unit root test and the stationariness test applied to each of the countries separately (country by country) do not present structural breaks between real per capita healthcare expenditure and GDP. According to Carrion-i-Silvestre (2005), this contradiction may be due to the loss of power of these tests when applied in isolation to each of the countries. The results of Carrion-i-Silvestre (2005) present multiple structural breaks in the evolution of healthcare expenditure and GDP throughout the period (1960–1997), which coincide with the petroleum crises.

All these attempts to justify the stationariness of the random disturbances of the time series may in some cases be unproductive, as the fact that two time series are not stationary does not inevitably imply the existence of spurious noncausal relationships between the time series observed, which may be due to problems of specification that are generally easily solved and should not always be interpreted as synonymous with spurious regression. Not passing the cointegration tests may occur in numerous cases of (nonspurious) causal regressions due to the existence of a very wide confidence interval for the parameter being tested in situations where there is very clear evidence of its nonnull nature (Guisán, 2002).

The review is subject to several methodological limitations. First, we may have omitted some studies that are not published in the databases consulted or were not captured by the selection criteria used. Another limitation is the nonexistence of a MesH term that alludes to the determinants of healthcare expenditure ('Determinants of health expenditure' or 'Health expenditure determinants'). Finally, with the aim of not incurring publication biases, language biases or bias as a consequence of local diffusion, the search was focused on electronic databases, sidelining publications by international bodies and the so-called grey literature. This restriction may have occasioned some losses in the selection of the articles.

V. Conclusions

This review identifies, from 1998 onwards, different econometric regressions and variables of healthcare expenditure in the countries of the OECD, due to the nonexistence of a typified methodology in this respect. Because of the heterogeneity of the results obtained, the review does not show solid empirical evidence that population ageing is one of the main determinants of healthcare expenditure, and factors such as technological progress, closeness to death and the territorial decentralization of healthcare gain

more and more importance in the development of explanatory models of healthcare expenditure.

The fact that the results of the review do not reveal a consistent theoretical base for affirming that population ageing is not a significant variable in healthcare expenditure may be due to different causes. First, in the studies prior to 1998, the baby boom generation did not form part of the proportion of the population of 65 years of age. Also, the emergence of theories like that of closeness to death causes the myth of population ageing to lose protagonism as a determinant of healthcare expenditure. Third, the existence of multicollinearity among the explanatory variables of healthcare expenditure may devalue its level of significance.

The variables included in the studies reviewed are of many kinds, so it is not possible to specify a general model to explain the determinants of healthcare expenditure. Only the econometric model developed by Zweifel *et al*. (1999) has been taken as a template in subsequent studies such as Felder *et al*. (2000), Seshamani and Gray (2004a, b), Stearns and Norton (2004), insisting on the importance of including the proximity to death in the specification of healthcare expenditure. Also, many of the studies have diverted their attention towards the formalization of stationariness and cointegration tests of the time series that contain the dynamic evolution of the variables determining healthcare expenditure.

To sum up, the published literature relating to the determinants of healthcare expenditure reveals that the consideration of the level of income as a variable explaining such expenditure depends on the level of analysis considered; healthcare services may be either a luxury good or a normal good. On the other hand, the empirical evidence does not support the idea that population ageing is one of the main factors causing healthcare expenditure. As for the theory of the proximity to death, its results, though robust, present certain methodological weaknesses, such as the presence of multicollinearity among the explanatory variables. Finally, it is not clear that territorial decentralization is a key explanatory factor of the increase in healthcare expenditure, this being an open subject and exposed to debate depending on the degree of autonomy and the institutional characteristics of each healthcare system.

This review suggests the need not only for a wider empirical base, and extension of the studies on determinants of healthcare expenditures, but above all, the methodological standardization essential for coherent accumulation of the best evidence available. It would therefore be of great utility to create a methodological guide that would permit a certain normalization of the econometric models used to analyse the determinants of healthcare expenditure – at least – in the countries of the OECD.

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Appendix

Table A1. Systematic review of the determinants of healthcare expenditure (1998–2007) (1 of 20)

Article/country	Objective(s) of the study	Methodology	Model and variables studied	Determinant(s) of healthcare expenditure	Results and conclusions
Barros (1998), OECD[a]	To improve understanding of the divergence in evolution of healthcare expenditure in the countries of the OECD for the period 1960–1990	– CREDES–OECD database (1960–1990). – Modelling of panel data on 24 countries of the OECD – Calculation of the contribution of the independent variables of healthcare expenditure to the rate of growth thereof – Study of the determinants of the growth of healthcare expenditure for five scenarios, resulting from combinations of the different independent variables (this is the reason for the range of values of the elasticities)	$\dot{y}_i = \alpha X_i + e_i$ Dependent variable: – growth of per capita healthcare expenditure Independent variable: – per capita healthcare expenditure at the start of the study period – existence of primary care practitioners (dummy) – type of healthcare system: public funding or public contract (dummy) – mean growth of per capita GDP – percentage of population aged over 65 – dummy variables for decades 1970–1980 and 1980–1990 – role of state funding of healthcare (dummy)	Mean growth of per capita GDP	– The coefficient of determination of the model estimated varies from 0.704 to 0.627 on the basis of the different explanatory models of healthcare expenditure – Income elasticity of demand for healthcare services varies between 0.62 and 0.92 – Population ageing does not contribute decisively to the increase in healthcare expenditure (−0.27, −0.31); nor do the type of funding system of the healthcare system (−0.02, −0.07) and the existence of primary care practitioners (−0.36, −0.71) as all these variables show a negative coefficient very close to zero
Breyer and Felder (2006), Switzerland and Germany[b]	To calculate the demographic impact on healthcare expenditure in Germany until 2050 on the basis of an analysis of the determinants of healthcare expenditure in Switzerland in individuals in their last 4 years of life and in survivors in 1999, taking into account that it is not the age but the proximity of death that mainly determines healthcare expenditure	– Data on 91 327 persons from a Swiss healthcare insurance. 4% of them died between 1 January 2000 and 30 June 2003 – Expenditure by age and sex is estimated for individuals in their last 4 years of life and for survivors on the basis of Swiss population data – Estimation in two stages, first the probability that expenditure will be made and secondly the level of expenditure – These profiles are applied to the projections of age structure in the German population between 2002 and 2050	$\Pr(H_i>0) = 0.786 - 0.001A_i + 0.2A_i^2/1000 - 1.16M_i + 0.014(A_iM_i) + 0.971D_i - 0.012(DiAi) - 0.008TtDi$ $Hi\|H_i>0 = 17\,234 - 189A_i + 2256A_i^2/1000 + 1520M_i - 29.7(A_iM_i) + 8488D_i - 75.8(D_iA_i) - 239\ TtD_i$ Dependent variable: – per capita healthcare expenditure Independent variables: – A_i, age – M_i, sex – D_i, deceased – TtD_i, time to death	Time to death	– Taking into account the costs of the last years of life causes the demographic impact of the per capita expenditure to decrease

(*continued*)

Table A1. Continued

Article/country	Objective(s) of the study	Methodology	Model and variables studied	Determinant(s) of healthcare expenditure	Results and conclusions
Clemente *et al.* (2004), OECD[a]	– To study the stability of healthcare expenditure in the countries of the OECD – To analyse whether there are differences in the countries of the OECD between private and public healthcare expenditure	– Differentiates public and private healthcare expenditure – The OECD database (1998) contains information on 22 countries for the period 1960–1977. With the exception of Canada (public healthcare expenditure only for 1970) and Japan (no information until 1970). Information on private healthcare expenditure is available for only 19 countries – Unit root test to analyse the stationariness of the series. (OLS is not valid) – Cointegration of the time series for total healthcare expenditure, public healthcare expenditure and private healthcare expenditure and GDP – Cobb–Douglas model of consumption of healthcare services	*Cobb–Douglas* utility function $U(c,s) = (c-a)^{\alpha}s^{1-\alpha}$, $0 < \alpha < 1$ Model variables: – a, level of healthcare services necessary to cover the basic needs of the population – s, value of the healthcare services received, by the public sector (g) and the private sector (x), so that $s = g + x$	Level of income	– The results of the cointegration test show the presence of a long-term relationship between total healthcare expenditure and GDP when countries are analysed separately – However, this relationship cannot be considered stable for the countries of the OECD as a whole in the period 1960–1977 due to the presence of structural breaks in the time series – When the model is estimated after including the presence of structural breaks in the time series, an income elasticity of the demand for healthcare services greater than unity is found, so healthcare services are a luxury good
Crivelli *et al.* (2006), Switzerland[a]	To analyse the determinants of the growth of healthcare expenditure in the 26 cantons of Switzerland in the period 1996–2002	– They estimate a model with a single equation in a sample of patients according to economic and demographic variables and structural factors – The exogeneity of the variables is tested	$HCE_{it} = f(Y_{it}, UN_{it}, PO_t, A75_{it}, A05_{it}, MO_{it}, DP_{it}, DDI_{it}, PHY_{it}, BEDS_{it}, DLAT_{it}, T_{it})$ Dependent variable: – real per capita healthcare expenditure in each canton i in each year t Independent variables: – Y_{it}, per capita income – UN_{it}, unemployment rate – PO_{it}, poverty rate – $A75_{it}$, % aged over 75 – $A05_{it}$, % aged under 5	– proportion of older people – payment of physicians by fee for service. They refer to the higher risk of illness and proximity to death of	Income elasticity negative and close to zero (−0.082)

			– MO_{it}, mortality rate – DP_{it}, density of population – DDI_{it}, democracy index, in terms of opportunities for individual political participation – PHY_{it}, density of physicians – $BEDS_{it}$, density of acute beds – $DLAT_{it}$, dummy variable for the Latin cantons – T, technology and other factors	people aged over 75	
Di Matteo and Di Matteo (1998), Canada[a]	To analyse the determinants of the growth of healthcare expenditure in the Canadian Atlantic provinces, Quebec, Ontario, Prairies and British Columbia in the period 1965–1991	– Database: *Statistic Canada*, *Public Finance Historical Data*, *Statistic Canada*, *Public Sector Finance Statistic Canada's Provincial Economic Account* – Development of an econometric model to explain the real per capita healthcare expenditure of Canada – Panel data corresponding to five provinces of Canada, in the period 1965–1991 (270 observations)	Dependent variable: – real per capita healthcare expenditure Independent variables: – real per capita GDP – percentage of the population aged over 65 – Real per capita federal transfers	– increase of the income level of the population – population ageing – real per capita federal transfers	– The coefficient of determination of the model estimated is 0.92 – According to the results of this study, healthcare services are a normal good and not a luxury good (income elasticity of demand, 0.77) –92% of the variation of real per capita healthcare expenditure is explained by the population aged over 65 – The transfers made by the state to the population play a fundamental role in the resources of the Canadian provinces. These federal transfers explain 48% of the total real healthcare expenditure
Di Matteo (2005), Canada, the USA[a]	– To examine the impact of demographic and technological change on the increase in healthcare expenditure – To analyse the determinants of the growth in healthcare expenditure in the USA and Canada	– Database at provincial level for Canada (1975–2000); database at state level for the USA (1980–1998) – Creation of two scenarios, one for the USA and another for Canada, to explain the expenditure in each of the countries	*Canada* Dependent variable: – per capita provincial healthcare expenditure Independent variables: – real per capita GDP – federal transfers to provinces per capita – percentage of population > 65 years (model 1) – geographical situation (dummy), a variable for each region	– proximity to death – population ageing	*Canada* – The coefficients of determination vary between 0.84 and 0.93 (for models 1 and 2, respectively) – The income elasticity of demand for healthcare services at regional level is significant in both models, with a value of 0.15 and 0.01 (regional level)

(*continued*)

Table A1. Continued

Article/country	Objective(s) of the study	Methodology	Model and variables studied	Determinant(s) of healthcare expenditure	Results and conclusions
		– Two models were calculated for each of the two countries: *Model 1* includes the percentage of the population aged over 65 *Model 2* disaggregates the population by age groups	– percentage of the population: 0–17,18–44,45–64, 65–74, + 74 (model 2) *The USA* Dependent variables: – real per capita healthcare expenditure Independent variables: – real per capita GNP – percentage of population > 65 years. (model 1) – geographical situation (dummy), a variable for each region – percentage of population: 0–24, 25–44, 45–64, 65–84, + 85 (model 2)		– A decrease in federal transfers has occurred, to approximately 15% in the late 1990s – The proportion of the population aged over 65 shows a close relationship to healthcare expenditure (coefficient = 1.07, model 1) – In model 2, only the age groups of the population of 18–44, 45–64 and +74 years have a positive relationship to the growth of healthcare expenditure, the population aged over 74 being the mostly responsible for the increase in healthcare expenditure *The USA* – The coefficients of determination vary between 0.68 and 0.89 (models 1 and 2, respectively) – The income elasticity of demand for healthcare services at national level is significant in both models with a value of 0.73 and 0.50 – The proportion of the population > 65 explains 94% of healthcare expenditure in model 1 – In model 2, only the age groups of the population of 0–24, 25–44, 65–84, +85 years show a significant coefficient

Dormont *et al.* (2006), France[a]	To analyse the determinants of the growth of healthcare expenditure in France (1992–2000)	Model in two parts based on microdata from random samples of patients. They first estimate the decision to use healthcare services and next the level of expenditure incurred	$P_{ij} = I_{P^*_{ij} > 0}$ $P^*_{ij} = W'_{ij}c + M'_{ij}b + a_j + u_{ij}$ $= X'_{1,ij}d + u_{ij}$ $C_{ij} = I_{(P_{ij}=1)} * [C^*_{ij}]$ where $E(C^*_{ij}\|X'_{2,ij})$ $= \exp(Z'_{ij}\gamma + M'_{ij}\beta + \alpha_j)$ $= \exp(X'_{2,ij}\delta)$ P_{ij}, a dichotomous variable expressing use and C_{ij} the healthcare expenditure for individual i in age group j, $u_{ij} \sim N(0, \sigma^2)$ $X'_{1,ij}$ and $X'_{2,ij}$ are the explanatory variables in the use and expenditure equations Dependent variable: – healthcare expenditure Independent variables: – a_j and α_j, dummies for the age groups – M'_{ij}, the indicators of morbidity: – disability – risk of death – number of illnesses – self-perceived health – indicators of various illnesses W''_{ij} and Z'_{ij}, socio-economic characteristics of individuals – income – social and occupational group – educational level – complementary healthcare cover – sex – size of household – marital status	– Change in practice measured as influence of morbidity on use	– The growth of expenditure due to population ageing is relatively small – The impact of the change on practice influence of morbidity on use is 3.8 times greater. The changes in morbidity act in the opposite direction, cancelling out the changes due to ageing – The consideration of the variable risk of death, together with a detailed set of indicators of morbidity for each individual, is preferable to proximity to death, which can present problems of exogeneity in estimations

(*continued*)

Table A1. Continued

Article/country	Objective(s) of the study	Methodology	Model and variables studied	Determinant(s) of healthcare expenditure	Results and conclusions
Felder *et al.* (2000), Switzerland[a]	To analyse the evolution of healthcare expenditure in terms of the proximity to death of the population in the period 1986–1992	– The data for this study are taken from the most important healthcare insurance company in Switzerland. The period studied is from 1986 to 1992 – Two explanatory models of healthcare expenditure are estimated, one for all individuals and another for those aged over 65. The last 2 years of individuals' lives (8 quarters) are taken into account. – The study is repeated for the last 5 years (20 quarters) of individuals' lives, taking only those individuals aged over 65 – Based on five hypotheses referring to the impact of age, closeness to death, level of income and type of cover of the healthcare insurance. These individuals died between 1985 and 1992.	$\ln \mathrm{HCE} = \beta_0 + \beta_1 \cdot A + \beta_2 \cdot A^2 + \beta_3 \cdot \mathrm{SEXF} + \beta_4 \cdot (A * \mathrm{SEXF}) + \beta_5 \cdot D_{65} + \beta_6 \cdot \lambda + \beta_7 \cdot \mathrm{Subs} + \beta_8 \cdot \mathrm{INS} + \sum_{q=1}^{7} Y_q \cdot Q_q + \sum_{t=1986}^{1992} \delta_t \cdot \mathrm{Year}_t + \varepsilon_t$ Dependent variable: – healthcare expenditure Independent variables: – A, age – square of age – SEXF, sex (woman) – interaction of age and sex – $D_{65,}$ age over 65 (dummy) – Sub, state subsidy (dummy) – INS, having supplementary insurance (dummy) – Q_q, quarter prior to death (dummy), one variable for each of the eight quarters – $\mathrm{Year}_{t\mathrm{B}}$, year (dummy), one variable for each year between 1986 and 1992 – λ, inverse of the Mills ratio (indicator of the propensity of each individual to participate in the labour market)	– proximity to death – level of income of the population	– Taking into account the 2 years (8 quarters) prior to death, the R^2 of the regression of the model stands between 0.11 and 0.08 – Age is significant only when all individuals are considered, with a coefficient of 0.066. For individuals older than 65, age presents a negative coefficient close to zero (−0.015) – Individuals aged over 65 and sex have a coefficient of 1.324. Women aged over 65 spend more than men – The state subsidy has an indirect relationship to the increase in healthcare expenditure. (coefficient of −0.109 for the over 65s) – Having supplementary insurance is fairly significant between 0.806 and 0.762 (the latter coefficient corresponds to individuals aged over 65) – The coefficient of the 4 months just before death is 1.944 for over-65s and 1.939 when all individuals are taken into account. (The coefficient decreases the further we get from the 4 months prior to death) – Healthcare expenditure decreases as an individual's age increases, though it increases as death approaches – Healthcare costs prior to death are greater for young

					individuals than for those aged over 65 Note: The results are similar to those of Zweifel *et al.* (1999).
Giannoni and Hitiris (2002), Italy[a]	– To identify the determinants of the growth of healthcare expenditure in Italy in the period 1980–1995 – To analyse the emergence of disparities among the regions of Italy	– Panel data and cross-sectional data (1980–1995) for the Italian regions provided by the Italian National Institute of Statistics (ISTAT); the data corresponding to healthcare expenditure and GDP come from the Regional Accounts. Finally, the Annual Yearbook of Statistics facilitated the information on the size of the population, the age structure of the population, the number of beds per hospital and the number of healthcare personnel – Estimation of an econometric model to explain regional healthcare expenditure in Italy and interpretation of the values of the coefficients of each of the explanatory factors of healthcare expenditure	Dependent variable: – per-capita public healthcare expenditure Independent variables: – real GDP – proportion of population aged over 65 – number of beds per hospital – number of healthcare and non-healthcare personnel per hospital.	– level of income per capita – population ageing	– The income variable shows an elasticity of demand of 0.33 – The ageing variable presents a coefficient of 0.16, so an increase in the number of senior citizens would increase healthcare expenditure though by a very small proportion – The coefficient of the number of hospital beds is −0.07, which can be interpreted as an indicator of Economies of Scale at regional level – The coefficient of healthcare and nonhealthcare personnel per hospital is 0.05, confirming that the intensive use of labour in the healthcare sector increases the expenditure – This study concludes that the level of income and population ageing are the main determinants of the increase in healthcare expenditure in Italy. However, they cannot be controlled directly by the government or by market policies. For this reason the government must act on variables that it can control, such as the existence of economies of scale and productivity labour in the healthcare sector

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Table A1. Continued

Article/country	Objective(s) of the study	Methodology	Model and variables studied	Determinant(s) of healthcare expenditure	Results and conclusions
Herwartz and Theilen (2003), OECD[a]	To analyse the variation of healthcare expenditure in the countries of the OECD in the period 1961–1979	– Database: OECD 1999. Panel data and time series with the evolution of healthcare expenditure in all countries of the OECD (except Greece, Luxembourg, New Zealand, Portugal and Turkey for which no data exist) – Once verified that the variables included in the model of healthcare expenditure are cointegrated, OLS are applied to estimate the model – Analysis of the variation in healthcare expenditure in the countries of the OECD in terms of level of income, ageing of the population and technological change for the period 1961–1979	$\Delta HCE_{n,t} = v_n + \delta_n t/100 + \alpha_n(\mathrm{HCE}_{n,t-1} - \beta_{1n}\mathrm{GDP}_{n,t-1} - \beta_{2n} P65_{n,t-1}) + \gamma_{1n}\Delta\mathrm{GDP}_{n,t} + \gamma_{2n}\Delta P65_{n,t} + \gamma_{3n}\Delta\mathrm{HCE}_{n,t-1} + u_{n,t}$ Dependent variable: – ΔHCE, healthcare expenditure (one variable for each country and for each year) Independent variables: – ΔGDP, increase of GDP (one variable for each country and for each year) – Δ*P*65, increase of the population aged over 65 years (one variable for each country and for each year)	Does not detail any specific determinant of the growth of healthcare expenditure	– The results of the regression of the model show an income elasticity of demand of 0.74, meaning that healthcare services are a normal good – Regarding the population aged over 65, no strong relationship is observed with the increase in healthcare expenditure, as it presents a coefficient of 0.095
Karatzas (2000), the USA[a]	To identify and value the importance of the impact of the primary and secondary determinants of healthcare growth in the USA in the period 1962–1989	– Annual observations for the period 1961–1989 in the USA, taken from: OECD; *Health Systems* (1993); International Monetary Fund (IMF), Internal Statistics; United Nations – Regression of four alternative explanatory econometric models of healthcare expenditure, combining economic variables, healthcare stock variables and demographic variables – These four econometric models are applied in	*Dependent variable:* – per-capita healthcare expenditure (public, private and total) *Independent variables* (for all models): – index of prices in the healthcare sector – income distribution (nominal GDP) – number of physicians employed per adjusted population – number of beds per adjusted population – number of US cities of more than 1000 inhabitants – percentage of the population aged over 65 years – real per capita GDP	– level of income – population ageing	– The models set out in this study have a coefficient of determination of 0.98 approximately – GDP presents an elasticity of demand in S1 (scenario one) of 0.578, indicating that healthcare services are a normal good and not a luxury – The coefficients of the index of prices in the healthcare sector vary in the different scenarios between −0.684 and −0.625, ratifying its inverse relationship to the demand for healthcare services – The coefficient of income distribution varies between 2.615–3.949, indicating that this variable has positive elasticity, unlike the

		four scenarios: Determinants of healthcare expenditure: (S1) per-capita; (S2) public; (S3) private; (S4) of total expenditure on patients – The unit root and cointegration tests are applied to the time series of the explanatory variables of per capita healthcare expenditure	– real per-capita insurance premium – medical speciality ratio – real per-capita administrative expenses adjusted for population – number of active nurses adjusted for population		number of beds, which presents negative coefficients between −1.514 and −1.674 – The percentage of the population aged over 65 is a highly significant variable (coefficient, 2.552) – The number of active nurses adjusted for population has a coefficient close to unity
Koening *et al.* (2003), the USA[a]	To identify and classify the factors contributing to the increase in healthcare expenditure and in the demand for healthcare services in the period 1999–2000	– Regression of two econometric models with data from two bases – The data for the SHE model are taken from *State Health Expenditure* (1990–1998) and are estimated using fixed effects, while the LNGH model from *Large National Group Health Insurer* (1998–2000) is estimated by OLS	Dependent variable: – healthcare expenditure Independent variables: 41 variables grouped into the following categories: – demographic and general economic conditions – health status – payment to providers/suppliers – healthcare insurance – supply of physicians and specialists – market structure of providers – providers' running costs – regulation of healthcare – treatment guidelines and technology	– excess supply of healthcare services – population ageing	SHE model – $R^2=0.98$ – The income elasticity of demand is 0.760. – An increase of 10% in the Hispanic and coloured population is associated with a fall in expenditure on healthcare services of 39% and 21%, respectively – The population aged over 65 years is associated with an increase in expenditure on healthcare services (0.67) – An increase of 10% in the population with high cholesterol is associated with an increase of 0.5% in expenditure on healthcare services – An increase of 10% in physicians' salaries is associated with a rise in expenditure on healthcare services of 2.2% LNGH model – $R^2=0.87$ – The age distribution of the population is also significant in this model – An increase of 10% in the immigrant population is associated with a 91% rise in expenditure on healthcare services – The technologies that exercise greatest pressure on the increase in healthcare expenditure are: magnetic resonance, CAT and catheterization

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Article/ country	Objective(s) of the study	Methodology	Model and variables studied	Determinant(s) of healthcare expenditure	Results and conclusions
Mosca (2007), OECD[a]	To analyse whether decentralization influences healthcare expenditure in 20 countries of the OECD in the period 1990–2000. It considers Greece, Italy, New Zealand, Portugal, Spain and the United Kingdom to be centralized NHSs (in the case of Spain it justifies that the process was very long and hard and ended in 2002 when the study was up to the year 2000, and furthermore the funding is collected centrally) Decentralized NHSs are Denmark, Finland, Ireland, Norway and Sweden, centralized Social Security Systems Belgium, France, Luxembourg and Holland, and finally Australia, Austria, Canada, Germany and Switzerland are decentralized SHIs	– formulates a log–log model in which it estimates by OLS	$\ln \mathrm{THE}_{it} = \beta_0 + \beta_1 \ln \mathrm{GDP}_{it} + \beta_2 \ln \mathrm{PHY}_{it} + \beta_3 \ln \mathrm{BEDS}_{it} + \beta_4 \ln A19_{it} + \beta_5 \ln A80_{it} + \beta_6 \ln \mathrm{UN}_{it} + \beta_7 \mathrm{NHS}d + \beta_8 \mathrm{SHI}\text{-}d + \beta_9 \mathrm{SHI}c + \beta_{10} T + \varepsilon_{it}$ Dependent variable: – total per capita healthcare expenditure Independent variables: – GDP – PHY, physicians per 1000 inhabitants – BED, acute beds per 1000 inhabitants – $A19$, percentage of population aged over 19 and $A80$, over 80 – UN, rate of unemployment – three dummy variables to classify countries in terms of whether they have a NHS or SHI and the degree of decentralization (in matters of management and whether they are in charge of raising the funding for the healthcare system)	All the variables except beds are statistically significant and have a positive effect on per capita healthcare expenditure (except the percentage of population aged under 19)	– An increase of 10% in the percentage of over-80s implies an increase in healthcare expenditure of 1.4% – Healthcare services are shown to be a normal good, with an elasticity of less than one (0.682) – Decentralized SHI systems ($\beta_8 = 0.246$), decentralized NHSs ($\beta_7 = 0.116$) and centralized SHI systems ($\beta_9 = 0.006$) have higher expenditures than centralized NHSs

Okunade and Murthy (2002), the USA[a]	– To confirm that technological change is the main determinant of the growth in healthcare expenditure – To study the relationship between real per capita healthcare expenditure, real per capita incomes and expenditure on R&D by means of the Johansen cointegration test	– Time series of the total expenditure on R&D in the healthcare sector for the period 1969–1999. – 3 unit root tests (Augmented Dickey–Fuller (ADF), Philips–Perron and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) are applied to the time series of real per-capita healthcare expenditure, real per capita income, total R&D, healthcare sector R&D and to their respective variations – Application of the cointegration test (Johansen). – Estimation of the system of panel equations by OLS Note: In the ADF and Philips–Perron tests, Ho = nonstationariness and for the KPSS test, Ho = stationariness	*Model 1* Dependent variable: – real per-capita healthcare expenditure Independent variables: – per-capita income – total R&D expenditure *Model 2* Dependent variable: – real per-capita healthcare expenditure Independent variables: – per-capita income – healthcare expenditure on R&D	Technological progress	– The results show that applying the ADF and Philips–Perron tests the Ho is rejected for all the time series, and for the KPSS test, it is accepted, which means that the series are stationary – The results of the test of cointegration between per capita GDP, per capita healthcare expenditure and the expenditure on R&D by the healthcare sector show a stable relationship in the long term. Technological progress can therefore be considered the most important determinant of healthcare expenditure in the USA for the period considered
Roberts (2000), EU[a]	– To re-examine the methodology of the study by Hitris (1997) – To propose an alternative explanatory model of healthcare expenditure to that of Hitiris (1997), and of its growth in the period 1960–1991	– The panel data are from the OECD (1993) and contain observations for the period 1960–1991 from 10 countries of the former European Community (Belgium, Denmark, Italy, Ireland, France, Germany, Greece, the Netherlands, Spain and Great Britain) – Unit root test (ADF and Phillips–Perron). The null hypothesis of the unit root test is rejected for the variables 'dependence ratio' and 'inflation', so they are eliminated from the econometric model, the 'proportion of the population aged over 65' being included as an alternative – Cointegration of the time series that show the evolution of the explanatory variables of healthcare expenditure, to verify the heteroscedasticity and self-correlation among the variables – Estimation of two econometric models: one to explain healthcare expenditure and another for its growth	Dependent variable: – per capita healthcare expenditure and its growth Independent variables: – Level of per-capita income – Dependence ratio (P) P = (population aged under 19 years + population aged over 65)/population aged 24–64 years – total public expenditure as a percentage of GDP – inflation – a dummy variable for Great Britain – proportion of the population aged over 65 – time trend (as *proxy* for technological progress)	– income level – population ageing	– In the model that explains healthcare expenditure, the proportion aged over 65 presents a coefficient of 0.211, showing a positive relationship to healthcare expenditure – The coefficient of determination is 0.9 – In the model that explains the growth of healthcare expenditure the coefficient of the over-65s is 0.049. This value may be due to two causes: (a) short term changes in the proportion aged over 65 are not detected by the model; (b) the fit of the model is not good (coefficient of determination 0.336) – However, when the healthcare expenditure model is compared with the growth of healthcare expenditure, we observe a reduction in the importance of the level of income of the total public expenditure as a percentage of GDP from 1.249 to 0.864 and from 0.571 to 0.366. respectively for each of the variables

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Article/ country	Objective(s) of the study	Methodology	Model and variables studied	Determinant(s) of healthcare expenditure	Results and conclusions
Seshamani and Gray (2004a), England[a]	To review the theory developed by Zweifel *et al.* (1999) which affirms that population ageing will not have a great impact on the growth of healthcare expenditure	– The data used are from The Oxford Record Linkage Study (ORLS) which contains longitudinal data on costs of hospital and other services of a hospital in Oxfordshire, England (1970–1999) – Repetition of the methodology developed by Zweifel *et al.* (1999). However, new variables have been included, such as: – cause of death (dummy) – cause of admission (dummy) – place of medical discharge (dummy) – marital status (dummy) – diagnosis (dummy) – patient's social class (dummy)	$\Pr(\text{HCE} > 0) = \beta_0 + \beta_1 \cdot A + \beta_2 \cdot A^2 + \beta_3 \cdot S + \beta_4 \cdot (A * S) + \sum_{q=2}^{24} \gamma_q \text{Yr}_q + \sum_{t=1971}^{1999} \delta_t Y_t + \sum_{c=2}^{5} \chi_c C_c + \sum_{s=2}^{5} \xi_s \text{Soc}_s$ Dependent variable: – HCE, healthcare expenditure Independent variables: – A, age – age squared – S, sex (dummy) – interaction of age and sex – Y_r, quarter prior to death (dummy), a variable for each of the eight quarters – Y, year (dummy), a variable for each year – C, cause of death (dummy) – cause of admission (dummy) – place of medical discharge (dummy) – marital status (dummy) – diagnosis (dummy) – Soc patient's social class (dummy)	– proximity to death – population ageing	Observing the sign of the coefficients of estimation, the authors conclude that: – There is an increased probability of being in hospital (incurring healthcare expenditure greater than zero) with closeness to death – Age has a significant effect on the possibility of being in hospital, but the square of the age presents a negative coefficient in the *probit* model – The sex is not significant as regards the probability of being in hospital – In the last years before death the probability of being hospitalized increases – Age and proximity to death both influence the growth of healthcare expenditure, but the influence of proximity to death is much greater – The model developed suffers problems of multicollinearity among its variables (weakness of the model)
Seshamani and Gray (2004b), England[a]	To examine the influence of age and closeness to death on hospital costs	– Panel database (ORLS) covering 90 929 patients aged over 65. Analysing the trajectory of these individuals from 1970 until their death – Various age cohorts (65,		– proximity to death – ageing of the population	– Taking into account the 2 years preceding death the R^2 of the second part of the model is 0.0926 – Age and sex present coefficients of 0.027 and 0.014, respectively

75, 85, 95) were established in order to estimate an econometric model to analyse the healthcare expenditure incurred by such patients – An econometric model to explain healthcare expenditure is proposed. In addition, as a second part, a *probit* model is posited (discrete choice model that avoids the possibility that there is any individual who does not incur any expenditure)	$$\Pr(\text{HCE} > 0) = \beta_0 + \beta_1 \cdot A + \beta_2 \cdot A^2 + \beta_3 \cdot \text{SEXF} + \beta_4 \cdot (A * \text{SEXF}) + \beta_5 \cdot \text{INS} + \beta_6 \cdot \lambda + \sum_{q=2}^{20} Y_q \cdot Q_q + \sum_{t=1971}^{1999} \delta_t \cdot Y_t + \varepsilon_t$$ Dependent variable: – HCE, per capita healthcare expenditure Independent variables: – A, age – age squared – SEXF, sex (dummy) – Interaction of age and sex – INS, possession of supplementary insurance – λ, inverse of the Mills ratio (indicator of the propensity of each individual to participate in the labour market). – Q_q, quarter prior to death (dummy), one variable for each one of the eight quarters – Y_q, number of years remaining until death (dummy) – one variable for each number of years – year (dummy), one variable for each year – cause of death (dummy) – cause of admission (dummy) – place of medical discharge (dummy) – marital status(dummy) – diagnosis (dummy) – patient's social class (dummy) Note: In this case the *probit* model has been linearized by means of logarithmic transformations to the dependent variable, so a reading can be made of the coefficients of regression of the model.	– The coefficient of the variables containing the 15 years prior to death show a rising trend, taking a value of 0.571 in the year just before death – Among the causes of death, those of a respiratory nature originate a higher healthcare expenditure (0.240) – Regarding marital status, single persons and widow(er)s generate higher healthcare expenditure (coefficients: 0.232 and 0.113, respectively) than married persons, who present a coefficient of 0.076 – The diagnoses that generate the highest expenditure are cancer and accidents, with coefficients of 0.217 and 0.231, respectively – Among causes of admission, the most significant value is that relating to long term care with a coefficient of 0.307

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Article/country	Objective(s) of the study	Methodology	Model and variables studied	Determinant(s) of healthcare expenditure	Results and conclusions
Stearns and Norton (2004), England[a]	– To analyse the explanatory power of the proximity to death in the growth of healthcare expenditure over the period 1992–1998 – To carry out a simulation of healthcare expenditure for the period 1998—2020	– Databases from the *Medicare Current Beneficiary Survey (MCBS)* for the period 1992–1998. The study is restricted to the population aged between 66 and 99 years – Comparative analysis of future costs taking into account 2 econometric models: one includes proximity to death as an independent variable; the other excludes proximity to death as an explanatory variable – An econometric model explanatory of healthcare expenditure is proposed. In addition, a *logit* model is proposed – The regression is carried out for one simple model and another expanded one (which includes proximity to death) – There are two variants of the expanded model: it is estimated including and not including the survivors at the end of the study period	*Simple model* (*age and socio-economic characteristics*) $E_{it} = \beta_0 + \beta_1 \cdot \mathrm{AGE}_{it} + \beta_2 \cdot \mathrm{MALE}_{it} + \beta_3 \cdot \mathrm{GEO/SEASON}_{it} + \varepsilon_{it}$ Dependent variable: – EB_{it}, per capita hospital costs Independent variables: – AGE groups: [66, 70), [70, 75), [75, 80), [80, 85), [85, 90), [90, 95) – MALE sex (man) – GEO/SEASON, geographical situation and time indicator(dummy) *Expanded model* (*age and socio-economic characteristics + proximity to death*) $E_{it} = \beta_0 + \beta_1 \cdot \mathrm{AGE}_{it} + \beta_2 \cdot \mathrm{MALE}_{it} + \beta_3 \cdot \mathrm{GEO/SEASON}_{it} + \beta_4 \cdot \mathrm{TTD}_{it} + \beta_5 \cdot \mathrm{AGE}_{it} * \mathrm{TTD}_{it} + \varepsilon_{it}$ Dependent variables: – per capita hospital costs Independent variables: – age groups: [66, 70), [70, 75), [75, 80), [80, 85), [85, 90), [90, 95) – sex (man) – geographical situation and time indicator (dummy) – TTD, quarter prior to death (dummy), one variable for each of the eight quarters – interaction of quarter prior to death, and age	– proximity to death – population ageing	– Gender and geographical location present negative coefficients in both simple and expanded models – The coefficients of the different age groups are positive. Except for age group [90, 95) in the expanded model. Also, they are more significant in the simple model than in the expanded one – The interaction of the quarter prior to death and age presents a non-significant coefficient in the expanded model. (negative sign of all the coefficients) – The regression of the *logit* model shows that the adjusted R^2 of the simple and expanded models is 0.038 and 0.0514, respectively, showing that the inclusion of the proximity to death increases the power to explain healthcare expenditure

Werblow *et al.* (2007), Switzerland[a]	To verify that population ageing is not significant for the increase in healthcare expenditure	To avoid the effect of age on the endogenous variables this is included raised to the cube and terms of interaction with sex and death are also included. Proximity to death is included squared, and also interacting with sex	$\Pr(\mathrm{HCE}_i>0)=\alpha_0+\alpha_1 X_i+\varepsilon_i$ $\mathrm{HCE}_i \mid \mathrm{HCE}_i>0=\beta_0+\beta_1 X_i+\varphi_i$ Dependent variable: – healthcare expenditure Independent variables: – age – proximity to death – sex – death before 2004 – a set of dummy variables to differentiate Zurich from Geneva, and complementary accident, hospital and other insurance and the average spend per insured in the community	Proximity to death	Age becomes of little significance when one controls for proximity to death
Zweifel *et al.* (1999), Switzerland[a]	To study the relationship between healthcare expenditure and population ageing in the period 1983–1994	– Data from two Swiss insurance companies. One of them, 'KKB', sample 1, covers mainly the rural population. The study period is 1983–1992. The other company, 'Helvetia', sample 2, covers the urban population from 1983 to 1994 – Two explanatory models of healthcare expenditure (one for each sample) are estimated for all individuals covered by each company and for those aged over 65. The last 2 years of individuals' lives (8 quarters) are taken into account – The study is repeated for the last 5 years of life (20 quarters), taking only individuals aged over 65 years Note: When the analysis is repeated for 5 years (20 quarters) prior to death, the results are similar to those obtained for 2 years.	$\ln \mathrm{HCE} = \beta_0+\beta_1\cdot A+\beta_2\cdot A^2+\beta_3\cdot \mathrm{SEXF}+\beta_4\cdot(A*\mathrm{SEXF})+\beta_5\cdot \mathrm{INS}+\beta_6\cdot\lambda+\sum_{q=1}^{7} Y_q\cdot Q_q+\sum_{t=1982}^{1992}\delta_t\cdot Y_t+\varepsilon_t$ Dependent variable: – HCE, healthcare expenditure Independent variables: – A, age – square of age – SEXF, sex (woman) – interaction of age and sex – INS, possession of supplementary insurance (dummy) – λ, inverse of the Mills ratio – Q_q, dummy variable taking the value 1 for the quarter q prior to death – Y_t, year (dummy), one variable for each year between 1982 and 1992	Proximity to death	– Taking into account the 2 years (8 quarters) preceding death, the R^2 of the regression of the model is between 0.11 and 0.09 – Age is a significant variable only in the regression of sample 1 and only when all individuals are considered, with a coefficient of 0.062. For individuals aged over 65, in the sample 1 and in sample 2, age presents a negative coefficient close to zero – In sample 1, for individuals aged over 65, sex has a coefficient of 1.632. Women aged over 65 spend more than men – Having supplementary insurance is fairly significant in both samples, being situated between 0.239 and 0.761 (the latter coefficient corresponds to sample 1, individuals aged over 65)

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Table A1. Continued

Article/country	Objective(s) of the study	Methodology	Model and variables studied	Determinant(s) of healthcare expenditure	Results and conclusions
					– The coefficient of the 4 months just before death varies between 1.888 (sample 1, individuals aged over 65) and 0.610 (sample 2, individuals aged over 65). The further we get from the period prior to death the lower the coefficient, implying that a greater healthcare expenditure is concentrated in the 4 months before death irrespective of the individual's age

Notes: [a]Authors' own preparation.
[b]Questions of methodology and of results of the projection of expenditure on the German population are avoided by detailing the prior analysis of the patterns of expenditure in the Swiss database.