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THE IMPACT OF DEATH-RELATED COSTS ON HEALTH-CARE EXPENDITURE:

A SURVEY

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Michele Raitano*

Abstract

In the economic policy debate it is often stated that population ageing will lead to huge increases in the age-related components of public expenditure – primarily pensions and health care. This paper analyses a factor that may, at least partly, alleviate the fear that increased life expectancy will accelerate the rise in health-care spending: namely the fact that independent of decedent age, the bulk of per capita health-care costs are concentrated in the last years of life (the so-called 'death-related' costs). It surveys the empirical literature on health economics, presenting the main results obtained by studies on the interaction among age, proximity to death and health-care expenditure. Based on this analysis, it concludes with certainty that age alone is not a good predictor of rises in health-care spending, and that proximity to death must also be used as a predictor of health-care expenditure.

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Introduction

In the economic policy debate it is often stated that the ageing of the population will lead to huge rises in the age-related components of public expenditure – primarily pensions and health care.

As often cited in health economics literature, the per capita health-care costs by age profile present a J-shaped curve: after childhood, per capita health-care consumption increases with age and its growth rate accelerates for the age groups of those over 65. It is thus easy to infer that ageing, in that it increases the share of the population in the older age groups, will generate a massive growth of health-care spending. Yet numerous studies have also pointed out that the effects of ageing on health-care expenditure (HCE) are much more uncertain than apparent from observation of the per capita health-care costs by age profile in a given year.

From a historical viewpoint, demography has never been a significant driver of health-care spending (Oxley & MacFarlan, 1994): the growth of spending has mainly been induced by other demand effects (per capita income growth and the extension of coverage by national health systems) and most of all by supply factors (technological progress, inflation and the supply-induced demand effect in a sector where information asymmetries are pervasive).

Moreover, the concern about the future increase in health-care costs as a result of population ageing depends on the use of a static and constant age-related HCE profile (the 'J curve'). But is it theoretically correct to assume the constancy of this profile, or does the age-related pattern change according to ageing as well?

Research shows that the age profile changes for two main demographic reasons: the possible improvement in health status following the increase in life expectancy[1] and the fact that the bulk of individual lifetime health-care costs are concentrated at the end of life (the so-called 'death-related' costs). Depending on possible changes in health status and on the death-costs component, observing at a given point of time that the elderly consume more health-care services than the young does not imply that the process of ageing alone – in that it increases the share of the elderly in the population – will inevitably lead to increases in health-care spending.

With regard to the death-costs factor, it has been suggested that there may not be a direct causal relationship between ageing and health-care costs. This is because the accelerated rise in costs at higher ages may not be a function of age per se, but rather of individual proximity to death, since age and death are closely correlated (hence the correlation between age and health-care

[1] The various scenarios of changes in health-status following increases in life expectancy are briefly summarised in section 4; for a survey see Seshamani (2004).

costs may be – at least in part – a spurious one because of this correlation). The relationship between ageing and HCE may therefore be more complex than usually discussed, given that the individual cost distribution over time is mainly determined by costs entailed in the last years of life, rather than by chronological age (see Brockmann, 2000). Thus the J-shaped age profile would not depend on an effective increase in consumption by the elderly, but rather on the enormous impact of death costs in the age groups for which the mortality rate is higher. Consequently, ageing, increasing life expectancy and diminishing mortality rates should postpone the onset of death costs and change the individual, age-related, health-care expenditure profile.

The importance of death costs has considerable consequences for health-cost projections. Given that the majority of HCE is concentrated near death, it is not possible to assume that the age profile of HCE will remain constant when life expectancy increases. Decreases in age-specific mortality rates lead to falls in age-specific costs, because declining mortality rates reduce the proportion of high-cost users (i.e. those close to death). The correct assumption may therefore be the constancy of the proximity-to-death profile of health-care spending.

This paper focuses on the impact of death costs on health-care spending. It surveys the empirical literature on health economics, presenting the main results obtained by studies on the interaction among age, proximity to death and health-care expenditure. It should be pointed out that empirical studies have focused mainly on health-care costs; only a few of them have examined long-term care as well. Table 1 shows the countries in which the impact of death costs has been studied and the kinds of analyses performed.

Table 1. Countries in which studies on death-related costs have been performed

Country	**Kinds of analyses**
US	Descriptive and projections
Canada	Descriptive
Switzerland	Econometric
Germany	Econometric, descriptive and projections
Italy	Descriptive and projections
Spain	Descriptive
Austria	Descriptive and projections
UK	Econometric, descriptive and projections
Denmark	Descriptive and projections
The Netherlands	Descriptive and projections
France	Descriptive
Sweden	Descriptive and projections
OECD countries	Projections

Source: Author’s compilation.

As shown in Table 1, these studies have used different methodologies and can be classified into the following three groups:

- descriptive studies, which evaluate the evolution of death costs by age at death and the ratio (at each age) between the health-care expenditures of decedents and survivors;

- econometric studies, which seek to estimate whether age and the length of time to death are significant drivers of health-care expenditures; and finally,
- projection studies, which aim at calculating the difference between health-care cost projections that include or otherwise the death-costs assumption.

A more elaborate discussion of each kind of study is presented in sections 1, 2 and 3; section 4 concludes.

1. Descriptive studies

As stated in the introduction, numerous recent empirical studies have shown that the bulk of individual lifetime HCE is concentrated in the last years – or months – of life, quite independently of the age at which death occurs. Since the seminal paper by Lubitz & Riley (1993), all the studies performed in a variety of countries have confirmed this finding, and have shown that the ratio between the costs incurred by decedents and survivors (no matter how these two groups are defined) is very high and tends to decrease with age.

The main descriptive studies of the interaction among age, proximity to death and HCE are listed in Table 2. It should be noted that most of these studies have been conducted using statistical methodologies alone (i.e. they describe the different costs by age and length of time to death), without inferring a causal relationship between these variables (see section 2 for the analysis of econometric papers that study this causal link).

Numerous studies are based on the US Medicare sample, which mostly records the acute-care costs incurred by patients. Some studies have also sought to analyse the share of long-term costs incurred in the terminal phase of life, although this analysis is made more difficult by a shortage of data. Descriptive studies usually analyse the per capita costs in the last period of life and their link with patient age, and they calculate the ratio between decedent and survivor costs by age (see Tables 3 and 4).

All studies show a rapidly decreasing trend in the ratio by age, even if the estimated size differs somewhat. These differences may depend on the sample observed, on the kinds of costs examined and on the definition of decedent and survivor. Most of the studies listed in Table 3 define decedents as individuals who do not survive in a given year,[2] while others (CNAMTS, 2003 and Seshamani & Gray, 2004a and 2004b) decompose the population by years of time to death (suggesting that the impact of death on health-care costs is not restricted to the last year of life). In the latter cases, the ratios are between the costs of individuals with different numbers of years remaining, which means that they are not strictly comparable to the ratios based on costs incurred by decedents and survivors in a given year. Busse, Krauth & Schwartz (2002) do not study the effect on spending, but rather the number of hospital admission days by age and length of time to death. They find that the oldest decedents (those more that 85 years old) are hospitalised for fewer days than younger decedents (also because they have different diseases and habits).

[2] See for example, Ahn, Garcia & Herce (2005), Cislaghi et al. (2003), Lubitz, Beebe & Baker (1995), Calfo, Smith & Zezza (2004) and McGrail et al. (2000).

Table 2. Descriptive studies on the interaction among age, proximity to death and health-care expenditure

Authors	Publication year	Country studied	Object of analysis
Calfo, Smith & Zezza	2004	US (Medicare)	Acute-care costs by age and decedent/survivor ratio
Hoover et al.	2002	US (Medicare)	Acute-care costs by age and decedent/survivor ratio
Hogan et al.	2001	US (Medicare)	Acute-care costs by age and decedent/survivor ratio
Miller	2001	US (Medicare)	Acute-care costs by age and length of time to death
Spillman & Lubitz	2000	US (Medicare)	Acute-care and nursing-care costs by age and decedent/survivor ratio
Lubitz et al.	1995	US (Medicare)	Acute-care costs by age and decedent/survivor ratio
Lubitz & Riley	1993	US (Medicare)	Acute-care costs by age and decedent/survivor ratio
McGrail et al.	2000	Canada (British Columbia)	Acute-care and nursing-care costs by age and decedent/survivor ratio
Gabriele et al.	2006	Italy	Acute-care costs by age and decedent/survivor ratio
Ahn, García & Herce	2005	Spain	Acute-care costs by age and decedent/survivor ratio
Batljan & Lagergren	2004	Sweden	Health and long-term care costs by length of time to death
Madsen	2004	Denmark	Acute-care costs by age and decedent/survivor ratio
Seshamani & Gray	2004	UK	Acute-care costs by age and length of time to death
Polder & Achteberg	2004	The Netherlands	Acute-care and nursing home care
CNAMTS	2003	France	Acute-care costs by age and decedent/survivor ratio
Cislaghi et al.	2003	Italy (Tuscany)	Acute-care costs by age and decedent/survivor ratio
Busse, Krauth & Schwartz	2002	Germany	Number of days spent in hospital by age and decedent/survivor ratio
Riedel et al.	2002	Austria	Acute-care costs by age and decedent/survivor ratio

Source: Author's compilation.

Table 3. Decedent/survivor expenditure ratios for the elderly in some studies

Authors	**Ahn, Garcia & Herce (2005)**	**CNAMTS (2003)**	**Cislaghi et al. (2003)**	**Lubitz, Beebe & Baker (1995)**	**Calfo, Smith & Zezza (2003)**	**Seshamani & Gray (2004a)**	**McGrail et al. (2000)**	**McGrail et al. (2000)**	**Busse, Krauth & Schwartz (2002)**
Country	Spain	France[1]	Italy	US	US	UK[2]	Canada[3]	Canada[4]	Germany[5]
60-64	15.8	45-54 8.5	15.8	–	8.2	–	–	–	–
65-69	11.9	55-64 3.3	10.0	10.6	12.1	14.6	65 17.9	65 11.9	65-74 2.2
70-74	9.4	65-74 2.6	7.2	8.6	9.2	17.9	75 10.4	75 6.0	–
75-79	7.4	75-84 2.8	4.9	6.8	7.1	20.5	85 6.2	85 2.7	75-84 1.6
80-84	6.3	–	3.2	5.3	5.5	21.9	93 4.7	93 1.9	–
>85	5.0	1.8	1.9	4.4	4.4	22	–	–	>85 1.3
All ages	24.1	–	11.5	>65 6.9	>65 6.8	–	–	–	–

Notes: 1) Proportion of costs borne by a person dying in the same year to those of a person dying in four years' time; 2) ratio between men 1 year from death and men 10 years from death; 3) acute-care costs; 4) nursing care costs; 5) quantity data.

Source: Author's compilation.

Gabriele et al. (2006) define a decedent as a person who does not survive a given year and show a monotonic and similar decreasing pattern of decedent/survivor hospital-cost ratios in all the Italian regions they analysed (Table 4).

Table 4. Decedent/survivor expenditure ratios for the elderly in some Italian regions

Age groups	**Lombardy**	**Tuscany**	**Abruzzo**	**Puglia**
65-69	10.0	13.1	8.3	8.6
70-74	7.4	8.9	6.3	6.3
75-79	5.2	6.1	4.4	4.2
80-84	3.8	4.1	3.2	3.2
85-89	2.7	3.0	2.2	1.9
>90	1.8	1.9	1.4	1.3
All ages	13.8	14.0	10.2	11.9

Source: Gabriele et al. (2006).

Ratio observation shows clearly that both age and length of time to death influence health-care costs. The impact on spending of both variables can be analysed by observing the absolute values of costs in the last years of life and in the years far from death. In other words, the intention is to determine whether the age-decreasing profile owes more to a reduction in the numerator or to an increase in the denominator.

Studies that compare the costs incurred by individuals who die or do not die in a given year at different ages (Tables 5 and 6) indicate that death costs decrease by age more rapidly than survivor costs increase by age. This suggests that because ageing postpones the onset of the more expensive terminal costs, it may reduce the pressure on health-care spending.[3]

Table 5. Hospital-care costs for decedents (last year of life) and survivors in Italy (in Tuscany; in Italian lira)

Age groups	Decedents	Survivors	Ratio
65-69	14,204,366	1,731,419	8.2
70-74	13,324,191	2,248,742	5.9
75-79	10,463,283	2,536,991	4.1
80-84	8,429,667	3,053,476	2.8
>85	5,566,044	3,114,140	1.8
All ages	10,509,881	838,010	12.5

Source: Cislaghi et al. (2002).

Table 6. Hospital-care costs for decedents (last year of life) and survivors in Austria (in euros)

	Men			Women		
Age groups	**Last year of life**	**Survivors**	**Ratio**	**Last year of life**	**Survivors**	**Ratio**
65-69	16,456	1,212	13.6	17,230	1,009	17.1
70-74	15,370	1,466	10.5	15,289	1,296	11.8
75-79	12,717	1,627	7.8	12,829	1,497	8.6
80-84	9,762	1,455	6.7	9,841	1,363	7.2
>85	7,037	1,134	6.2	6,164	1,144	5.4

Source: Riedel et al. (2002).

A similar pattern is reported in studies that decompose the population according to years of remaining life (see Tables 7, 8 and 9), although Seshamani & Gray (2004a)[4] and Miller (2001) find a ∩-shaped death-cost profile by age after the age of 65, rather than a monotonically decreasing one, because it increases until the age of 80 and then declines.[5] Yet studies that also decompose populations by length of time to death confirm that costs increase steadily in the last year of life, although the increase is substantial (independent of age) in the previous years as well. This finding suggests that death has a more profound impact on health-care expenditure than that observed if only the last year of life is considered (see Table 9).

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[3] These results have also been confirmed for the various Italian regions by Gabriele et al. (2006).

[4] Seshamani & Gray (2004a) use econometric methodology (their paper is discussed in detail in the next section), but they also provide some descriptive indicators on the UK sample analysed.

[5] Nevertheless, Seshamani & Gray (2004a) stress that the effects of proximity to death on acute-care costs far outweigh the effect of age. Moreover, as previously mentioned, it has to be noted that ratios based on costs incurred by decedents and survivors in a given year and ratios based on costs incurred by individuals with a different number of years to death (especially those who have a considerable length of time to death) are not strictly comparable.

Table 7. Hospital costs by age and length of time to death (in Danish krone)

Age groups	Last year of life	Surviving more than 3 years	Ratio
50-59	64.9	6.1	10.6
60-69	69.4	8.7	8.0
70-79	58.8	12.2	4.8
80-89	35.5	14.8	2.4
>90	18.6	10.3	1.8
All ages	47.7	10.4	4.6

Source: Madsen (2004).

Table 8. Average annual hospital costs by years of time to death (in GPB)

	Women			Men		
Age	**1 year prior to death**	**10 years prior to death**	**Ratio**	**1 year prior to death**	**10 years prior to death**	**Ratio**
65	3,176	209	15.2	2,460	168	14.6
70	3,649	212	17.2	2,885	161	17.9
75	3,977	218	18.2	3,201	156	20.5
80	4,121	227	18.2	3,369	154	21.9
85	4,052	240	16.9	3,363	154	21.8
90	3,765	256	14.7	3,175	156	20.4
95	3,279	278	11.8	2,817	160	17.6

Source: Seshamani & Gray (2004a).

Table 9. Health-care costs by years of time to death (various currencies as noted below)

	Miller[1]				Seshamani & Gray[2]	Batljan & Lagergren[3]	
Years from death	**>65**	**75**	**85**	**95**	**>65**	**All ages**	
< 1	11,100	13,500	10,700	7,000	4,382	0	52
2	7,000	8,600	6,900	4,900	917	1	35
3	4,500	5,100	4,600	3,700	616	2	21
4	3,800	4,200	4,000	3,200	440	3	17
5	3,400	3,400	3,600	3,300	354	4	14
6	3,100	3,000	3,300	3,000	273	5	12
7	2,800	3,000	2,800	2,800	225	6	9
8	2,500	2,400	2,800	2,500	197	>6	3
9	2,300	2,400	2,500	2,400	173	–	–
10	2,200	1,900	2,200	2,100	154	–	–
> 10	1,600	–	1,700	1,800	–	–	–

Notes: 1) US dollars; 2) UK GPB; 3) Swedish Krona.

Sources: Miller (2001), Seshamani & Gray (2004a and 2004b) and Batljan & Lagergren (2004).

The age-decreasing pattern of terminal health-care costs may depend on various factors: different diseases afflicting young and old decedents, different hospitalisation rates by age group, more aggressive care given to the young compared with the old, 'care rationing' with regard to the elderly (the behaviour of doctors changes when they deal with patients of different ages) and substitution between health and long-term care for the oldest old. Descriptive analysis does not allow a causal inference to be drawn as to which factor most significantly influences this pattern. It should be noted, however, that long-term care costs in the last year of life seem to increase with age,[6] so that the age-decreasing pattern of terminal health-care costs may be partly offset by the age-increasing profile of long-term care costs (see Table 10). But this conclusion (i.e. the positive shape of age-linked, long-term care costs) might be (at least partly) reversed if it were possible to analyse the effect on long-term costs of a larger number of years of remaining life and not just the final year (in the case of long-term care, which is often provided informally, it is very difficult to obtain data with which to conduct detailed analyses of the interaction among costs, age and length of time to death).

Table 10. Costs for health and long-term care during the last year of life in the US

Age groups	Medicare	Non-Medicare sources
5-74	27,832	9,211
75-84	26,078	12,451
>85	18,226	18,689

Source: Hoover et al. (2002).

Nevertheless, it should be pointed out that empirical descriptive evidence shows that proximity to death is a key driver of HCE, and that it cannot be overlooked when the impact of ageing on HCE is analysed. In other words, the J-profile of the age-costs profile seems to depend mainly on the impact of per capita costs in the last years of life, rather than on a genuine increase in health-care needs by age.

2. Econometric studies

As discussed in the previous section, numerous empirical studies have found that the bulk of individual, lifetime health-care expenditures are concentrated in the last period of life. It should be borne in mind, however, that the studies presented in section 1 are mainly descriptive. On the basis of a sample of the older age groups, they show some indicators for health- (and sometimes long-term) care costs disaggregated by survivor status, age and proximity to death. But they do not infer a causal link between age, proximity to death and health-care spending. This link can only be shown by econometric studies.

Zweifel, Felder & Meiers (1999) analysed the importance of the death-costs component using an econometric methodology. Since their seminal paper, other studies have applied econometric methodology to study the relationship among health-care expenditure, age and years of life to death (see Table 11).

[6] See Hoover et al. (2002) and McGrail et al. (2000).

Table 11. Econometric analysis of the interaction among age, proximity to death and health-care expenditure

Authors	Publication year	Country studied	Estimation method	Results
Zweifel, Felder & Werblow	2004	Switzerland	Two-part model	Only proximity to death is significant.
Felder, Meiers & Schmitt	2000	Switzerland	Two-part model	HCE increases with proximity to death. HCE in the last months of life decreases with age.
Zweifel, Felder & Meiers	1999	Switzerland	Heckman model	Only proximity to death is significant.
Gray & Seshamani	2004a	England	Two-part model with panel data	Age and proximity to death have significant effects.
Gray & Seshamani	2004b	England	Two-part model	Age and proximity to death have significant effects.
O'Neill et al.	2000	England	OLS	Only proximity to death is significant.
Brockmann	2000	Germany	OLS	Proximity to death is significant. There are negative interactions between age- and disease-specific costs.

Source: Author's compilation.

Their analysis is based on a sample of individuals aged over 65 and enrolled in a Swiss insurance fund. A Heckman model was used to estimate the impact of age and proximity to death on hospital expenditures, using the last quarters of life as indicators of proximity to death. The authors estimated the impact of both the last 8 and the last 20 quarters of life (i.e. the last 2 and 5 years of life), finding that length of time to death has a highly significant effect on hospital costs, while age is not significant at all.

Zweifel, Felder & Meiers thus proved that, given the large difference in health-care costs between survivors and decedents, the positive relationship between age and health-care spending depends on a spurious correlation between these two variables induced by the higher mortality rates (and then by the onset of death costs) in the older age groups.

These authors then demonstrate that, once remaining lifetime has been controlled for (at least for individuals older than 65), health-care costs do not depend on age: hence it is likely that ageing and increased life expectancy do not cause a large increase in spending.

Intense debate ensued from this seminal paper:[7] some authors argued that issues of econometric methodology limited the robustness of the results by Zweifel, Felder & Meiers, while others repeated their analysis with new datasets.

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[7] See Gray & Seshamani (2004a and 2004b), O'Neill et al. (2004) and Zweifel, Felder & Werblow (2004). For a technical analysis of the econometric problems raised by Zweifel, Felder & Meiers (1999), see Salas & Raftery (2001).

Seshamani & Gray (2004a) pointed out the following problems with the results of Zweifel, Felder & Meiers: the sample was relatively small; the quarters of remaining life studied (no more than 20) were too few to infer a real link between length of time to death and costs (the impact of death costs may therefore have been underestimated); and the quarterly observations were used as independent ones, without taking account of the clustering of observations on the same individual. Seshamani & Gray then criticised the approach of Zweifel, Felder & Meiers as not genuinely longitudinal and used a panel data approach in a truly longitudinal fashion in their own studies.

Seshamani & Gray also criticised the use of the Heckman estimation model. On replicating that model with their dataset (derived from the Oxford Record Linkage Study – ORLS – a sample of English hospital patients from 1970 to 1999 consisting of more than 100,000 individuals) Seshamani & Gray (2004b) then show that neither age nor proximity to death are significant drivers of health-care costs.[8] Instead, and confirming the importance of the econometric methodology, they use a two-part model,[9] which finds that both variables (age and proximity to death) are significant, although it confirms that the latter is the main driver of hospital costs (for example, it shows that in the last three years of life hospital-care costs increase sevenfold, while they increase by only about 30% between the ages of 65 and 80).

The results of Seshamani & Gray (2004a and 2004b) clearly confirm the need to incorporate the death-costs component in projections of health-care expenditure. Analysing the impact of remaining years of life up to 29 years to death (and not just up to 5 years, as in the previous studies), they show that length of time to death is highly significant until 15 years to death. They suggest that when used, panel data allow a closer link (than that shown by cross-sectional data) to be inferred between hospital costs and years of remaining life, because panel data record each individual's hospitalisation history. But somewhat contradictory to Zweifel, Felder & Meiers (1999), they find that age is not neutral but has a significant impact on hospital costs.

Moreover, when focusing on the relationship between age and costs in the last period of life, Seshamani & Gray show that the link between age and death costs is not monotonic: death costs increase with age from 65 to 80 and then decline, mainly because after the age of 80, the likelihood of being hospitalised diminishes. Zweifel, Felder & Meiers (1999) instead show age neutrality on costs in the terminal phase of life, whereas most empirical studies (outlined in section 1) suggest that such costs have an age-decreasing profile. It should be noted, however, that more robust econometric papers by Felder, Meiers & Schmitt (2000) and Zweifel, Felder & Werblow (2004) have confirmed that age is not a significant driver of survivors' costs by showing an age-decreasing pattern of death costs.

Thus, an estimation technique even more robust than the one used by Zweifel, Felder & Meiers (1999) has shown that the widespread belief that increased life expectancy will generate higher hospital expenditure is based on a misunderstanding of the real link among age, length of time to death and health-care costs.

That being said, it should be pointed out that such econometric studies analyse only the hospital component of health-care costs and overlook other components of health care (i.e. drugs) and

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[8] They observe that the Heckam model is affected by multi-collinearity problems, so that the impact of the independent variables is very often found to be insignificant.

[9] The two-part estimation model of hospital care costs in analysis, using a probit model, initially consists of the probability of being hospitalised in a certain period; then, if the probability is positive, the analysis involves estimating (by means of an ordinary least squares (OLS) method) the amount of costs incurred by the hospitalised person.

long-term care. These other components (which, it should be noted, are less important in terms of expenditure) may reveal a different link between age and proximity to death.

As previously stated, Zweifel, Felder & Werblow (2004) have confirmed the dependence on the sample studied by applying a two-part model to their original Swiss dataset (to avoid multi-collinearity problems). They repeated the Zweifel, Felder & Meiers (1999) estimation and again found that the only significant driver of health-care costs is proximity to death, while age does not appear to have a significant impact on hospital spending. This conclusion has been confirmed by an econometric study based on an English sample (different from the ORLS) conducted by O'Neill et al. (2000), who applied a simple OLS method to hospital costs disaggregated for age and survivor status (where decedents are defined as individuals in their last year of life).

Interesting results have been obtained by Brockmann (2000), whose analysis focuses on a sample of two German Länder hospitals. It confirms that proximity to death is the main driver of the hospital component of health-care costs, and also finds a negative relationship between costs related to the last year of life and age. In particular, it shows that the hospital costs in the last year of life of a 90-year-old are about 55% lower than those of a 65-year-old.

This negative relationship may depend on various factors: different (and less expensive) diseases suffered by the oldest old; different hospitalisation rates by age (because the elderly prefer long-term care to hospital care); and an age rationing of hospital care (i.e. doctors prefer to devote scarce resources to the young, whose life value is higher, or apply less intensive medical treatments to the elderly).

Brockmann (2000) confirms the hypothesis of age rationing by finding a negative relationship even in a multivariate econometric analysis that controls for the type of disease. In other words, in their last year of life, the oldest old patients receive less costly treatment than younger patients with the same illness. Given this result, the consequences of ageing may be even less severe than is commonly assumed. If ageing postpones the onset of death-related costs at higher ages, and if such costs decrease with age, increased life expectancy may reduce the death-costs component, which, as widely confirmed by both descriptive and econometric empirical studies, accounts for the largest share of individual, lifetime health-care costs and is the main driver of the link between age and HCE.

In concluding this section, it should be noted that all econometric studies agree that proximity to death, rather than age is the main demographic driver of health-care costs (i.e. of hospital-care costs), although there is general disagreement on the effect of age once proximity to death has been controlled for. Moreover, when the time span is increased (see Seshamani & Gray's studies) and decedents are not arbitrarily defined as those in their last year of life, proximity to death is highly significant even in years far from death. In other words, the impact of death on HCE is underestimated if the focus is only on individual spending in the last year of life.

As regards the impact of age on death costs, while some studies find some sort of age neutrality, others find that death costs decrease with age, owing to the age rationing of hospital care, while still others report a ∩-shaped relationship between death costs and age in the over-65 age groups. It should be recognised that the effects of death costs and their age profile may be very different when applied to long-term care. But since adequate data are not available, an econometric study analysing the link among age, length of time to death and long-term care expenditure has not yet been published.

3. Projection studies

The standard methodology used to project the impact of ageing on health-care spending combines a static, age-related per capita expenditure profile (the so-called 'J curve', derived in one instant of time) with demographic projections of the future size of each age group. In that it is based on a constant age-related expenditure profile, this methodology does not take account of possible improvements in health status, the impact of death-related costs or the effects of non-demographic drivers of health-care spending (i.e. technical progress, GDP growth rate and inflation in the health sector, especially for drugs).

When analysing the size of the demographic driver, one cannot overlook the expected effects on spending exerted by changes in the health status of the population following the ageing process or by the component of death costs. Moreover, use of a static age profile does not allow account to be taken of these two effects, and it may probably lead to overestimation of the effect of ageing on HCE.

A static link between age and individual health-care costs implies that death costs do not matter and that, even if life expectancy increases, the care needs of each individual do not change. In other words, it implies that every further year of life is spent in bad health, as if the expansion of morbidity hypothesis were true, which suggests that growth in life expectancy is not driven by a better health status, but by a longer period spent in illness. From an empirical point of view, however, two other scenarios appear more plausible:[10] the compression of morbidity scenario (the number of years spent in good health increase more than life expectancy) and the dynamic equilibrium scenario (every further year of life expectancy is spent in good health, so that if life expectancy increases by five years, the care needs of a 75-year-old individual become the same as the needs of the previous 70-year-old).

The second round of health and long-term care expenditure projections, which were due to be run by the Ageing Working Group on behalf of the Economic Policy Committee (EPC) at the end of 2005, will probably differ from the first round of such projections (see EPC, 2001)[11] by taking account of the effects exerted on spending by health status improvement, by individual survival status (i.e. death-related costs) and by certain non-demographic drivers.

This section focuses on the methodology used to project spending with account taken of the death-costs effect and on the results of the main projection studies that analyse this effect (summarised in Table 12).

Given that the bulk of individual, lifetime health-care costs are concentrated at the end of life (as we saw in sections 1 and 2), and given that mortality rates are higher in the older age groups, excluding the relevance of death costs generates an upward bias in the average per capita expenditure attributed to these groups owing to the decrease in mortality rates. Consequently, when projections are run using a static age-related expenditure profile, and when life expectancy is supposed to increase, this bias leads to the overestimation of future aggregate health-care spending. It has been accordingly suggested that proximity to death should replace age as the indicator of the health status of an elderly population and as a fair basis for predictions (Miller, 2001).

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[10] For a survey of different scenarios on expected health-status changes, see the European Commission (2005).

[11] It should be pointed out, however, that the EPC (2001) acknowledges the limitations of using a methodology based on a constant age-related profile, and different hypotheses are tested for some countries.

Table 12. Projection studies of health-care costs including the impact of death costs.

Authors	Publication year	Country studied	Main results
Breyer & Felder	2004	Germany	Per capita HCE increases in the period 2005-50 from €2,596 to €3,217 with a standard projection and to €2,959 with a projection that includes death costs.
Schulz, Leidl & Konig	2004	Germany	Projections for quantity; the number of hospital days increases from 172 million in 1998 to 231 million in 2050 with a standard projection, and 212 million with a projection that includes death costs.
Miller	2001	US (Medicare)	Standard projection results are 14% higher than those including the death-costs assumption.
Stearns & Norton	2004	US (Medicare)	Standard projection results are 15% higher than those including the death-costs assumption.
Serup-Hansen, Wickstrom & Kristiansen	2001	Denmark	In the period 2005-20 HCE will increase by 18.5% with a standard projection, and by 15.1% with a projection that includes death costs.
Riedel et al.	2002	Austria	Starting from 2.9% of GDP in 2000, in 2050 hospital costs will be 3.79% in the baseline scenario and 3.60% or 3.44% (depending on the assumptions made) if death costs are included.
Madsen	2004	Denmark	If death costs are included, projected spending will be 0.75 percentage points lower than shown by a standard projection.
Seshamani	2004	UK	Incorporating death costs halves the projected annual growth rate of national hospital expenditure (yearly from 0.85% to 0.42%).
Polder & Achterberg	2004	The Netherlands	With a standard projection, the annual growth rate of HCE is 0.6% in 2002-10 and 0.7% in 2010-20, while it is respectively 0.02 and 0.04 percentage points lower when assuming the impact of death costs.
EPC	2001	The Netherlands	Very significant overestimation occurs in the baseline scenario with respect to the death-costs scenario (in 2050 the increase will be 0.4 percentage points lower, i.e. from 4.7% in 2000 to 5.2% or 5.6% in 2050).
EPC	2001	Sweden	Significant overestimation occurs in the baseline scenario with respect to the death-costs scenario (in 2050 the increase will be 0.3 percentage points lower, i.e. from 6.0% in 2000 to 6.7% or 7.0% in 2050).
EPC	2001	Italy	Significant overestimation occurs in the baseline scenario with respect to the death-costs scenario (in 2050 the increase will be 0.3 percentage points lower, i.e. from 4.9% in 2000 to 6.2% or 6.5% in 2050).
OECD	2005	OECD countries	Reveals a very significant effect of projections including death costs and healthy ageing; on average, in the period 2005-50, health-care expenditure will rise from 5.6% to 7.2% in the baseline scenario (pure ageing effect) and to 6.1% when death costs and healthy ageing are included.

Note: These projections only analyse health-care costs and do not include long-term care costs.

Source: Author's compilation.

A very useful exercise is to project spending by linking individual needs with both age and years of remaining life. But projections that include the death-related costs component require micro-data that disaggregate individual costs per age and years of remaining life, and these data (even if based on a sample) are not always available.[12]

Moreover, when such data are available, individuals are often not classified by the number of remaining years, but only by their status in a given year, so that those who die in one year are defined as decedents, whereas those who survive in that year are defined as survivors. Nevertheless, econometric analyses (see Seshamani & Gray, 2004a) show that the impact of length of time to death is significant for many years of remaining life. A distinction by survivor status based on only one year may therefore underestimate the projected impact of the death-costs component on HCE.

The various projection methods applied and the data available may explain the different results obtained by the studies set out in Table 12, even though they all report that excluding death costs leads to the overestimation of health-care spending.

Breyer & Felder (2004) apply the costs profile of a Swiss sample (where individuals are sub-divided into four groups on the basis of their remaining years of life) to German demographic forecasts. They show a reduction – of about 20% – in HCE projections when death costs are included and point out that the main driver of HCE is technical progress, suggesting that the projection error of excluding the death-costs component is very small compared with that of excluding the very costly effect of technical progress.

Schulz & Leidl (2004) divide populations of those with up to three years of remaining life into groups and project the number of hospital days for Germany (their projection focuses on quantity rather than on spending). Even if they assume constant age morbidity, they find a significant reduction in the days projected when the impact of proximity to death is taken into account.

Two other studies (Miller, 2001 and Stearns & Norton, 2004) focus on the US Medicare source dataset and show a similar reduction in projected expenditure (about 15%) when death cost effects are included. They divide individuals into only two groups (decedents and survivors in a given year) and show that the time-to-death projection methodology yields lower expenditure than does the standard methodology, but the cost saving is not large enough to offset the strain from ageing. A similar, limited expenditure savings is obtained when account is taken of death costs for Denmark by Serup-Hansen, Wickstrom & Kristiansen (2001) and for the Netherlands by Polder & Achterberg (2004).

The limited HCE savings in the projections that include death costs do not imply, however, that these costs have scant effect. Rather, they can be explained by the huge increase in the share of survivors in old age groups. Although at the individual level proximity to death is the main driver of health-care spending (as proved by econometric analysis), in the aggregate, ageing may induce an increase in spending. If per capita survivor costs are age-increasing, given that the share of survivors in the population is much greater than the share of decedents because longer life expectancy increases the share of old survivors, it may induce an aggregate expenditure growth that cannot be offset by including death costs in projections.

Yet, other studies in Table 12 report that incorporating the death-costs component into health-care projections has a relatively significant effect (see also Riedel et al., 2002). Madsen (2004)

[12] Data disaggregated for survivor status are even more difficult to collect for long-term care. All the projection studies presented in this section, in fact, only concern heath-care spending.

demonstrates that if the population is decomposed into four age groups by number of years of remaining life, the inclusion of death costs reduces the increase of HCE by 0.75 of a percentage point. Seshamani (2004), on dividing the population into numerous groups according to years of remaining life, shows that excluding this component generates estimates of future health-care costs that have a sharp upward bias (the annual growth rate of national hospital expenditure decreases from 0.85% to 0.42% when death costs are taken into account). She suggests that the standard forecasting approach is biased and not useful because it does not consider the dynamic effect of ageing.

In an OECD (2005) study, the HCE increase is split into two different components: the pure ageing effect (i.e. the standard methodology) and the effects deriving from a non-static age-consumption profile (i.e. the death-costs component plus a dynamic equilibrium assumption). Based on an average of 30 OECD countries, the study reveals that public HCE will rise from 5.6% in 2005 to 7.2% in 2050 if a static age profile is assumed and to 6.1% if the age profile is assumed to vary owing to death costs and healthy ageing. This finding confirms that while pure ageing has a positive impact on the expenditure increase, the inclusion of other demographic effects (death costs and morbidity changes) has a negative impact and can (at least partly) offset the effect of ageing on HCE.

The EPC (2001) analysis offers an optional projection that analyses the effect of death costs on spending in three countries – Italy, Sweden and the Netherlands – and confirms that standard projections significantly overestimate the impact of ageing on HCE. But the EPC used different methodologies for these optional projections. Whereas forecasts for Italy and the Netherlands were based on splitting the costs between those surviving for a certain period (one year) and those dying in that period (for each age class individuals were divided into two groups – survivors and decedents), the projections for Sweden were based on a more detailed breakdown of the population by years of remaining life (six groups of individuals per each age group were selected on the basis of their length of time to death and individuals at least six years of remaining life were defined as survivors).

Essentially, as noted, there are two main methodologies with which to include death costs in health-care projections and to extend the standard approach, where the population is decomposed only by age and gender and the derived age profile is linked to demographic forecasts. The first is based on the decomposition of the population in each cohort into only two groups – survivors and decedents in a certain period (usually one year) – to which different cost profiles are applied. The second methodology, which requires more specific data, decomposes the population into numerous groups[13] according to years of time to death, without restricting the effect of death costs to an arbitrarily chosen number of years of remaining life (i.e. one year).

Both approaches estimate the costs for each group (which are kept constant in the projection period) and assume that the share of each group in every age cohort evolves in line with mortality rates. Thus each cohort's average health-care costs become the weighted average of the various groups' costs, the amount of which amount changes with variations in life expectancy.[14]

[13] See Batljan & Lagergren (2004), who decompose the population (based on a Swedish sample) into seven groups, from those having no years left to live to those with more than six years of remaining life.

[14] Given the lack of data with which to calculate each group's costs (i.e. specific costs for decedents or for years of remaining life), RGS (2004) has proposed that direct costs should not be included in the model but rather a coefficient expressing the proportion between the costs borne by non-survivors and those

Obviously, given the empirical evidence that costs prior to death not only increase in the last year of life but also in the previous years, disaggregating the data on individuals on the sole basis of one year to death may lead to the underestimation of the savings induced by the death-costs component. Yet data that differentiate the population by those with only one year of remaining life are usually more easily available than data that break down the population by many years of remaining lifetime.

In both methodologies, the cost profile by age is not constant but evolves in line with the mortality rate, i.e. in line with the evolution of the share between decedents and survivors in each age group or with the increase in the average length of time to death. The first method has an arbitrary element because it is obliged to assume a specific period of time (i.e. one year) in order to classify individuals as decedents or survivors, while the second approach does not suffer from this limitation but requires much more detailed data.

To solve the problem of obtaining data linking per capita health-care costs to years of remaining life, Madsen (2004) has proposed the so-called 'half-longevity correction method', which allows a rough estimation of death costs even when there are no data linking costs to survivor status. He notes that if a 'full-longevity correction method' is used, it is possible to fix costs for years to death (so that if at age 70 life expectancy increases from 7 to 12 years, one can impute to a 75-year-old individual the cost profile of a previous 70-year-old one). Yet the effect of age on health-care costs – even if less significant, it is still a driver of HCE (Seshamani & Gray, 2004a) – is thus entirely ignored.

In the half-longevity correction method, both age and remaining life are assumed to be drivers of HCE with equal 50% weights: thus, in the previous example, the 75-year-old's costs become those of the 72.5-year-old. Madsen (2004) states that although this method is arbitrary, it is sensible because it empirically gives the same projection results as derived by splitting each age cohort into four groups based on the length of remaining lifetime.

It is notable that projection studies also confirm that age alone is not a good basis for predicting the effects of ageing on health-care spending. In all the studies surveyed, projections that include time to death yield lower expenditure increases than standard ones, but this does not offset the impact of ageing.

It should also be pointed out that the differences among results may depend on the methodology used to incorporate the death-costs assumption and the sample on which the estimation of death costs is made. Even depending on the data availability, however, there is still no broad consensus on how that assumption can be included.

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borne by survivors in a given age-gender cohort. Direct costs can thus be replaced by a coefficient (or more than one coefficient if groups with many years to death are considered), which can be empirically estimated in some countries and used for projections in other member states where data are not available, on the assumption that the ratio between the decedent's and survivor's costs is constant in the various states. For example, the Italian optional projection in EPC (2001) was based on the estimation of this ratio using a sample derived from Tuscan hospitals by Cislaghi et al. (2003).

4. Conclusions

Starting from concerns that health-care costs may grow exponentially owing to population ageing, this paper has analysed a factor that may, at least partly, alleviate the fear that increased life expectancy will accelerate the rise in health-care spending: namely the fact that independent of decedent age, the bulk of per capita health-care costs are concentrated in the last years of life (the 'death-related' costs).

In the recent literature on health economics it is often argued that per capita costs by age profile may not depend on an effective increase in consumption by the elderly, but rather on the huge impact of death costs in those age groups where the mortality rate is highest.

This study has surveyed such literature in order to evaluate the importance of proximity to death and age as drivers of health spending. It has classified the empirical literature into three kinds of studies: descriptive (which observe the differences in costs between survivors and decedents), econometric (which seek to determine a causal link among age, length of time to death and spending) and projections (which compare forecasts including or otherwise the death-costs component).

Descriptive studies show that decedent costs are much higher than survivor costs. The ratio between the expenditures of these two groups on health care has an age-decreasing character, as do the costs in the last period of life. A different age pattern can be observed in long-term care, however, despite the fact that a shortage of data has led to a paucity of studies that also analyse long-term care.

Econometric studies confirm that proximity to death, rather than age, is the main driver of health-care spending, at least for the over-65 age groups. Yet there is still disagreement on the effect of age, once time to death has been controlled for (as well as on the different methodologies used by certain authors). Some studies show an 'age neutrality' of death costs; others suggest a constant age-decreasing profile; and still others report a ∩-shaped relationship between age and health-care costs in the last period of life.

At the individual level, the major importance of death costs is confirmed. Projection studies include the differences in per capita costs between survivors and decedents (although they use different methods to define these groups) and seek to predict the growth in aggregate health-care spending related to ageing. The amount of the reduction in spending once death costs have been included in the projection differs significantly among studies, but they all confirm that including death costs reduces the concern that health-care spending will increase exorbitantly in the future. It can consequently be concluded with certainty that age alone is not a good predictor of rises in health-care spending, and that proximity to death must also be used as a predictor of health-care expenditure.

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