Population ageing and health care expenditure: a school of 'red herrings'?°

ANDREAS WERBLOW*, STEFAN FELDER* and PETER ZWEIFEL**

Abstract: This paper revisits the debate on the 'red herring', viz. the claim that population ageing will not have a significant impact on health care expenditure (HCE). It decomposes HCE into seven components, includes both survivors and deceased individuals and applies a two-part model to the demand for health care services, using a large Swiss data set. It finds no age effect on HCE for almost all components of HCE when proximity to death is controlled for, and points to differences between individuals receiving long-term care (LTC) services and non-LTC individuals. For the latter a flat or even a falling age curve for all components of HCE except for inpatient care is observed. LTC patients are high user of health care services, their conditional HCE generally shows a decreasing age profile, while the probability of being in need of LTC markedly increases in old age. A 'school of red herrings' can be claimed to exist except for long-term care where ageing appears to matter regardless of proximity to death.

JEL-Classification: I12, J14

Keywords: Ageing, proximity to death, health care expenditure, long-term care

° We are grateful to PD Dr. Konstantin Beck and to Bernhard Keller, CSS Sickness Fund in Lucerne, for the provision of the data set and for their diligence in dealing with our specific needs, and to Prof. Dr. Alexander Karmann, Technical University of Dresden for a discussion which gave rise to the present paper.
* Institute of Social Medicine and Health Economics, Otto-von-Guericke University Magdeburg, Germany.
** Socioeconomic Institute, University of Zurich, Switzerland.

1 Introduction

Twenty years ago Robert Evans suggested that the fixation on ageing provides an "illusion of necessity" (EVANS, 1985). By making it seem as though health care expenditure is inevitable in higher age, attention is diverted from the real causes of growth of the health care sector. These are technical progress in medicine, the secular increase in income, and wrong incentives for providers and consumers of health care caused by government regulation and extensive social health insurance coverage. Rephrasing Evans, ZWEIFEL, FELDER and MEIER (1999) stated that blaming population ageing serves as a red herring, distracting from choices that ought to be made to curb the steadily rising health care costs in the western world.

Our claim was based on the analysis of health care expenditure (HCE) of deceased persons in their last years of life. The number of quarters remaining until death was significant while the age of the persons was not. In a recent paper (ZWEIFEL, FELDER and WERBLOW, 2004) we vindicated our case using a larger data set, including HCE of survivors, and taking into account methodological concerns raised by SALAS and RAFTERY (2001) and DOW and NORTON (2002). In particular, we no longer focused on the time path to death of HCE, which involves a whole host of time dummies each of which is potentially endogenous since HCE may contribute to survival. Instead, we related individual HCE of a given year to remaining time to death, which was on average 21 months for the sample of decedents. Additionally, we extended the sample to include surviving individuals, since a concern has always been that the effect of age on HCE may be different for survivors.

This paper deals with yet another concern, viz. the generality of the red herring argument. Up to present, testing has been confined to total HCE, and the question arises as to whether the red herring applies equally to ambulatory care, hospital care, drugs, and particularly long-term care (LTC). Chronic illnesses are prevalent in old age and often lead to permanent stays in nursing homes. Since nursing home care is expensive, it largely contributes to HCE in old age and may be responsible for the findings reported in the literature. SPILLMAN and LUBITZ (2000) did analyze HCE of the U.S. Medicare population, i.e. individuals aged 65+. They report a convex (from below) age profile for both nursing home care and (less accentuated) for home care. By contrast, services covered by Medicare and prescription drugs exhibit a decreasing age profile. This implies a continuing shift from acute to LTC late in the lifespan. Spillman and Lubitz conclude that population ageing will mainly drive the demand for LTC, leaving the acute sector unaffected. The aim of this paper, then, is to find out whether the ‘red herring’ is indeed limited to acute care services or whether there is ‘a school of red herrings’ characterizing most if not all components of HCE.

The relationship between age and major components of HCE has been extensively studied in recent years, using data from different sources. O’NEILL, GROOM, AVERY, BOOT, and THORNHILL (2000) found no age effect on the cost of general practitioners when controlling for time to death. SESHAMANI and GRAY (2004a and 2004b) used longitudinal data of individuals in Oxfordshire to show that proximity to death is strongly associated with hospital costs as far back as 15 years before death, while age plays a much smaller role. *Stearns* and *Norton* (2004), concluded on the basis of U.S. Medicare data that it is "time to include time to death" as an explanatory variable in any analysis of individual HCE. The Swiss data set used by ZWEIFEL, FELDER and WERBLOW (2004) is the most comprehensive so far as it covers a much broader age range (30+) as well as almost all components of HCE. In particular, as Swiss social health insurance covers the cost in nursing homes and home care to the extent that it is medically indicated, its claims data include at least part of the expenditure on LTC.

The remainder of the paper is organised as follows: *Section 2* presents the data set, including the descriptive statistics of the main variables. *Section 3* reports on the estimation results regarding the age effect on an individual's total HCE, based on a two-part model, differentiating between the probability of incurring HCE above the deductible and conditional HCE. *Section 4* decomposes the individuals' HCE. The first step differentiates between LTC and non-LTC individuals, the second step estimates the probability of incurring component-wise positive HCE, and the third step models HCE conditional on positive outlays. *Section 5* summarises.

2. Data

The 1999 claims data of 91,327 persons from the Cantons of Zurich and Geneva were made available by a major Swiss sickness fund. To ensure a sufficient number of persons in every age class, the age range was restricted to the interval (30, 95), resulting in a sample of 62,160 persons still alive and enrolled at the end of 2004 (57,085 individuals) or deceased in the meantime (5,075 individuals) (see *Table 1*). Average age at death is 76 years, that of the survivors, 54 years. The share of men is 40 percent in both groups, and roughly 75 percent of all individuals live in the Canton of Zurich. Mean time to death is 29 months; HCE is observed in 1999 while survivor status is verified up to the end of year 2004, resulting in a maximum value of time to death of 60 months.

There are significant differences in the insurance contracts of surviving and deceased individuals. Prior to the introduction of the new law on health insurance of 1994 (LHI94, effective 1996), a uniform deductible was imposed (along with a rate of coinsurance of 10 percent that still obtains today). The LHI94 allows individuals to choose deductibles in excess of the minimum, which was CHF (Swiss francs) 230 (some $ 177 at 2004 exchange rates) per annum during the observation period. Among the deceased, 23 percent opted for high-deductible contracts, compared to 43 percent among the survivors.

Finally, individually contracted accident insurance could be bought from sickness funds in combination with health insurance, an option that continues to prevail among the elderly. Today, individuals in the labour force obtain accident insurance through their employer, who may contract with a sickness fund for a group policy that is not regulated by the LHI94 but the law on private insurance. This explains why the share of individuals having combined health and accident insurance is lower among survivors, who are younger on average.

The LHI94 permits sickness funds to also write supplementary insurance (covering stay in a private hospital room and complementary medicine). Since the LHI94 added many medical services to the benefit package of mandatory insurance, demand for supplementary coverage dropped after 1996. However, one-third of the deceased and 45 percent of the survivors still have hospital supplementary insurance with the sickness fund which provided the data. 86 percent and 95 percent, respectively of these opted for at least one further supplement, the higher share again relating to survivors.

Table 1: Descriptive statistics of samples

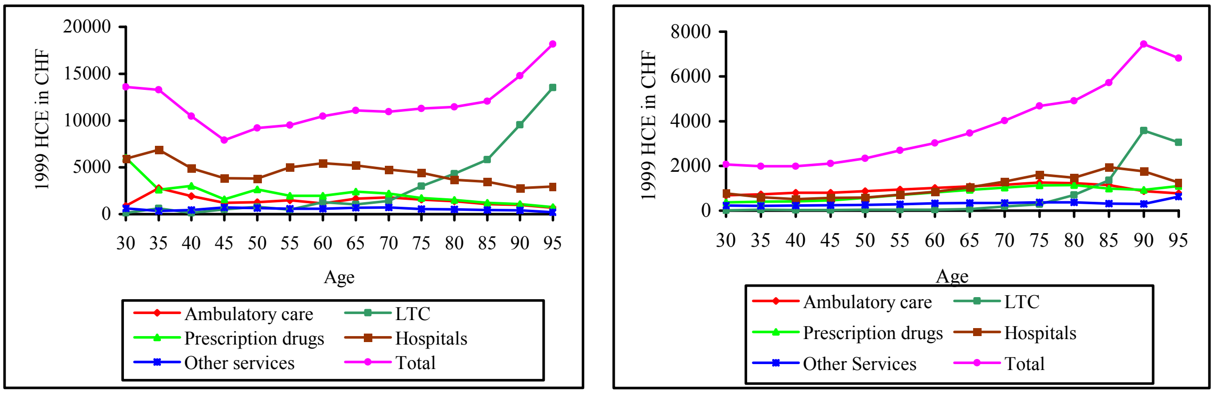
	Deceased (n = 5,075)		Survivors (n = 57,085)	
Variable	Mean	SE	Mean	SE
Age	75.78	13.23	54.09	14.39
Time to death in months	29	17	>60	0
Share of men	0.41	0.49	0.40	0.49
Share of individuals from Zurich	0.72	0.46	0.76	0.43
Share of individuals				
with higher deductibles	0.23	0.42	0.43	0.49
with accident insurance	0.93	0.25	0.66	0.47
with suppl. hospital insurance	0.33	0.47	0.45	0.50
with other supplements	0.86	0.35	0.95	0.25
Total HCE (in 1999; CHF)	11,567	14,071	2,795	5,277
Ambulatory care	1,395	2,725	918	1,416
Nursing home care	3,291	8,034	90	1,326
Home care	460	2,299	24	427
Hospital inpatient care	3,261	8,316	544	2,911
Hospital outpatient care	871	4,170	282	1426
Prescription drugs	1,750	3,240	660	1,507
Other services	539	1,272	279	738

Health care expenditure in 1999 of those who died since January 1st, 2000 was CHF 11,567 or four times the average HCE of survivors (CHF 2,795). The composition of HCE markedly differs between the two groups, too. Among the deceased, acute inpatient care and nursing home care each account for 28 percent of total HCE, followed by prescription drugs with 15 percent. This figure does not include drug use in hospitals, which is covered by the per diem for acute inpatient care. Ambulatory care (mainly physician visits) amounts to 12 percent, while home care services reimbursed by the sickness fund account for 4 percent of total HCE among the deceased.

By way of contrast, ambulatory care ranks first among survivors with a share of one-third of total HCE. The share of medication is one-fourth and that of hospital care (with the Canton of residence paying up to 50 percent, causing only the other half to appear here) is one-fifth of total HCE. No difference exists regarding ambulatory care provided by hospitals, where the share is roughly ten percent among both groups.

Figures 1a and *1b* show the age profiles of HCE and its components for deceased and survived individuals, respectively. Expenditure for nursing home care (NHC) and home care (HC) care are aggregated to form the category 'LTC', and expenditure for hospital-provided acute care and ambulatory care, to form the category 'hospitals'. Among the deceased aged 50+, a concave age profile obtains for all components of HCE except LTC. In that category, expenditures sharply increase from age 70 onwards, much the same way as reported by SPILLMAN and LUBITZ (2000) for the United States. At an age at death of 95 years or older LTC accounts for no less than 75 percent of total HCE. For young individuals, prescription drugs and hospital services are the leading components of HCE, in particular among men.[1]

Figure 1: Observed age profiles of HCE components



a) deceased **b) survivors**

Regarding the survivors (*Figure 1b*), a small but steady increase in all components of HCE is observed over the life cycle. Again, LTC stands out, showing a sharp increase after the age of 70, and reaching almost 50 percent of total HCE at the age of 90. Under a 'red herring' perspective, this is surprising because these individuals continued to live for at least another

[1] In the age class 30 to 45, the variance of prescription drug expenditure is 12 times higher than that in rest of the sample, pointing to intensive treatment of a subgroup of individuals due to HIV-infection and cardiovascular diseases prevalent among young men.

five years past the year of HCE observation. However, the observed figures may mask the separate influences of age, proximity to death, and other determinants of HCE and its components.

3. The effect of age on an individual's total HCE

As in the earlier study (ZWEIFEL, FELDER and WERBLOW, 2004) we analyse *HCE* in a given period, the year 1999, as a function of the remaining time to death (*TTD*) expressed in months. This procedure mitigates potential endogeneity of the *TTD* dummy regressors used when analysing the time path of HCE towards the time of death (ZWEIFEL, FELDER and MEIER, 1999, SESHAMANI and GRAY, 2004a and 2004b, STEARNS and NORTON, 2004). We estimate a two-part model, treating the two equations as stochastically independent, of the following form:

$$\Pr\left(HCE_i > 0\right) = \alpha_0 + \alpha_1 X_i + \varepsilon_i \ , \tag{1}$$

$$HCE_i \middle| HCE_i > 0 = \beta_0 + \beta_1 X_i + \varphi_i \ , \tag{2}$$

with X_i (i = 1...*N* individuals) containing *AGE*, *TTD*, the dummy variables *SEXM* (male = 1), *DEATH* (= 1 if the individual died prior to the end of year 2004), and $W = \{ZH, ACC, HOSP, OSI, DED, EI\}$ where *ZH* differentiates between Zurich and Geneva, *ACC*, *HOSP*, *OSI* and *DED* respectively are dummy variables for supplementary insurance (accident, hospital, other supplementary schemes) and optional high deductibles, and *EI* is the average amount of HCE paid by the insurer in the community where the individual considered lives. The possible effect of *AGE* on the endogenous variables is modelled up to a cubic term, including interaction terms with *SEXM* and *DEATH*. Finally, *TTD* enters in squared format in the conditional *HCE*, taking into account the rising cost towards time to death, and interacts with *SEXM* as well. Expected total HCE of individual *i* then equals his/her probability of incurring costs times the conditional amount of *HCE*,

$$E\left(HCE_i\right) = \Pr\left(HCE_i > DED\right) \cdot HCE_i \middle| HCE_i > DED \, . \tag{3}$$

Despite the approximately lognormal distribution of HCE data, we use arithmetic rather than logarithmic HCE here because this alternative allows a simple calculation of expected HCE, avoiding the problems associated with the smearing factor if heteroskedasticity is present (MANNING, 1998). Survivors are persons still alive by the end of 2004. Their time to death is unknown by definition; however, it must exceed the maximum value of the deceased, which is 60 months. Therefore, $TTD = 60$ is coded for all survivors.

Table 2: Two-part estimation of total HCE, with survivors and the deceased

Model	Probit Pr(HCE>230)		OLS HCE | HCE>230	
Dependent Variable	Coeff.	Std.Err.	Coeff.	Std.Err.
CONSTANT	2.029**	0.325	15,423**	1,050
AGE	-0.117**	0.016	-114**	21
AGE2/1000	2.311**	0.301	1,342**	191
AGE3/1000	-0.013**	0.002		
SEXM	-0.963**	0.124	5,661	3,878
SEXM * AGE	0.013**	0.001	-461*	197
SEXM * AGE2/1000			7,886*	3,460
SEXM * AGE3/1000			-45*	20
DEATH	1.857**	0.541	7,329**	1,610
DEATH * AGE	-0.050**	0.017	-56**	20
DEATH * AGE2/1000	0.347**	0.126		
TTD	-0.005**	0.002	-370**	49
TTD2			3**	1
TTD* SEXM	-0.002	0.002	55**	15
Zurich	-0.085**	0.028	-60	160
High optional deductible	-0.324**	0.012	-683**	61
Suppl. hospital insurance	0.117**	0.012	-12	65
Other suppl. Schemes	0.287**	0.025	-1,016**	192
Accident insurance	-0.035*	0.014	640**	67
Community level of HCE	0.004**	0.000	21**	2
Number of observations	62,160		47,397	
R^2 or Pseudo-R^2	0.425		0.168	

When analysing total *HCE*, the threshold for Pr(*HCE* > *DED*) in the probit estimation is set at CHF 230, the minimum annual deductible prescribed by the law since individuals with lower HCE will not report it to the sickness fund as a rule, resulting in a thinning out of the distribution at the low end. The estimation results for total *HCE* pertaining to this specification are shown in *Table 2*. In the probit step, individuals who died during the observation period have a substantially higher likelihood of *HCE* above the deductible. All age-related variables are significant with expected signs, but so is *TTD*. In the OLS estimation for conditional *HCE* the age coefficients are significant, but offset each other to a large extent. The death dummy alone and in combination with age is highly significant, pointing at high cost of dying that decrease in old age. *TTD* is highly significant too, explaining roughly CHF 8,500 for women and CHF 6,500 for men, respectively of the difference in *HCE* between deceased and survivors.[2] However, the effect is not as progressive as in the original paper by ZWEIFEL, FELDER and MEIER (1999), quite likely because HCE refers to one year and not to quarters.[3] This shows that the importance of death in the determination of *HCE* shrinks as the *TTD* range observed in the data set increases.

Interestingly, individuals with supplementary hospital insurance appear to have a higher likelihood of HCE in excess of the minimum deductible but not necessarily a higher level of HCE. Those having other supplements have both a higher likelihood and higher conditional HCE compared to the others. Finally, there is evidence that moral hazard effects are dampened by high deductibles, which are associated both with a lower likelihood of positive HCE and a lower conditional level of HCE.

Figure 2: Expected HCE of surviving and deceased men as a function of age

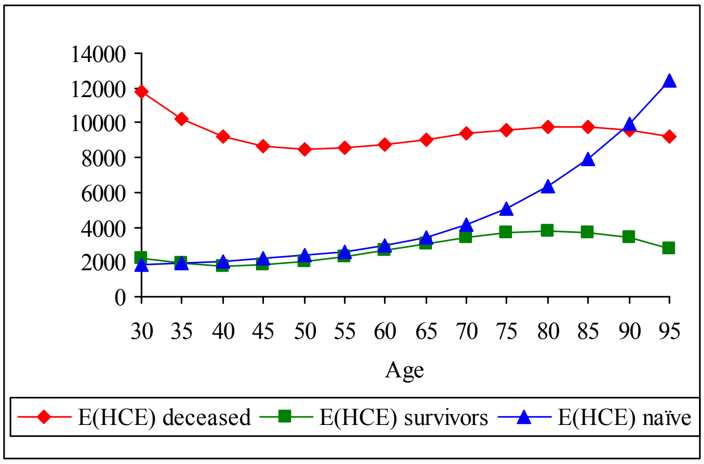


Figure 2 shows expected HCE of men [as defined in eq. (3)] as a function of age for survivors and the deceased, as well as the age profile based on a naïve forecast that does not differentiate between survivors and deceased. For the latter, the likelihood of HCE above the deductible is around 0.92, with a slight increase with age. For the survivors, this probability starts at 50 percent at age 30 and almost reaches the deceased's curve at age 65. At age 30, predicted HCE of the deceased by far exceeds that of survivors; the multiple is almost six, falling to roughly 3 at age 95. This constitutes evidence to the effect that deaths at younger age may be more costly both in absolute and relative terms than those in retirement age.

---

[2] The respective average difference in *TTD* between survivors and decedents is 29.5 months for women and 28.4 months for men. Taking into account coefficient value for *TTD* (– CHF 370 for women and – CHF 315 for men) and for *TTD*2 (CHF 3) gives CHF 8,304 and CHF 6,526 for women and men, respectively.

[3] Quarterly data reveal a sharp increase in the cost of dying in the last two quarters of life.

Among the survivors the combined effect of age on HCE is significantly positive between age 55 and 70 only, and even there, the gradients are low. In comparison, a naïve estimation not considering the high cost of dying leads to a much more marked age gradient, as shown by the third graph in *Figure 2*. This confirms our earlier results and those of others, viz. that failure to distinguish between surviving and deceased persons causes one to grossly overestimate the effect of age on HCE. This has the consequence of predicting an alarmist "health cost explosion" when modelling the ageing of a population.

4. Age effects in components of health care expenditure

In this section, total HCE is broken up in its main components in order to find out whether the 'red herring' argument applies to only a subset of them. This question occasions a change in econometric methodology because these components are likely to be subject to common unobserved influences. Indeed, preliminary estimations revealed a correlation coefficient of almost 0.3 between residuals pertaining to the equations for ambulatory care and for drugs prescribed to patients undergoing acute care. The correlation between the residuals of the estimation for outlay on nursing home services and that for ambulatory care of patients receiving LTC even attained –0.35. In order to benefit from the information contained in these correlations, SUR (seemingly unrelated) estimation is appropriate (GREENE, 2000, ch. 15.2.2). Moreover, it does not make sense to impose the condition *HCE* > *DED* in this context anymore because the deductible is levied on total HCE rather than on its components.

Figures 1 and *1b* revealed an important difference in the age profiles of acute and LT care. While all components of acute care increase only slightly, LTC expenditure exhibits a sharp increase with age. Moreover, residuals among the equations pertaining to individuals who are not LTC cases are positively correlated throughout, whereas those pertaining to the components of HCE that also include LTC services exhibit a consistent negative correlation between nursing home services and all the other components. Therefore, we endogenized the probability of an insured being a LTC case, using a probit model once more. For individual *i* we have

$$\Pr\left(LTC_i > 0\right) = \gamma_0 + \gamma_1 X_i + \upsilon_i \ , \tag{4}$$

where $LTC > 0 = NHC_i > 0 \vee HC_i > 0$, with *NHC* and *HC* indicating outlays for nursing home care and home care, respectively. Apart from this, estimation proceeds according to the two-part model presented in *Section 3*. First, a multivariate probit model of the form

$$\Pr\left(HCE_{ij} > 0 \mid LTC_i > 0\right) = \phi_0 + \phi_1 X_i + \kappa_{ij} \text{ for LTC users, and} \tag{5}$$

$$\Pr\left(HCE_{ij} > 0 \mid LTC_i = 0\right) = \phi_0 + \phi_1 X_i + \kappa_{ij} \text{ for non-LTC users} \tag{6}$$

is estimated with $j = AC, Drug, HOP, HIP, NHC, HC, OS$ for the 7 components of HCE (acute care, drugs, hospital outpatient, hospital inpatient, nursing home care, home care, other services). For non-LTC patients, this simultaneous system reduces to 5 equations (acute care, drugs, hospital outpatient, hospital inpatient). The error terms κ_{ij} are distributed multivariate normal with mean vector 0 and covariance matrix with diagonal elements equal to 1. Second, SUR estimation components is applied to conditional HCE:

$$HCE_{ij} \Big| HCE_{ij} > 0 \wedge LTC_i > 0 = \lambda_0 + \lambda_1 X_i + \vartheta_{ij} \text{ for LTC users,} \tag{7}$$

$$HCE_{ij} \Big| HCE_{ij} > 0 \wedge LTC_i = 0 = \lambda_0 + \lambda_1 X_i + \vartheta_{ij} \text{ for non-LTC users,} \tag{8}$$

with $E\left(\vartheta\right) = 0$ and covariance matrix Σ (with no restrictions on correlations of disturbances across equations imposed). This procedure is computationally demanding as samples are unbalanced, i.e. the equations have an unequal number of observations (see MCDOWELL, 2004).

4.1 The prevalence of LTC

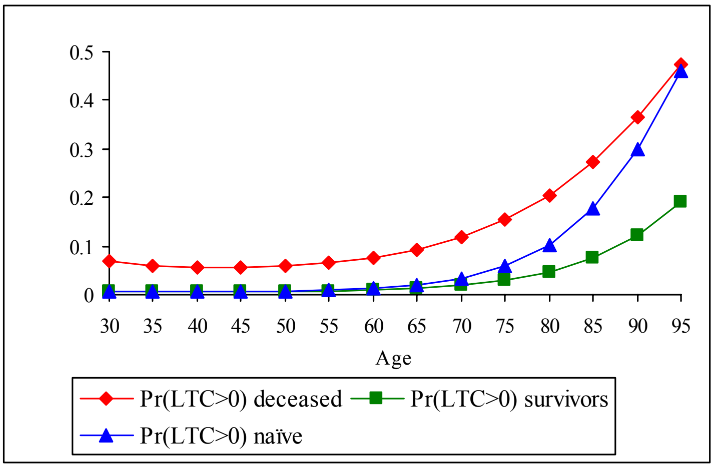
The results of the univariate probit estimation (4) are given in *Table 3*. Age has a significantly positive and increasing effect on the probability of being an LTC user. However, regressors related to death and its proximity (*DEATH, TTD*) are clearly important as well, contributing to an improvement of the goodness of fit that is significant according to the *LR* test. Among individuals aged 80, the LTC probability for the deceased is 4.4 times (men) and 3.5 times (women) as high as for survivors.

The men's age profile of LTC prevalence is illustrated in *Figure 3*. For those who ultimately died, LTC prevalence is higher than for survivors, with the differential reaching almost 30 percentage points at age 95.The third curve reflects the probability of $LTC > 0$ based on a naïve regression, whose results are also presented in *Table 3*. Again, the naïve regression heavily overestimates the convexity of the age profile.

Table 3: Probit estimation of *LTC* > 0, with survivors and the deceased

Model	With TTD		Naïve	
Dependent Variable	Coeff.	Std. Err	Coeff.	Std. Err
CONSTANT	0.312	(0.262)	0.012	(0.237)
AGE	-0.073**	(0.007)	-0.100**	(0.006)
AGE2/1000	0.832**	(0.053)	1.115**	(0.047)
SEXM	-0.754*	(0.346)	-0.943**	(0.332)
SEXM * AGE	0.026**	(0.011)	0.032**	(0.011)
SEXM * AGE2/1000	-0.259**	(0.089)	-0.275**	(0.086)
DEATH	0.565**	(0.169)		
DEATH * AGE	-0.003	(0.002)		
TTD	-0.016**	(0.001)		
Zurich	-0.084	(0.050)	-0.038	(0.049)
High optional deductible	-0.044	(0.024)	-0.063**	(0.023)
Suppl. hospital insurance	-0.189**	(0.038)	-0.282**	(0.036)
Other suppl. schemes	0.403**	(0.044)	0.391**	(0.043)
Accident insurance	-0.195**	(0.026)	-0.244**	(0.025)
Community level of HCE	-0.001	(0.001)	0.000	(0.001)
Number of observations	62,160		62,160	
Log-Likelihood	-7,692		-8,308	
LR-Test	1,413**			
R^2 or Pseudo-R^2	0.348		0.296	

Figure 3: Probability of LTC >0 of surviving and deceased men as a function of age



4.2 Age effects in non-LTC patients

For the individuals not in the LTC category, results of the multivariate probit model are given in the upper part of *Table 4*. The age pattern of the probability of positive outlays is similar for all HCE components, while the estimated amount of influence of age is different. The effect of age on the probability of positive HCE is highest for ambulatory care and drug prescriptions, followed by other services, hospital outpatient and inpatient care. Proximity to death has a significantly positive effect on the probability of positive HCE (as indicated by the positive coefficient of *DEATH* and the negative one of *TTD*), but the difference between survivors and the deceased decreases in old age for all components.

SUR estimation results are presented in the lower part of *Table 4*. Based on a first estimation with the full set of regressors in each equation, we set 6 coefficients to zero. These restrictions, reflected by a blank in *Table 4*, did not have to be rejected, the value of the $\chi 2$ (6) statistic being 4.56. Individuals had on average three out of a maximum of five positive observations.

With regard to the age pattern, four components of acute conditional HCE (ambulatory care, prescription drugs, hospital outpatient, and other) distinguished agree. The coefficient of *AGE* is negative, that of *AGE*2 positive (two times significantly so), and that of *AGE*3 negative again (where estimated, two times significant). Turning to death and its closeness as the competing hypothesis, SUR estimation emphasizes the relative importance of the dummy variable *DEATH* as compared to *TTD*. This is in contrast to the aggregate estimation of *Section 2* where the inclusion of the *TTD* variable served to diminish the difference between survivors and the deceased as captured by *DEATH*. Conditional HCE for the deceased is higher than for survivors, but for inpatient care and other services the effect is insignificant. For the deceased, the age profile is decreasing in all categories, confirming evidence from other studies of a negative age gradient in the cost of dying for the elderly (SPILLMAN and LUBITZ, 2000, FELDER, MEIER and SCHMITT, 2000, SCHELLHORN, STUCK, MINDER AND BECK, 2000, and CHERNICHOVSKY and MARKOWITZ, 2004).

Combining all elements of the model, one can derive expected health care expenditure for components of acute HCE according to

$$\begin{aligned} &E\left(HCE_{ij} \middle| LTC_i = 0\right) \\ &= \left[1 - \Pr\left(LTC > 0\right)\right] \cdot \Pr\left(HCE_{ij} > 0 \middle| LTC_i = 0\right) \cdot HCE_{ij} \middle| HCE_{ij} > 0 \wedge LTC_i = 0\ . \end{aligned} \tag{9}$$

Regarding the age profile, the first factor decreases as the prevalence of LTC increases in old age. According to *Table 4*, the second factor usually increases with an increase in age, while the conditional HCE expenditure is flat or decreasing except for U-shaped inpatient care.

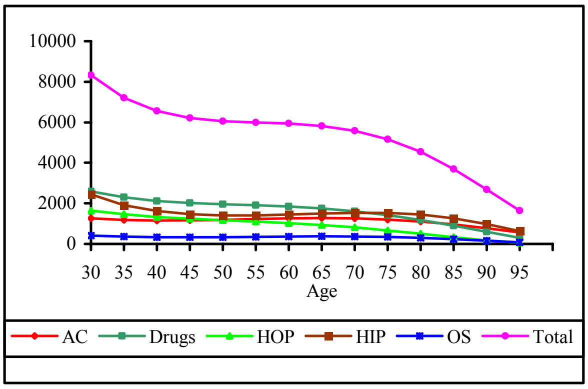
Table 4: Multivariate probit and SUR estimation of conditional HCE components: Non-LTC individuals [a]

Multivariate Probit estimation of Pr ($HCE_j > 0$)	Number of observations: 59,233 Log-likelihood test for all elements of $\Sigma = 0$: 126,590									
	Ambulatory care		**Drugs**		**Hospital outpatient**		**Hospital inpatient**		**Other services**	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Constant	2.710**	(0.335)	2.571**	0.316	1.156**	(0.303)	2.371**	(0.370)	3.098**	(0.289)
AGE	-0.129**	(0.017)	-0.147**	0.016	-0.117**	(0.015)	-0.197**	(0.019)	-0.180**	(0.014)
AGE2/1000	2.417**	(0.298)	2.973**	0.282	2.361**	(0.269)	3.283**	(0.327)	3.277**	(0.255)
AGE3/1000	-0.013**	(0.002)	-0.017**	0.002	-0.015**	(0.002)	-0.017**	(0.002)	-0.018**	(0.001)
SEXM	-1.065**	(0.163)	-0.530**	0.155	-0.220	(0.156)	-1.622**	(0.199)	-1.218**	(0.145)
SEXM*AGE	0.009	(0.006)	-0.005	0.006	-0.008	(0.006)	0.046**	(0.007)	0.013**	(0.005)
SEXM*AGE2/1000	0.049	(0.055)	0.133**	0.052	0.139**	(0.050)	-0.304**	(0.061)	0.042	(0.047)
DEATH	0.454**	(0.152)	0.566**	0.150	1.142	(0.135)	1.079**	(0.147)	0.736**	(0.133)
DEATH*AGE	-0.006**	(0.002)	-0.007**	0.002	-0.014**	(0.002)	-0.013**	(0.002)	-0.009**	(0.002)
TTD	-0.002	(0.002)	-0.003*	0.002	-0.005**	(0.001)	-0.009**	(0.001)	-0.001	(0.001)
SUR estimation of $HCE_j \mid HCE_j > 0$	Total number of observations: 145,489 Observation per group 3 (1, 5) Test Restrictions:						Number of groups: 48,731 Chi2(73) 47,008 (p=0.000) Chi2(6): 4.56 (p=0.602)			
Constant	558	(517)	1,939**	(489)	3,405**	(1,268)	11,449**	(2,357)	1,167**	(257)
AGE	-52**	(22)	-119**	(22)	-122*	(61)	-188**	(54)	-31**	(13)
AGE2/1000	1,143**	(398)	2,575**	(402)	2,481*	(1,085)	1,916**	(464)	631**	(243)
AGE3/1000	-8**	(2)	-16**	(2)	-16*	(6)			-4**	(1)
SEXM	63	(208)	1,569**	(473)	108	(57)	2,833**	(1,039)	-7	(11)
SEXM*AGE	-14	(8)	-46**	(16)			-38*	(16)		
SEXM*AGE2/1000	166**	(67)	341**	(125)						
DEATH	1,221**	(557)	4,090**	(899)	3,201**	(893)	2,657	(2,385)	381	(223)
DEATH*AGE	-13	(7)	-48**	(12)	-37**	(11)	-38	(32)	-5	(3)
TTD	-6	(3)	-11**	(3)	-21	(12)	-88**	(22)	-4**	(1)
Number of observations	45,730		44,149		16,936		6,185		32,489	

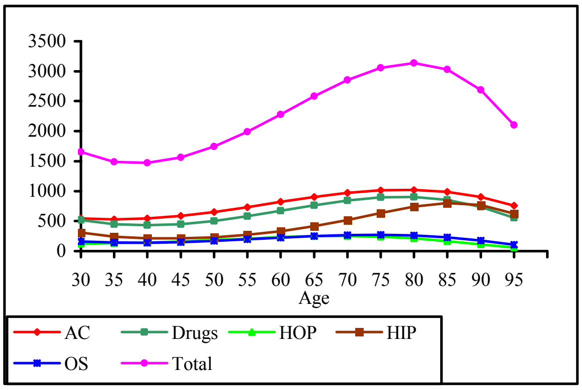
a) Coefficients for variables not connected to age or proximity to death are not presented.

Figure 4 presents the men's age profile for the 5 components of expected HCE. Not surprisingly, there is a significant difference in levels between the deceased and survivors. However, the age profile is decreasing for all HCE components among deceased patients. Conversely, surviving men incur outlays in ambulatory care, prescription drugs and most notably in inpatient care that rise with age.

Figure 4: Expected outlay for acute HCE components for deceased and surviving non-LTC men as a function of age



a) deceased



b) survivors

4.2 Age effects in LTC patients

This time, there are two additional components of HCE, viz. LTC in a nursing home and LTC provided at home. Interestingly, these two components systematically differ regarding the effects of age both with regard to the probability of positive HCE and to conditional HCE (see *Table 5*). In old age, more individuals are going to stay in a nursing home ($\Pr\left(NHC_{ij} > 0\right)$), while the share of LTC individuals receiving care at their own home decreases.

The age profile of LTC services in nursing homes is flat ceteris paribus. By way of contrast, in the home care component, the coefficients of *AGE*, *AGE*2, and *AGE*3 are all highly significant, with the sign pattern the same as in physician billings, drugs, and sundry expenses. Indeed, the coefficient of AGE3 is positive in all these cases, indicating a tendency to a progression of HCE with increasing age in old age. Inpatient care differs from the other components, as the age effect is generally decreasing here.

Table 5 Multivariate probit and SUR estimation of conditional HCE components: LTC individuals [a]

Multivariate Probit estimation of Pr (*HCE_j* > 0)

Number of observations: 2,927
Log-likelihood test for all elements of Σ= 0: 5,176

	Nursing home		Home care		Ambulatory care		Drugs		Hospital outpatient		Hospital inpatient		Other	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Constant	-0.469	(0.677)	-0.534	(0.656)	-0.758	(0.716)	-1.204**	(0.657)	-1.311**	(0.624)	-0.866	(0.621)	-1.022	(0.645)
AGE	-0.053**	(0.017)	0.068**	(0.017)	0.052**	(0.018)	0.064**	(0.017)	0.036**	(0.016)	0.031*	(0.016)	0.060**	(0.016)
AGE2/1000	0.545**	(0.130)	-0.640**	(0.126)	-0.390**	(0.139)	-0.478**	(0.128)	-0.375**	(0.121)	-0.353**	(0.120)	-0.487**	(0.125)
SEXM	2.088**	(0.428)	-1.818**	(0.416)	-1.069**	(0.458)	-0.718	(0.426)	-0.050	(0.398)	-0.517	(0.396)	-1.113**	(0.414)
SEXM*AGE	-0.028**	(0.005)	0.026**	(0.005)	0.016**	(0.005)	0.011*	(0.005)	0.002	(0.004)	0.008*	(0.004)	0.015**	(0.005)
DEATH	-0.038	(0.451)	-0.028	(0.430)	0.964*	(0.491)	0.573	(0.451)	1.498**	(0.426)	1.204**	(0.419)	0.824	(0.444)
DEATH*AGE	0.001	(0.005)	-0.001	(0.005)	-0.011	(0.006)	-0.006	(0.005)	-0.020**	(0.005)	-0.015**	(0.005)	-0.009	(0.005)
TTD	0.004	(0.008)	-0.007	(0.007)	0.000	(0.008)	-0.003	(0.008)	-0.001	(0.007)	-0.016**	(0.007)	-0.004	(0.007)
TTD2/100	-0.021	(0.013)	0.019	(0.012)	0.016	(0.014)	0.019	(0.014)	0.005	(0.013)	0.020	(0.013)	0.000	(0.000)
SEXM*TTD	0.002	(0.003)	-0.004	(0.003)	-0.002	(0.003)	-0.004	(0.003)	0.000	(0.003)	0.001	(0.003)	-0.002	(0.003)

SUR estimation of *HCE_j* | *HCE_j* > 0

Total number of observations 12,865
Observation per group 4.4
Test Restriction

Number of groups: 2,927
Chi2(117): 12,570 (p=0.000)
Chi2(5): 2.89 (p=0.89)

	Nursing home		Home care		Ambulatory care		Drugs		Hospital outpatient		Hospital inpatient		Other	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
Constant	25,078**	(7,768)	-16,084**	(5,408)	-1,585	(2,365)	-9,552	(5,170)	1,675	(2,593)	52,550**	(21,888)	-8,932**	(2,449)
AGE	-80	(195)	658**	(195)	182	(115)	639**	(241)	100	(79)	-2,617**	(1,053)	556**	(125)
AGE2/1000	218	(1,421)	-10,891**	(1,421)	-3,006	(1,825)	-10,120**	(3,770)	-989	(609)	41,854**	(16,474)	-8,369**	(1,994)
AGE3/1000			59**	(23)	14	(9)	50**	(19)			-213**	(83)	39**	(10)
SEXM	-3,913	(3,547)	518	(3,547)	-1,214**	(489)	5,549	(3,907)	12,671	(7,574)	21,588	(16,192)	2,735	(1,577)
SEXM*AGE	24	(45)	-10	(45)	14**	(6)	-151	(108)	-363	(216)	-471	(476)	-94*	(46)
SEXM*AGE2							1,001	(745)	2,499	(1,500)	2,720	(3,406)	727*	(334)
DEATH	-11,295**	(4,492)	4,314	(4,492)	1,759**	(802)	7,504**	(2,070)	3,309*	(1,578)	16,961**	(6,139)	1,888**	(735)
DEATH*AGE	146**	(56)	-37	(56)	-23**	(10)	-88**	(26)	-42*	(21)	-224**	(77)	-21*	(9)
TTD	-72**	(19)	12	(19)	-7**	(3)	-11**	(4)	-22	(12)	-74**	(27)	-4	(3)
Number of obs.	1,376		1,746		2,405		2,392		1,276		1,444		2,226	

[a)] Coefficients for variables not connected to age or proximity to death are not presented.

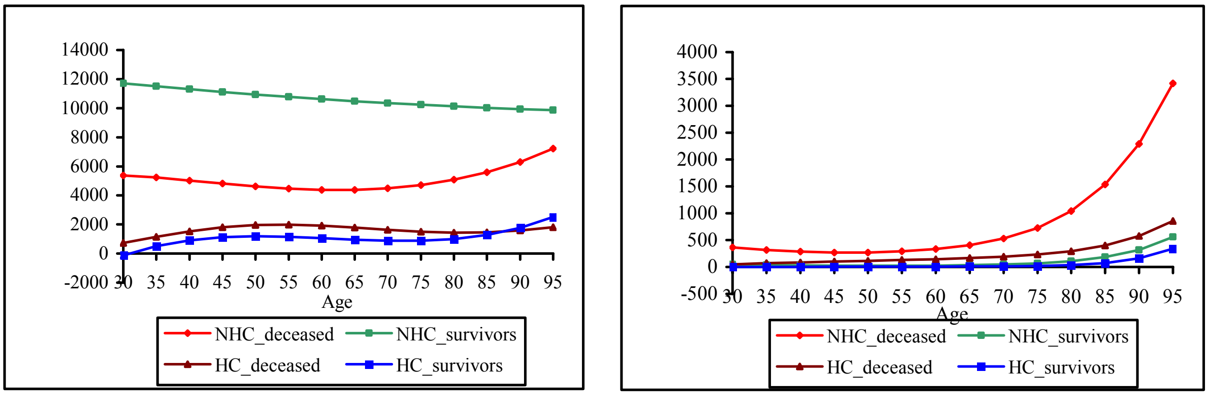
Proximity to death has the expected impact (a negative coefficient of *TTD*) when significant. However, the indicators associated with actual death (*DEATH*, *AGE∗DEATH*) indicate important differences between components of HCE. In the nursing home, death means less HCE, while in all other settings and dimensions, it results in a big upsurge of cost, attaining no less than CHF 17,000 ceteris paribus in hospital inpatient care. Therefore, hospitals do on average undertake costly efforts to preserve a life regardless of whether the patient belongs to the LTC category or not. Conversely, it is in the case of the nursing home only that *DEATH∗ AGE* has a positive coefficient. In all other components of HCE, it is the other way around.

Figure 5a shows conditional LTC expenditure in nursing homes and at home. While the higher outlays on survivors pertain throughout the lifecycle, the differential decreases somewhat in old age due the positive coefficient of *DEATH·AGE*. However, when calculating expected HCE according to

$$E\left(HCE_{ij}\middle|LTC_i>0\right)=\Pr\left(LTC>0\right)\cdot\Pr\left(HCE_{ij}>0\middle|LTC_i>0\right)\cdot HCE_{ij}\middle|HCE_{ij}>0\wedge LTC_i>0, \quad (10)$$

the normal order is re-established, the reason being the low share of LTC patients dying at home (see *Figure 5b*, noting the change in scale). Expected outlay on inpatient LTC also shows a clear positive age gradient. In home care as well as for surviving patients in nursing homes however, convexity of expected HCE is much less accentuated.

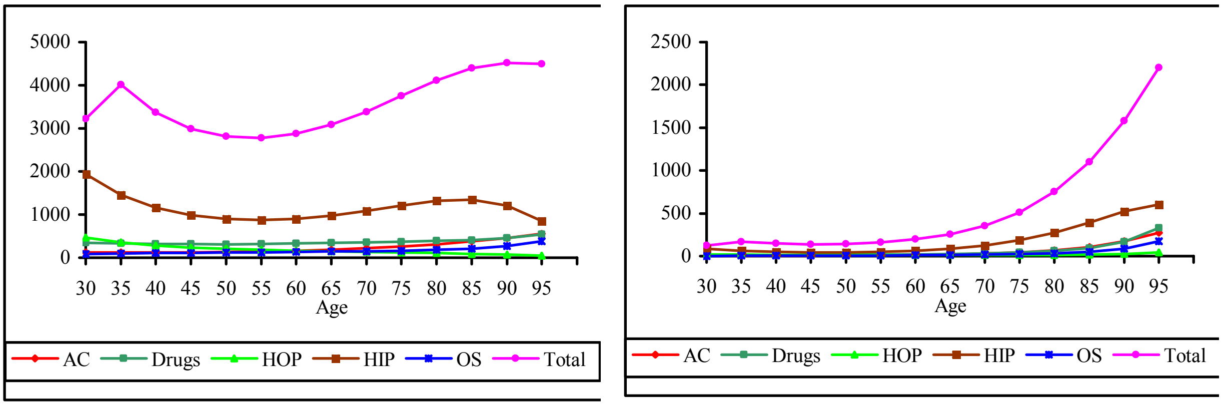
Figure 5: Conditional and expected outlays for nursing home care (NHC) and home care (HC) of surviving and deceased LTC men as a function of age



a) $\boldsymbol{HCE \mid HCE > 0 \wedge LTC > 0}$ **b)** $\boldsymbol{E(HCE)}$

With regard to acute care expenses, deceased LTC patients differ markedly from surviving ones, patients incurring much higher costs (see *Figure 6a and 6b*, again noting the difference in scale). Moreover, the only component of acute HCE spent on the deceased to exhibit a marked age gradient is physician visits. It looks as though physicians attending death-bound patients in nursing homes use age as a reason to still intensify their treatment. The convexity of the age profile is even more marked among survivors in nursing homes, although it is known that remaining life expectancy is much reduced given that an old person is admitted to a nursing home (FELDER, 1997). All the other components of acute HCE display flat or rather weakly increasing age profiles regardless of survivor status, vindicating the red herring hypothesis once more.

Figure 6: Expected outlay for acute HCE components for deceased and surviving LTC men as a function of age



a) deceased **b) survivors**

5. Conclusion

On the aggregate level, age has a negligible effect on an individual's health care expenditure (HCE) both for survivors and the deceased. Conversely, proximity to death is strongly positively related to an individual's HCE. Thus, the 'red herring' claim is vindicated by this study which includes 60,000 survivors who lived at least 60 months past the observational year of their HCE (1999) and 5,000 deceased who on average died 29 months past the end of 1999. This difference in time to death of at least 31 months, combined with the categorical variable indicating death, fully explains the difference in HCE between the deceased and survivors, while the effect of age is insignificant.

However the novelty of this study lies in the analysis of components of HCE, some of which are strongly related to long-term care (LTC) which generally is believed not to conform to the 'red herring' hypothesis. The claims data of Swiss individuals aged 30+ include ambulatory care, prescription drugs, hospitals' in- and outpatient care, LTC in nursing homes, LTC provided at home, and other services. The first step consists in estimating a probit model to distinguish between deceased and surviving individuals using a SUR (seemingly unrelated) specification. While age-related regressors are significant alongside those indicating death and its proximity, their impact remains small. Next, LTC status is endogenized. Again, when added on to age-related regressors, the two death-related variables contribute importantly to explanation. Moreover, age effects are too small to importantly affect the expected value of HCE, which is the product of the likelihood of positive HCE and the amount of HCE given that it is positive. Among non-LTC patients, age gradients are zero or even decreasing (at least beyond age 80) regardless of survivor status. Among LTC patients, weak age effects on HCE incurred in nursing homes can be identified. The one exception with a strong progression is the component 'physician visits'. Turning finally to outlays on acute care, a stunning finding is that both the deceased LTC patients and the survivors who are however known to have a much reduced remaining life expectancy, seem to be treated more and more intensively by visiting physicians the older they get.

In line with this paper's title, a 'school of red herrings' can be said to exist. Most components of health care expenditure are driven not by age but by closeness to death. The one exception to the rule seems to be acute care provided to long-term care patients, regardless of whether they end up dying or surviving. This is in line with the conclusion reached in earlier work on the 'red herring', stating that the cost of health care ultimately is driven by medical technology, some of which appears to be lavished on patients with rather limited remaining life expectancy.

6. References

CHERNICHOWSKI, DOV and SARA MARKOWITZ (2004), Ageing and aggregate cost of medical care: conceptual and policy issues, *Health Economics* 13, 543-562.

DOW WILLIAM H. and EDWARD C. NORTON (2002), The red herring that eats cake: Heckit versus two-part model redux, *Triangle Health Economics Working Paper Series*, No. 1, University of North Carolina at Chapel Hill.

EVANS ROBERT G. (1989), Illusion of Necessity: Evading Responsibility for Choice in Health Care, *Journal of Health Politics, Policy and Law* 10, 439-67.

FELDER, STEFAN (1997), Costs of Dying: Alternatives to Rationing, *Health Policy*, 39, 167-176.

FELDER, STEFAN, MARKUS MEIER and HORST SCHMITT (2000), Health care expenditure in the last months of life, *Journal of Health Economics* 19, 679-695.

GREENE, WILLIAM H. (2000), *Econometric Analysis*, Prentice-Hall, London et al.

HOGAN CHRISTOPHER., JUNE LUNNEY, JON GABEL and JOANNE LYNN (2001), Medicare beneficiaries' cost of care in the last year of life, *Health Affairs* 20, 188-195.

LUBITZ JAMES B. and GERALD F. RILEY (1993), Trends in Medicare payments in the last year of life, *New England Journal of Medicine* 328, 1092-1096.

MANNING WILLARD G. (1998), The logged dependent variable, heteroskedasticity, and the retransformation problem, *Journal of Health Economics* 17, 283-295.

MCDOWELL ALLEN (2004), From the help desk: Seemingly unrelated regression with unbalanced equations, *The Stata Journal* 4 (4), 442-448.

O'NEILL CLARAN, LINDSAY GROOM, ANTHONY J. AVERY, DAPHNE BOOT and KARINE THORNHILL (2000), Age and proximity to death as predictors of GP care costs: Results from a study of nursing home patients, *Health Economics* 9, 733-738.

SALAS CHRISTIAN and JAMES P. RAFTERY (2001), Econometric issues in testing the age neutrality of health care expenditure, *Health Economics Letters* 10, 669-671.

SCHELLHORN, MARTIN, ANDREAS E. STUCK, CHRISTOPH E. MINDER and JOHN C. BECK (2000), Health services utilization of elderly Swiss: Evidence from panel data, *Health Economics* 9, 533-545.

SESHAMANI MEENA and ALLASTAIR M. GRAY (2004a), Ageing and health care expenditure: the red herring argument revisited, *Health Economics* 13, 303-314.

SESHAMANI MEENA and ALLASTAIR M. GRAY (2004b), A longitudinal study of the effects of age and time to death on hospital costs, Journal of Health Economics 23, 217-235.

SPILLMAN BRENDA C. and JAMES LUBITZ (2000), The effect of longevity on spending for acute and long-term care, *New England Journal of Medicine* 342, 1409-1415.

STEARNS SALLY C. and EDVARD C. NORTON (2004), Time to include time to death? The future of health care expenditure predictions, *Health Economics* 13, 315-327.

ZWEIFEL PETER, STEFAN FELDER and MARKUS MEIER (1999), Ageing of population and health care expenditure: a red herring?, *Health Economics* 8, 485-496.

ZWEIFEL PETER, STEFAN FELDER and ANDREAS WERBLOW (2004), Population ageing and health care expenditure: New evidence on the ‚red herring', *Geneva Papers on Risk and Insurance: Issues and Practice* 29 (4), 653-667.