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POPULATION AGEING AND HEALTH CARE EXPENDITURE: A SCHOOL OF 'RED HERRINGS'?

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SUMMARY

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 estimates a two-part model of the demand for health care services, using a large Swiss data set for 1999. It finds no or weak age effects on HCE for the components of HCE when proximity to death is controlled for, and points to differences between users and non-users of long-term care (LTC). For deceased non-users of LTC services, a falling age curve for all components of HCE except for inpatient care is observed, while survivors show a weak age effect in ambulatory and inpatient care once proximity to death is controlled for. As to surviving users of LTC services, their probability of incurring LTC expenses markedly increases in old age, while most of the components of their conditional HCE show a decreasing age profile. Thus, a 'school of red herrings' can be claimed to exist–with the possible exception of LTC, where ageing might matter regardless of proximity to death.

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INTRODUCTION

Twenty years ago, Evans (1985) suggested that the fixation on ageing provides an 'illusion of necessity'. 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 *et al.* (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 *et al.*, 2004), we vindicated our case using a larger data set, including HCE of survivors, and taking into account methodological concerns that have been raised (Salas and Raftery, 2001; 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

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the sample to include surviving individuals, since one concern has always been that the effect of age on HCE may be different for survivors.

This paper deals with yet another issue, 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, often leading 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) analyze HCE of the US 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 life. The authors conclude that population ageing will be the main driver of the demand for LTC, leaving the acute sector unaffected. Yang *et al.* (2003) analyze HCE during the last 36 months before death of Medicare beneficiaries. They find significant differences in age effects between persons in their last year of life and 2 (3) years away from death. Last-year HCE, while high, is roughly independent of age. By contrast, HCE of those two and three years away from death increases with age, driven mainly by increasing expenditure for nursing home and home health care, with inpatient care remaining constant.

The relationship between age and major components of HCE has been extensively studied in recent years, using data from different sources. O'Neill *et al.* (2000) found no age effect on the cost of general practitioners when controlling for time to death. Seshamani and Gray (2004a,b) 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 US 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 *et al.* (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.

Another strand of literature studies the age effect on HCE controlling for health status. By using morbidity indicators including information on vital risks available in a French data set, Dormont *et al.* (2006) show that 'pure' age effects vanish in the case of drugs, inpatient care, and ambulatory care.

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. However, it will not deal with the 'pure' age effect because the data lack information on health status. Following the presentation of the data set and methods used, we will report on the estimation results regarding the age effect on total HCE, based on a two-part model, differentiating between the probability of incurring HCE above the deductible and HCE conditional on exceeding the deductible. In an attempt to validate the model, alternative specifications of age and time-to-death variables and GLM as opposed to OLS estimations will be presented. Then, we will decompose the individuals' HCE, differentiating between LTC and non-LTC individuals in a first step. A finer categorization of HCE will be considered in a second step, taking into account correlations between unobserved shocks through seemingly unrelated regression (SUR) estimation. A summary and conclusions are provided at the end of this paper.

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

Table I. Descriptive statistics of samples

	Deceased (n = 5075)			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
HCE (in 1999); mean (in CHF) and the probability of non-zero expenditure (in parentheses)						
Total HCE	11 567	(0.94)	14 071	2795	(0.82)	5277
Ambulatory care	1395	(0.83)	2725	918	(0.77)	1416
Nursing home care	3291	(0.19)	8034	90	(0.01)	1326
Home care	460	(0.16)	2299	24	(0.02)	427
Hospital inpatient care	3261	(0.32)	8316	544	(0.11)	2911
Hospital outpatient care	871	(0.40)	4170	282	(0.28)	1426
Prescription drugs	1750	(0.84)	3240	660	(0.74)	1507
Other services	539	(0.68)	1272	279	(0.55)	738

the end of 2004 (57 085 individuals) or deceased in the meantime (5075 individuals; see Table I). Average age at death is 76 years, that of the survivors 54 years. The share of men is 40 percent in both groups, that of individuals residing in the Canton of Zurich, roughly 75 percent. Mean time to death is 29 months; HCE is observed in 1999 while survivor status is verified up to the end of the year 2004, resulting in a maximum value of time to death of 60 months.

Swiss social health insurance covers LTC expenses provided they are of the medical type, excluding only non-medical home care services and accommodation in nursing homes. Contracts with nursing homes vary substantially, causing the precise degree of coverage of LTC services to be unknown. However, a reasonable estimate is that one-half of total LTC expenses was covered by health insurance in 1999.

There happen to be 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 had opted for high-deductible contracts, compared to 43 percent among the survivors.

Finally, individually contracted accident insurance could previously 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 new law 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 and 95 percent, respectively, of these opted for at least one further supplement, the higher share again relating to survivors.

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HCE in 1999 of those who died since 1 January, 2000 was CHF 11 567, or four times the average HCE of survivors (CHF 2795). The probability of non-zero expenditure is also much higher among the deceased. 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 10 percent among both groups. A similar pattern arises as regard to the probability of non-zero expenditure, being much higher among the deceased for the two components of LTC expenditure.

Figure 1 shows the age profiles of HCE and its components for people 1 year before death (panel A), 3 years before death (panel B), 5 years before death (panel C) and survivors (panel D) identified as individuals at least 5 years away from death (beware of the difference in scale). Aggregating categories that are likely to be complements, expenditure on nursing home care (NHC) and home care (HC), are combined to form the category 'LTC', and expenditure on hospital-provided acute care (both inpatient and ambulatory), to form the category 'Hospitals'. Among the deceased aged 50+, a concave age profile obtains for all components of HCE except LTC. In the LTC category, expenditures sharply increase from age 70 onwards, much the same way as reported for the United States (Yang *et al.*, 2003; Lubitz and Riley, 1993). At an age at death of 95 years or older, LTC accounts for no less than 75 percent of total HCE. By way of contrast, inpatient expenditure of the deceased sharply decreases beyond age 60, which again is in line with evidence from Medicare (Yang *et al.*, 2003).

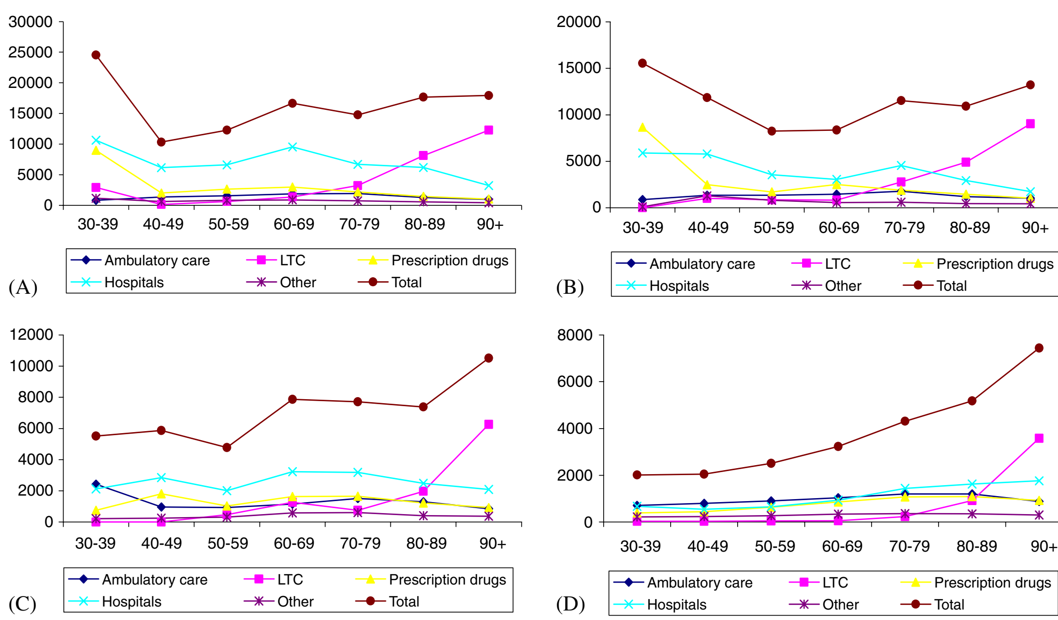

Figure 1. Observed age profiles of HCE components: (A) TTD 1–12 months; (B) TTD 25–36 months; and (C) TTD 49–59 months; and (D) TTD at least 60 months (survivors)

Among young individuals, prescription drugs and hospital services are the leading components of HCE, in particular among men. However, differences loom large at younger ages. In the age class 30–45, the variance of prescription drug expenditure is 12 times higher than that in the rest of the sample, pointing to intensive treatment of a subgroup of individuals, presumably due to diseases prevalent among young men such as HIV infection and cardiovascular conditions.

Regarding survivors (panel D of Figure 1), 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 5 years past the year of HCE observation. However, measured HCE may mask the separate influences of age, proximity to death, and other determinants. Moreover, LTC cases are few among the young, calling for caution in the interpretation of the data.

Quite generally, HCE of the deceased (panels A–C of Figure 1) differ in both amount and age pattern from HCE of those who survived during 2000–2004 (panel D). First, average HCE of persons 1 year away from their death is roughly five times, those 4 years away still two times as high as average HCE of the survivors. Second, HCE of the deceased does not consistently increase with age, while HCE of survivors shows a clear increase, which is driven by the LTC component. These differences argue in favor of simultaneously incorporating time to death and introducing the distinction between the deceased and the survivors in an attempt at explaining HCE.

METHODS

As in the earlier study (Zweifel *et al*., 2004), we analyze HCE in a given year (1999) as a function of the remaining time to death (TTD) expressed in months. This procedure mitigates potential endogeneity of TTD when this variable is given the form of a whole host of dummy regressors for tracking the time path of HCE towards the end of life (Zweifel *et al*., 1999; Sheshamany and Gray, 2004a,b; Stearns and Norton, 2004). We estimate a two-part model, treating the two equations as stochastically independent, of the following form:

$$\Pr(\mathrm{HCE}_i > 0) = \alpha_0 + \alpha_1 X_i + \varepsilon_i \quad (1)$$

$$\mathrm{HCE}_i|\mathrm{HCE}_i > 0 = \beta_0 + \beta_1 X_i + \varphi_i \quad (2)$$

with $X_i (i = 1, \ldots, N$ individuals) containing AGE, TTD, the dummy variables SEXM (male = 1), DEATH (= 1 if the individual died before the end of the 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. Finally, 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 form in the equation for HCE conditional on it exceeding the deductible in order to take into account the progressive surge of HCE towards time to death, interacting it with SEXM as well. As reported in the section on model validation, additional specifications were checked as well; however, the one described here proved to have favorable statistical properties.

Expected total HCE of individual i then equals his/her probability of incurring HCE times the conditional amount of HCE,

$$E(\mathrm{HCE}_i) = Pr(\mathrm{HCE}_i > \mathrm{DED}) \cdot \mathrm{HCE}_i|\mathrm{HCE}_i > \mathrm{DED} \quad (3)$$

Despite the approximately lognormal distribution of conditional HCE, we predominantly use arithmetic rather than logarithmic data here because this alternative allows a simple calculation of

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expected HCE, avoiding the problems associated with the smearing factor if heteroskedasticity is present (Manning, 1998). Moreover, the generalized model (GLM) provides an alternative to the log transformed OLS model $E(\ln(y|x)) = x'b$ with its well-known problem of retransformation. The attractiveness of GLM is given by the fact that the mean and variance functions are directly based on the original (arithmetic) scale, with the relationship between the two determined by the assumed distribution. Additionally, the expected value of the dependent variable is linked to the independent variables using a specific function (Buntin and Zaslavsky, 2004). In the case of a logarithmic specification, one has $\ln E(y|x) = x'b$ and thus $E(y|x) = \exp(x'b)$. For total HCE, we discuss the results for both the OLS and the GLM variant.

Survivors are defined to be still alive by the end of 2004. Their time to death (TTD) is unknown by definition; however, their TTD must exceed the maximum value of the deceased, which is 60 months. Therefore, TTD = 60 is coded for all survivors, which of course causes this variable to be measured with error. In an attempt to control for the effect of this error, deceased and survivors are distinguished by the dummy variable DEATH (= 1 if deceased).

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. This threshold makes sense since individuals with lower HCE will not report their outlays to the sickness fund as a rule, resulting in a thinning out of the distribution at the low end.

Finally, econometric methodology needs to be modified when total HCE is broken up in its main components 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 coefficient between the residuals for outlay on nursing home services and those 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 regression) estimation is appropriate (for details, see Greene, 2000, Chapter 14.2.7). 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.

Figure 1 revealed an important difference in the age profiles of acute and LT care. While components of acute care increase only slightly, LTC expenditure sharply surges with age. Moreover, residuals among the equations pertaining to non-LTC expenditure is positively correlated throughout, whereas those pertaining to LTC-related components of HCE exhibit a consistent negative correlation between nursing home services and all the other components. These differences justify a more detailed analysis of the LTC component of HCE. In analogy with Equations (1) and (2), we distinguish between the probability of positive LTC expenditure and its amount conditional on being positive. Using a probit model once more, we have for individual i,

$$\Pr(\mathrm{LTC}_i > 0) = \gamma_0 + \gamma_1 X_i + \upsilon_i \tag{4}$$

where $\mathrm{LTC}_i > 0 = \mathrm{NHC}_i > 0 \vee \mathrm{HC}_i > 0$, with NHC and HC indicating outlays for nursing home care and home care (which together make up LTC expenditure), respectively. Apart from this, estimation proceeds according to the two-part model presented earlier. First, a multivariate probit model of the form

$$\Pr\left(\mathrm{HCE}_{ij} > 0 | \mathrm{LTC}_i > 0\right) = \phi_0 + \phi_1 X_i + \kappa_{ij} \text{ for LTC users, and} \tag{5}$$

$$\Pr\left(\mathrm{HCE}_{ij} > 0 | \mathrm{LTC}_i = 0\right) = \omega_0 + \omega_1 X_i + \varsigma_{ij} \text{ for non-LTC users} \tag{6}$$

is estimated with j = AC, Drug, HOP, HIP, NHC, HC, OS for the seven components of HCE (ambulatory care, drugs, hospital outpatient, hospital inpatient, nursing home care, home care, other

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services). For non-LTC patients, this simultaneous system reduces to five equations (ambulatory care, drugs, hospital outpatient, hospital inpatient). The error terms κ_{ij}, and ζ_{ij} are assumed to be multivariate normal with mean vector 0 and a covariance matrix whose diagonal elements are normalized to 1. Second, SUR estimation is applied to conditional HCE:

$$\mathrm{HCE}_{ij}\big|\mathrm{HCE}_{ij} > 0 \wedge \mathrm{LTC}_i > 0 = \lambda_0 + \lambda_1 X_i + \vartheta_{ij} \text{ for users of LTC services} \tag{7}$$

$$\mathrm{HCE}_{ij}\big|\mathrm{HCE}_{ij} > 0 \wedge \mathrm{LTC}_i = 0 = \psi_0 + \psi_1 X_i + \zeta_{ij} \text{ for non-users of LTC services} \tag{8}$$

with $E(\vartheta)$, $E(\zeta) = 0$ and covariance matrix Σ (with no restrictions on correlations of disturbances across equations imposed). Estimation (*xtgee* of STATA 8) is computationally demanding because the samples are unbalanced, i.e. the equations have an unequal number of observations. Data preparation and model estimation are demonstrated in McDowell (2004). Dependent variables are assumed to be normally distributed despite the fact that most HCE components are strongly skewed to the left. As an exception, nursing home care is more or less equally distributed. Using GLM with a gamma link would lead to strongly biased results in this case. We demonstrate this with additional results for GLM using components of the model. In all cases we use robust variance estimation to account for strong heteroskedasticity in the data.

RESULTS I: THE EFFECT OF AGE ON AN INDIVIDUAL'S TOTAL HCE

The estimation results for total HCE pertaining to the specification (1) and (2) are shown in Table II. 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, while significant, offset each

Table II. Two-part estimation, total HCE of both survivors and deceased persons

Model	Probit Pr(HCE > 230)		OLS HCE|HCE > 230	
dependent variable	Coeff.	Std.err.	Coeff.	Std.err.
CONSTANT	2.029**	0.325	15 423**	1050
AGE	−0.117**	0.016	−114**	21
AGE2/1000	2.311**	0.301	1342**	191
AGE3/1000	−0.013**	0.002		
SEXM	−0.963**	0.124	5661	3878
SEXM · AGE	0.013**	0.001	−461*	197
SEXM · AGE2/1000			7886*	3460
SEXM · AGE3/1000			−45*	20
DEATH	1.857**	0.541	7329**	1610
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	−1016**	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	

**Significant at the 99% confidence level; *significant at the 95% confidence level.

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other to a large extent. The death dummy alone and in combination with age is highly significant, pointing at high costs of dying that decrease in old age. TTD is highly significant too, accounting for roughly CHF 8300 for women and CHF 6500 for men, respectively, of the difference in HCE between deceased and survivors. This estimate derives from the average difference in TTD between survivors and decedents, which amounts to 29.5 months for women and 28.4 months for men. Using the values of the coefficients for TTD (CHF 370 for women and CHF 315 for men) and for TTD2 (CHF 3), one obtains CHF 8304 and CHF 6526 for women and men, respectively. However, the time-to-death effect is not as progressive as in the original paper by Zweifel *et al.* (1999), quite likely because HCE refers to 1 year here rather than quarters as in the original, where the cost of dying increase sharply in the last two quarters of life. Apparently, the decrease in the range of TTD values causes the importance of time-to-death in the determination of HCE to shrink. Justifiably this argument also applies to the reduction of the range occasioned by setting TTD = 60 for survivors. It implies that the influence of TTD will tend to be understated in what follows.

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 conditional HCE. Those having other supplements have both a higher likelihood and higher conditional HCE compared to the others, suggesting moral hazard effects. 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.

Table III presents significance tests of possible age effects using bootstrap statistics. Estimated Equations (1) and (2) with regressors set at their mean values were replicated 100 times, randomly drawing observations from the original sample with replacement until the bootstrap sample had as many observations as the original one. Means and standard errors were calculated for each age class of both men and women. While average HCE turned out significantly higher for the deceased than survivors, most confidence intervals overlap for the seven age classes distinguished (not all shown). Still, the seven differences consistently are in the expected direction. With a 50 percent chance of a true difference in each age class, this combined outcome has a likelihood of a mere 1.6 percent ($=(0.5)^6$). At age age 30, predicted HCE of the deceased exceeds that of survivors by a factor of almost five, while this factor is roughly two at age 90. Since panel A of Figure 1 shows that total HCE of the deceased (TTD between 1 and 12 months) is maximum at age 30, then falls and rises only slightly past age 50, deaths may well be more costly both in absolute and relative terms at young than at old age.

Table III. Confidence intervals of total HCE, by age, survivor status and sex (in CHF)

	Deceased		Survivors	
Age	Mean	95% Confidence interval	Mean	95% Confidence interval
Men				
30	8896	(6466–11 471)	1945	(1129–2664)
40	7759	(6132–9348)	1827	(1610–2035)
50	7614	(6345–8760)	2117	(1967–2245)
60	8078	(7083–9028)	2696	(2563–2807)
70	8761	(7878–9593)	3427	(3239–3595)
80	9381	(8619–10 224)	4150	(3751–4485)
90	9791	(8615–11 033)	4716	(3676–5880)
Women				
30	10 949	(8647–13 096)	2575	(2263–2966)
40	9976	(8238–11 638)	2381	(2245–2548)
50	9636	(8270–11 023)	2552	(2460–2646)
60	9845	(8747–11 012)	3015	(2894–3109)
70	10 420	(9654–11 298)	3729	(3624–3833)
80	11 209	(10 586–11 887)	4659	(4463–4864)
90	12 137	(11 254–12 878)	5733	(5272–6246)

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In all, this re-estimation confirms earlier findings by the same authors as well as by others, viz. that failure to distinguish between surviving and deceased persons causes one to overestimate the effect of age on HCE, with the risk of predicting an alarmist ‘health cost explosion’ due to the ageing of population.

MODEL VALIDATION

Specification of age variables

In Equations (1) and (2), AGE appears in linear, quadratic, and cubic form. To test for the possible influence of outliers on the pertinent coefficient estimates, we specified two variants of the model. The first introduces dummies for seven age groups, while the second uses age splines. Splines are similar to age dummies except that they take on the maximum value of the corresponding age category. The original specification was retained otherwise, involving in particular DEATH $\cdot\, x$ (x = alternative specification for AGE), TTD = 1, 2, ,..., 60) and TTD · SEXM. Akaike’s (AIC) and Bayes’ information criterion (BIC) were used to test the overall fit, while the mean square error (MSE) criterion was adopted for judging predictive power in the different age groups and deceased and survivors. Both in terms of AIC and BIC, the original model proved to fare best, while the MSE criterion favors the age splines, in particular for the deceased at the upper and lower end of the age distribution (results not shown).

Specification of TTD

We know whether someone died within the observation period up to 5 years after the observation year for HCE. The dummy variable DEATH captures this information. Secondly, time to death in month is available. TTD is a continuous variable for the deceased with values between 1 and 59. For the survivors we set TTD = 60. In connection to the DEATH = 0, the interpretation is ‘the individual survived for at least 60 months’.

The alternative specification for time-to-death was to complement Equations (1) and (2) by interacting TTD with AGE in order to allow for the possibility of age influencing the way closeness to death impacts on HCE. Moreover, dummies for the last year, the second-last year etc. were added, again also in interaction with AGE. Again, we used AIC and BIC to judge overall fit and MSE for performance within age subgroups. The extended model including TTD · AGE did dominate the original specification for deceased persons in old age. However, the overall criteria indicated a slight dominance of the original model.

OLS vs GLM

Total HCE (beyond the CHF 230 deductible) approximately follows a log-normal distribution with skewness = 0.29 (down from 5.29 for arithmetic values) and kurtosis = 2.78 (down from 51.73). In a comparison between OLS and GLM, the information criteria (AIC, BIC) as well as MSE for age subgroups indicate superiority of GLM.

However, when combining the gamma distribution with a logarithmic link function, we end up with the same qualitative results as with simple OLS estimation using arithmetic values. Furthermore, GLM estimates mean HCE in older age groups with much larger MSE than OLS. Since the choice of the ‘correct’ estimator is not obvious (Buntin and Zaslasky, 2004; Manning *et al.*, 2005; Manning and Mullahy, 2001), we retained OLS.

Analogous tests were performed to gauge the performance of OLS vs GLM in estimating components of HCE. Again, as a rule OLS was not dominated by GLM. For some components, OLS even outperformed GLM in older age classes. Given that correlations of disturbance terms across components were substantial throughout large, OLS-SUR remained the method of choice.

RESULTS II: THE EFFECT OF AGE ON COMPONENTS OF HCE

As can be gleaned from Figure 1, the main difference in age profiles is between LTC and all other expenditure categories, giving rise to an analysis of the distinction between users and non-users of LTC services (see Table IV). Next, two-part models are applied to the users and non-users of LTC services separately. Among the non-users of LTC services, the likelihood of one or more categories of HCE being positive is estimated using multivariate probit estimation (which again amounts to applying SUR methods, justified in view of the likely existence of unmeasured influences such as health status in all components). Results are displayed in the upper half of Table V. In the lower part, HCE conditional on being non-zero is analyzed, applying SUR estimation for the same reason given above. In analogous manner, the two-part model is used to estimate the probability and the quantity components of HCE caused by users of LTC services (see the upper and lower parts of Table VI).

Distinguishing users from non-users of LTC services

Here, the dependent variable is the probability of LTC being positive, which defines users of LTC services. The results of univariate probit estimation according to Equation (4) are given in Table IV. Age has a significantly positive and increasing effect on the probability of having positive LTC expenditure (and hence a LTC case). However, regressors related to death and its proximity (DEATH, TTD) continue to be clearly important as well, judged by their significant contribution to overall goodness of fit, according to a LR test. Additionally, the Hosmer and Lemeshow (1995) test shows that the specification that includes DEATH and TTD fits the probability distribution better. For this test we assigned ranked estimated probabilities to the equal-sized segments. While the residuals derived from the equation comprising DEATH and TTD were not significantly different from zero, the null hypothesis that the means of the residuals derived from the naïve model are zero in all ten groups had to be rejected. Among individuals aged 80, the probability of positive LTC expenditure is 4.4 times higher among deceased men) and 3.5 times among deceased women than among survivors.

Table IV. Probit estimation of LTC > 0, both survivors and deceased persons

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	−7692		−8308	
LR-Test		1413**		
R^2 or Pseudo-R^2	0.348		0.296	

**significant at the 99% confidence level.
*significant at the 95% confidence level.

Men's age profile of positive LTC expenditure is illustrated in Figure 2. For those who died, this probability is higher than for survivors throughout, with the differential increasing to almost 30 percentage points at age 95. This evidence suggests that death and closeness to death must be taken into account in the domain of long-term care as well. Women's age profiles are not different from the men's. This also holds for the figures which follow below, which is why confine the figures to men only.

Age effects in non-LTC patients

For individuals not in the LTC category, results of the first part of the two-part model (designed to predict whether all components of HCE are zero or not) are given in the upper part of Table V. A log-likelihood test indicates that multivariate estimation is appropriate, correlations between the residuals being different from zero for at least some components (null hypothesis: all elements of Σ defined below Equation (8) are zero). While estimated age patterns are similar for all components, they differ in terms of their importance. The effect of age is highest for ambulatory care and drug prescriptions, followed by other services, hospital outpatient and inpatient care. However, death and its proximity to death have a consistently positive effect on the probability of positive HCE (as indicated by the positive coefficient of DEATH and the negative one of TTD), the magnitude of which decreases at old age for all components of HCE.

SUR estimation results for conditional HCE are presented in the lower part of Table V. Based on a first estimation with the full set of regressors in each equation, six coefficients were set to zero. These restrictions, symbolized by blanks, did not have to be rejected, the value of the χ^2 (6) statistic being 4.56. Recall that SUR yields an efficiency gain only if regressors differ across equations (Greene, 2000, Chapter 17.4.2). Individuals had on average three out of a maximum of five categories with HCE>0.

Due to the small number of observations in the lower age classes, estimation results are not very dependable. For this reason, the data base was restricted to a sub-sample of individuals of age 60 and more in order to see whether the estimation results are robust. The (out of sample) prediction error is highest in the age class just below the cut-off point (50–59); but even there, it does not exceed 18 percent of the value derived from the full sample. Conversely, excluding the observations from the <60 years old does not affect predictions in the higher age groups, deviations amounting to 1 percent or less. Alternative specifications of the TTD and AGE variables were again estimated; they proved to be inferior to the original formulation, defined by Equations (5) and (6).

Four components of acute conditional HCE (ambulatory care, prescription drugs, hospital outpatient, and other) have the same age pattern. The coefficient of AGE is negative, that of AGE2 positive (two times significantly so), and that of AGE3 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

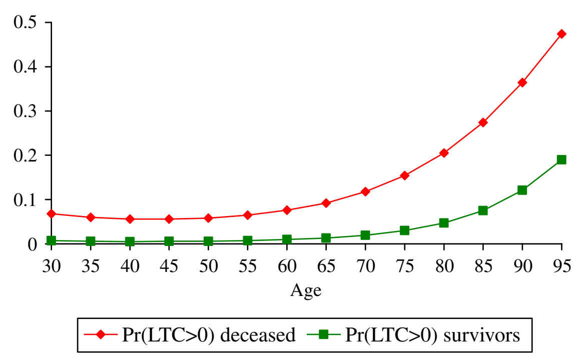

Figure 2. Probability of LTC >0 of surviving and deceased men as a function of age

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Table V. Multivariate probit and SUR estimation of conditional HCE components: non-users of LTC services[a]

	Ambulatory care		Drugs		Hospital outpatient		Hospital inpatient		Other services	
	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.	Coeff.	Std. err.
Multivariate probit estimation of Pr ($HCE_j > 0$)[b]										
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 $\mathrm{HCE}_j \vert \mathrm{HCE}_j > 0$[c]										
Constant	558	(517)	1939**	(489)	3405**	(1268)	11 449**	(2357)	1167**	(257)
AGE	−52**	(22)	−119**	(22)	−122*	(61)	−188**	(54)	−31**	(13)
AGE2/1000	1143**	(398)	2575**	(402)	2481*	(1085)	1916**	(464)	631**	(243)
AGE3/1000	−8**	(2)	−16**	(2)	−16*	(6)			−4**	(1)
SEXM	63	(208)	1569**	(473)	108	(57)	2833**	(1039)	−7	(11)
SEXM · AGE	−14	(8)	−46**	(16)			−38*	(16)		
SEXM · AGE2/1000	166**	(67)	341**	(125)						
DEATH	1221**	(557)	4090**	(899)	3201**	(893)	2657	(2385)	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		6185		32 489	

[a] Coefficients for variables not connected to age or proximity to death are not presented.
[b] Number of observations: 59 233 (55 795 survivors, 3438 decedents) log-likelihood test for all elements of $\Sigma = 0$: 126 590.
[c] Total number of observations: 145 489; Observation per group 3 (1, 5); Test Restrictions: $\chi^2(6)$; 4.56 ($p = 0.602$); Number of groups: 48 731; χ^2 (73) 47 008 ($p = 0.000$); χ^2 (6) 4.56 ($p = 0.602$).
[**] Significant at the 99% confidence level; [*] Significant at the 95% confidence level.

estimation of total conditional HCE, 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. The age profile is decreasing in all categories, confirming evidence from other studies suggesting a negative age gradient in the cost of dying for the elderly (Lubitz and Riley, 1993; Felder *et al.*, 2000; Schellhorn *et al.*, 2000; Chernichowski and Markowitz, 2004).

Combining all elements of the model, one can derive expected values for component j of acute HCE according to

$$
\begin{aligned}
&E\big(\mathrm{HCE}_{ij} \vert \mathrm{LTC}_i = 0\big) \\
&\quad = [1 - Pr(\mathrm{LTC}_i > 0)] \cdot \Pr\big(\mathrm{HCE}_{ij} > 0 \vert \mathrm{LTC}_i = 0\big) \cdot \mathrm{HCE}_{ij} \big\vert \mathrm{HCE}_{ij} > 0 \wedge \mathrm{LTC}_i = 0
\end{aligned} \tag{9}
$$

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

Figure 3 presents men's age profiles for the five components of expected HCE. In panel A, the values relating to the disease are shown, whereas *panel B* documents those of survivors. 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 receiving acute health care only (panel A). Conversely, outlays on ambulatory care, prescription drugs, and most notably in inpatient care rise with age among surviving men (panel B).

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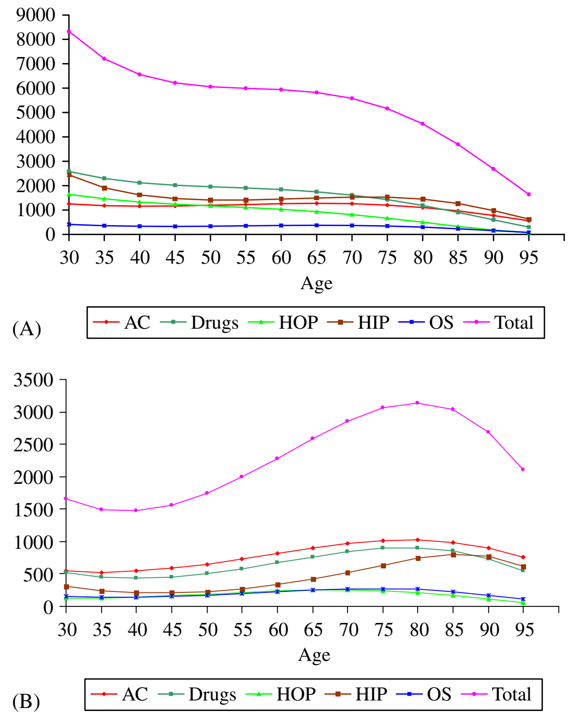

Figure 3. Expected values of for acute HCE components for deceased and surviving male non-LTC users as a function of age, in CHF: (A) deceased persons and (B) survivors

Age effects in LTC patients

For LTC patients, the appropriateness of the two-part model consisting of a multivariate probit model at the first and SUR estimation at the second stage is again confirmed. The null hypothesis that all elements of the covariance matrix are zero is clearly rejected (see upper part of Table VI). Therefore, at least two of the probabilities of positive HCE considered are correlated. Furthermore, the Chi-square test indicates that the restrictions imposed on the SURE model need not be rejected (see lower part of Table VI).

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. In old age, more individuals are staying in a nursing home (Pr ($NHC_{ij} > 0$)), while the share of LTC individuals receiving care at their own home decreases.

While the age profile of LTC services in nursing homes is increasing for the deceased person, it is flat for survivors. By way of contrast, in the home care component, the coefficients of AGE, AGE2, and AGE3 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 its age effect is generally decreasing. Proximity to death has the expected impact (a negative coefficient of TTD) where significant. However, the indicators associated with actual death (DEATH, AGE $\cdot$ 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 substantial cost surge, attaining no less than CHF17 000 ceteris paribus in hospital inpatient care. Therefore, hospitals do on

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Table VI. Multivariate probit and SUR estimation of conditional HCE components: users of LTC services[a]

	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.
Multivariate probit estimation of Pr ($HCE_j > 0$)[b]														
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 $HCE_i \mid HCE_j > 0$[c]														
Constant	25 078**	(7768)	−16 084**	(5408)	−1585	(2365)	−9552	(5170)	1675	(2593)	52 550**	(21 888)	−8932**	(2449)
AGE	−80	(195)	658**	(195)	182	(115)	639**	(241)	100	(79)	−2617**	(1053)	556**	(125)
AGE2/1000	218	(1421)	−10 891**	(1421)	−3006	(1825)	−10 120**	(3770)	−989	(609)	41 854**	(16 474)	−8369**	(1994)
AGE3/1000			59**	(23)	14	(9)	50**	(19)			−213**	(83)	39**	(10)
SEXM	−3913	(3547)	518	(3547)	−1214**	(489)	5549	(3907)	12 671	(7574)	21 588	(16 192)	2735	(1577)
SEXM · AGE	24	(45)	−10	(45)	14**	(6)	−151	(108)	−363	(216)	−471	(476)	−94*	(46)
SEXM · AGE2							1001	(745)	2499	(1500)	2720	(3406)	727*	(334)
DEATH	−11 295**	(4492)	4314	(4492)	1759**	(802)	7504**	(2070)	3309*	(1578)	16 961**	(6139)	1888**	(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.	1376		1746		2405		2392		1276		1444		2 226	

[a] Coefficients for variables not connected to age or proximity to death are not presented.
[b] Number of observations: 2927 (1290 survivors, 1637 decedents); log-likelihood test for all elements of $\Sigma = 0$: 5176.
[c] Total number of observations: 12865; observation per group: 4.4; test restriction; number of groups: 2927; $\chi^2(117)$: 12 570 ($p = 0.000$); $\chi^2(5)$: 2.89 ($p = 0.89$).
[**] Significant at the 99% confidence level; [*] Significant at the 95% confidence level.

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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 $\cdot$ AGE has a positive coefficient. In all other components of HCE, it is the other way around.

These results are being confirmed by Panel A and Panel B of Figure 4 showing the age profiles of conditional and expected LTC expenditure in nursing homes and at home of LTC users. Panel C presents the expected HCE according to

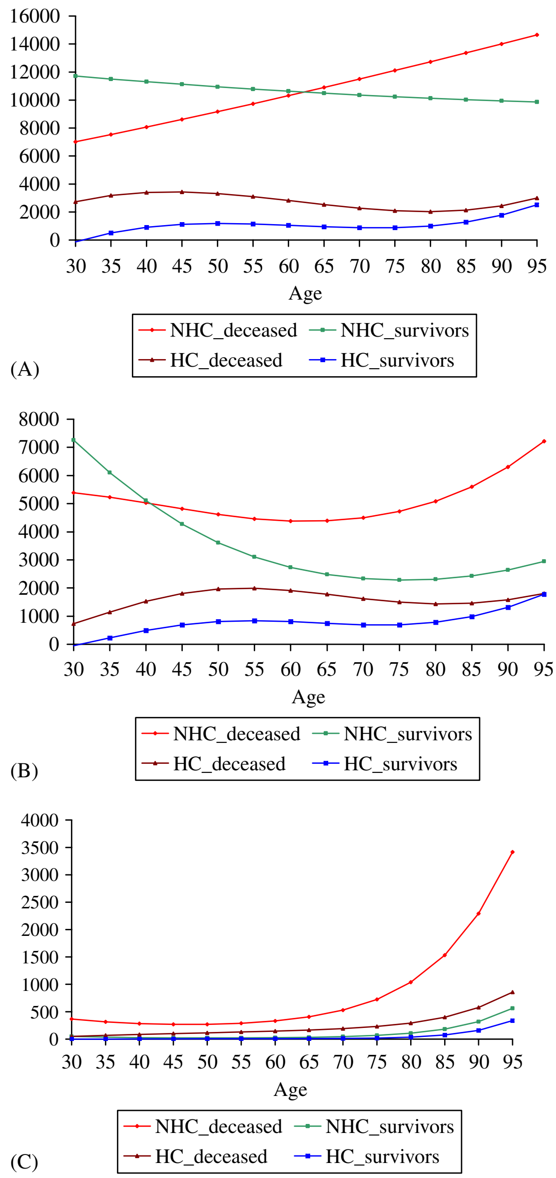

Figure 4. Conditional and expected values of nursing home care (NHC) and home care (HC) expenditure of surviving and deceased male LTC users as a function of age, in CHF: (A) $\mathrm{HCE}|\mathrm{HCE}>0 \wedge \mathrm{LTC}>0$; (B) $Pr(\mathrm{HCE}>0|\mathrm{LTC}>0)\cdot \mathrm{HCE}|\mathrm{HCE}>0 \wedge \mathrm{LTC}>0$; and (C) $E(\mathrm{HCE}_{ij}|\mathrm{LTC}_i>0) = Pr(\mathrm{LTC}>0)\cdot Pr(\mathrm{HCE}_{ij}>0|\mathrm{LTC}_i>0)\cdot \mathrm{HCE}_{ij}|\mathrm{HCE}_{ij}>0 \wedge \mathrm{LTC}_i>0$

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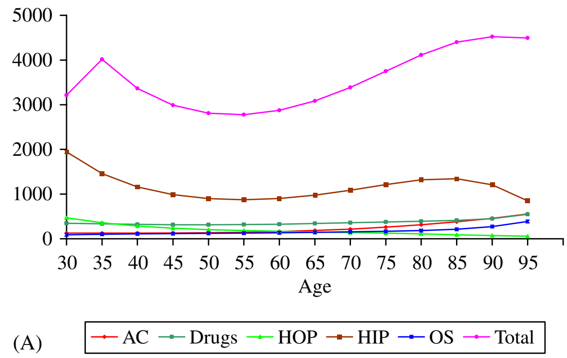
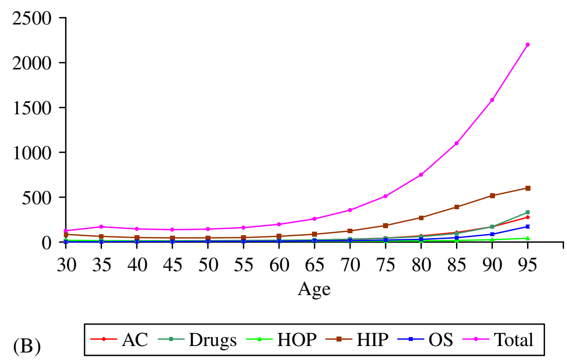


(A)



(B)

Figure 5. Expected values of acute HCE components for deceased and surviving male LTC users as a function of age, in CHF: (A) deceased persons and (B) survivors

$$E\left(\mathrm{HCE}_{ij}|\mathrm{LTC}_i > 0\right) = \Pr(\mathrm{LTC} > 0) \cdot \Pr\left(\mathrm{HCE}_{ij} > 0|\mathrm{LTC}_i > 0\right) \cdot \mathrm{HCE}_{ij}\left|\mathrm{HCE}_{ij} > 0 \wedge \mathrm{LTC}_i > 0 \right. \quad (10)$$

Expected outlay on inpatient LTC clearly shows a positive age gradient. In home care as well as for surviving patients in nursing homes however, expected HCE exhibits much less of a progression with higher age.

With regard to acute care expenses, deceased LTC patients differ markedly from surviving ones, patients incurring much higher HCE (see Figure 5, again noting the difference in scale between panels A and B). The age profile of expected hospital inpatient expenditure depends on survivor status. While they are more or less constant among the deceased, they do increase with age among survivors, although it is known that remaining life expectancy is much reduced given that an old person is admitted to a nursing home (Felder, 1997). In view of the age profile of being in need of LTC which is similar for survivors and the deceased (see Figure 1) the difference comes from the conditional hospital inpatient expenditure. All the other components of expected acute HCE display flat or rather weakly increasing age profiles regardless of survivor status, vindicating the red herring hypothesis once more.

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 5000 deceased who on average died 29 months past the end of 1999. This difference in time to death of at least

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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 HCE by components, 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' inpatient 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 individuals with positive LTC and zero LTC expenditure. While age-related regressors are significant alongside those indicating death and its proximity, their impact remains small. Next, HCE conditional on being positive is analyzed, which comprises LTC-related expenditure for one group and acute care expenditure for the other. When added on to age-related regressors, the two death-related variables (DEATH = 1, time-to-death TTD) contribute significantly 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 deceased non-LTC patients, age gradients are zero or even decreasing (at least beyond age 80). Among LTC patients, weak age effects in HCE incurred in nursing homes can be identified.

In line with this paper's title, a 'school of red herrings' can therefore 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.

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