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Do the Age Profiles of Health Care Expenditure Really Steepen over Time?

New Evidence from Swiss Cantons

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Abstract:

The ‘red herring’ hypothesis contends that the high health care expenditure in old age is caused by proximity to death rather than calendar age. Dissenters point to longitudinal data and claim that health care expenditure age profiles tend to steepen over time. The present paper tests the steepening claim for Swiss health insurance, covering the time period 1997 to 2006 and 25 cantons. It analyzes the cantonal health care expenditure profile of men and women, taking into account differences in the mortality rates. The study covers seven components of health care, including long-term care. By and large, no evidence is found for relevant steepening effects of age profiles for either total, or the components, of health care expenditure.

JEL-Classification: I12, J14

Keywords: Ageing, health care expenditure, end-of-life expenditure

1. Introduction

A growing body of evidence suggests that the higher health care expenditures (HCE) incurred by older people may be caused by proximity to death rather than calendar age. Consequently, projections not accounting for proximity to death are likely to overstate the effect of population ageing on future HCE. Evidence for the 'age neutrality' or 'red herring' hypothesis often rests on the analysis of cross-sectional data. Sceptics thus point to longitudinal data in the hope of re-establishing the old 'age matters' hypothesis.

In a recent paper, *Buchner* and *Wasem* (2006) found for the largest German private health insurer that high cost older age groups had larger increases in HCE than the young and middle aged groups in the period from 1979 to 1996. OECD HCE data on the time trends in per capita expenditure for the 65-and-older age group versus the under-65 age group show a similar pattern (see *Seshamani* and *Gray*, 2002). Buchner and Wasem introduced the term "steepening" of the health expenditure profile to characterize the effects of age and time on HCE. If steepening can be assumed to prevail, they claim that "the future increase of health care costs will even be larger than in predictions that keep expenditure profiles constant" (*Buchner* and *Wasmer*, 2006, p. 582). This quote echoes the catastrophic scenarios on future HCE that were in vogue in the nineties. For example, *Schneider* and *Guralnik* (1990) expect HCE for older people to double by 2020, largely due to the ageing of the baby boom generation.

Several factors can influence the age profile of per capita HCE. The profile will steepen if the expansion of the technological frontier in medicine is biased towards the treatment of old age diseases. On the other hand, there are several factors which will work in the opposite direction. Firstly, if compression of morbidity takes place and the average health status in old age improves with the passage of time, average HCE in old age decreases (*Fries*, 2005). Secondly, greater longevity, which pushes death later in life, will also lower per capita HCE, due to the level and the age profile of the end-of-life expenditure. The high cost of dying reduces average HCE when the mortality rate decreases. The reduction of mortality pertinent to all ages, but accentuated in old age, will therefore reduce the age gradient of HCE in old age. Research also shows that those who die at older ages have lower health care costs than those who die at younger ages. Per capita HCE in old age thus will decrease with the deferral of death to ever higher ages.

This paper tests the steepening claim using longitudinal HCE data of social health insurance for the years 1997 to 2006 in the 26 Swiss cantons. The data distinguishes between women and men as well as between 20 five-year age groups. Aggregate HCE can be decomposed into seven components, including ambulatory care, prescription drugs, hospital inpatient and outpatient care, home care, nursing home care, and other services. Furthermore, the data include age-, sex- and regional-specific mortality rates. Therefore, we can analyze the interdependence between mortality and age in their impact on HCE.

This paper is organized as follows. Section 2 presents the data and a first glimpse of steepening. Section 3 characterizes steepening of the HCE age profile for an exponentially growing HCE time path. Section 4 describes the econometric approach and presents the results regarding steepening of aggregated HCE data. Section 5 deals with the components of HCE. Section 6 concludes.

2. A first look at the data

This study is based on age profiles of HCE and mortality rates in the 26 Swiss cantons for the ten years from 1997 to 2006. HCE data stem from the association of the Swiss sickness funds, and mortality rates data come from the federal office of statistics. The social health insurance expenditure data distinguishes 20 five-year age groups of health care spending for men and women, starting at ages 0-5, 6-10 and ending at ages 96 and older. Using the producer price index (GDP deflator), we express all HCE in 2006 SFr. Cantonal mortality rates for men and women are also available in 20 five-year age groups for the years 1997 to 2006.

In 2006, the per capita HCE in social health insurance was 2,759 SFr., which amounts to roughly 40 percent of total per capita HCE of the Swiss population. In 1997, HCE in social health insurance was 1,928 SFr. The average annual real growth rate amounted to 4.3 percent over the ten-year period. The average HCE of a woman was higher than that of a man by a factor of 1.35 (in 2006 3,163 SFr. as against 2,338 SFr.). The age profiles for women and men are relatively flat at young ages, with a small gradient beyond age 20. 60-year-olds incur on average 3,398 SFr. for health care. This amount doubles by the age of 80 and reaches 16,919 SFr. for men of age 95+ and 20,711 SFr. for women of the same age.

Figure 1 shows the average age profile of per capita HCE in the Swiss cantons at the beginning and the end of the study interval. For the very old, i.e. people older than 80 years, the age profile seems to have become flatter between 1997 and 2006. Hence, steepening appears not to be present for the very old. By comparison, some steepening might be occurring for the ages 60 to 80.

Figure 1: The change in the age profile of per capita HCE in Switzerland, 1997-2006

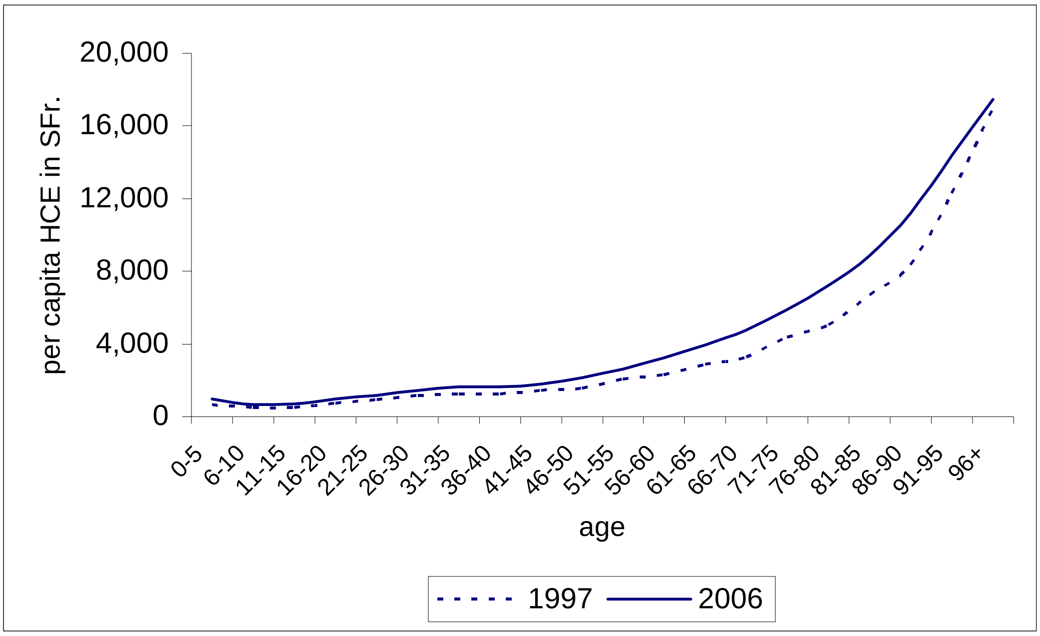

Table 1 presents two ratios of per capita HCE between the old and the young for 25 Swiss cantons (we aggregated the small two semi-cantons of Appenzell to one canton). For the country as a whole, per capita spending in 2006 for ages 66 and over was 4 times higher than for ages 0-65. In 1997, this ratio equals 3.85, which is 3.93 percent lower than in 2006. In the cantons, the 66+/0-65-ratio of per capita HCE ranges between 3.62 and 4.6 in 2006, and between 3.5 and 4.93 in 1997. Hence, between 1997 and 2006, the range became smaller. The increase in the ratio ranges between -9.68 percent and 14.54 percent. In 10 out of 25 cantons the ratio decreased, indicating an absence of steepening, whereas in 15 cantons the ratio increased, pointing to possible steepening effects.

The second ratio compares ages 51 and older with ages 50 and younger. Not surprisingly, this ratio is lower than the 66+/0-65-ratio. Interestingly, however, the change in the 51+/0-50-ratio from 1997 to 2006 is much higher (6.01 percent as opposed to 3.93 percent). The change ranges from -9.56 percent to 18.98 percent, and it is negative in six cantons only. The difference between the two indicators points to a marked increase in per capita HCE for the ages 51-65. In the econometrics, by using the ages 0-50 as the benchmark, we will apply the sharper test for the occurrence of steepening.

Table 1: The ratio of per capita HCE between the old and the young generation

	Ratio of 66+ to 0-65			Ratio of 51+ to 0-50		
	1997	2006	Relative change	1997	2006	Relative change
Aargau	3.92	3.87	-1.36%	3.49	3.49	-0.06%
Appenzell	3.78	3.92	3.67%	3.59	3.72	3.57%
Baselland	3.59	3.62	0.90%	3.12	3.26	4.75%
Basel-Stadt	3.50	3.73	6.59%	3.28	3.67	11.83%
Bern	4.04	3.98	-1.43%	3.62	3.78	4.38%
Fribourg	4.25	4.09	-3.93%	3.63	3.64	0.37%
Genève	3.70	3.91	5.49%	3.04	3.34	9.67%
Glarus	3.94	3.68	-6.48%	3.63	3.28	-9.56%
Graubünden	3.69	4.14	12.16%	3.51	3.81	8.60%
Jura	4.93	4.45	-9.68%	4.26	4.15	-2.56%
Luzern	4.19	4.49	7.04%	3.85	4.04	5.05%
Neuchâtel	4.07	4.17	2.52%	3.54	3.96	11.77%
Nidwalden	4.05	3.93	-2.92%	3.60	3.51	-2.35%
Obwalden	4.53	4.40	-2.94%	3.93	3.91	-0.61%
Schaffhausen	3.89	3.83	-1.72%	3.67	3.61	-1.77%
Schwyz	4.34	4.15	-4.38%	3.73	3.59	-3.83%
Solothurn	3.88	3.90	0.69%	3.52	3.63	2.97%
St. Gallen	3.78	3.85	1.70%	3.44	3.53	2.51%
Ticino	3.60	4.03	11.94%	3.34	3.97	18.98%
Thurgau	3.98	3.98	-0.10%	3.54	3.55	0.26%
Uri	4.30	4.60	7.01%	4.20	4.26	1.55%
Vaud	3.62	4.15	14.54%	3.17	3.71	17.16%
Valais	4.05	4.14	2.00%	3.78	3.81	0.75%
Zug	4.00	4.09	2.39%	3.33	3.55	6.84%
Zürich	3.66	3.86	5.46%	3.13	3.37	7.65%
Switzerland	3.85	4.00	3.93%	3.42	3.62	6.01%

The HCE data distinguishes several components of acute and long-term care. Acute HCE include ambulatory care (AC), hospital outpatient care (HOP), hospital inpatient care (HIP), prescription drugs, and other services. Long-term care has two components, nursing home care (NHC) and home care (HC). Table 2 shows HCE and its components across 25 Swiss cantons.

The table is sorted according to the average HCE of men. Cantons in the centre of Switzerland show the lowest per capita HCE followed by cantons in the east. Roman cantons incur the highest per capita HCE. Total hospital care (HOP and HIP) makes up 40 percent of total HCE, ambulatory care 25 percent, drugs 20 percent, followed by long-term care and other services, which both have a share of roughly 10 percent.

Table 2: Population, per capita total and components of health care expenditure in Swiss cantons

Canton		Population	HCE		Components of HCE						
Name	No.	(in 100,000)	Men	Women	AC	Drugs	HIP	HOP	HC	NHC	Other
Nidwalden	13	0.39	1,724	2,366	443	407	478	321	42	147	204
Obwalden	14	0.33	1,779	2,478	438	412	469	404	41	173	191
Appenzell	2	0.66	1,780	2,325	478	385	514	316	33	181	145
Zug	24	1.05	1,855	2,642	556	414	533	323	24	193	203
Uri	21	0.35	1,894	2,525	466	414	585	351	45	208	140
Luzern	11	3.57	1,925	2,588	486	442	553	340	36	221	183
St. Gallen	18	4.50	1,944	2,591	573	469	547	287	35	185	175
Schwyz	16	1.36	1,972	2,658	577	452	548	311	33	195	196
Graubünden	9	1.89	1,975	2,710	549	506	545	312	48	185	200
Glarus	8	0.37	1,995	2,673	554	478	509	335	32	228	200
Thurgau	20	2.30	2,004	2,641	498	407	670	338	35	185	191
Schaffhausen	15	0.72	2,119	3,064	578	565	573	408	42	236	205
Wallis	23	2.97	2,135	2,780	527	572	604	324	41	172	222
Aargau	**1**	**5.58**	**2,149**	**2,819**	**546**	**546**	**650**	**372**	**34**	**148**	**189**
Fribourg	6	2.54	2,200	2,990	584	564	621	329	40	236	225
Zürich	25	12.44	2,260	3,116	720	530	601	353	46	238	208
Solothurn	17	2.41	2,319	2,988	595	561	656	401	63	150	231
Jura	10	0.64	2,411	3,114	504	648	723	441	92	173	186
Neuchâtel	12	1.68	2,451	3,465	567	734	624	338	86	361	264
Baselland	3	2.58	2,471	3,187	732	569	706	420	51	126	232
Bern	5	9.18	2,552	3,381	584	568	829	435	69	280	214
Vaud	22	6.36	2,670	3,671	690	691	644	585	101	213	264
Ticino	19	3.12	2,878	3,667	688	723	867	397	56	255	303
Genève	7	4.03	3,008	4,287	989	797	762	494	72	215	342
Basel-Stadt	4	1.76	3,024	4,151	739	766	987	545	85	245	251
Switzerland		72.79	2,338	3,163	634	571	665	394	55	216	223

Table 3 shows the 66+/0-65-ratio and the 51+/0-50-ratio of per capita HCE between the old and the young for the components of health care at the federal level. For the use of prescription drugs, we observe no relative change between 1997 and 2006 for both ratios. The changes are negative for hospital inpatient care as well as for other services. Thus, there is no indication of steepening in these three components of health care. However, in ambulatory care, hospital outpatient care and the two components of long-term care, the increase in the ratios is substantial, in particular for nursing home care.

We observe large differences between the two ratios for long-term care. When we compare the group of age 66 and older with the 0-65 age group, the ratio for home care decreased by 7.18 percent whereas for nursing home care it increased by 37.39 percent between 1997 and 2006. By comparison, when we cut at age 51, the ratios increased by 10.29 percent and as much as 104.89 percent, respectively. These differences point to significant changes in long-term care for ages 51-65 relative to the other age groups.

Table 3: The ratio of per capita HCE between the old and the young generation – components of health care

	Ratio of 66+ to 0-65			Ratio of 51+ to 0-50		
Components	**1997**	**2006**	**Rel. change**	**1997**	**2006**	**Rel. change**
AC	2.03	2.29	12.93%	2.01	2.24	11.36%
Drugs	3.83	3.86	0.70%	4.33	4.35	0.41%
HIP	5.28	4.66	-11.71%	4.51	4.17	-7.51%
HOP	2.43	2.48	2.28%	2.43	2.61	7.46%
HC	31.02	28.79	-7.18%	28.79	31.75	10.29%
NHC	59.25	81.41	37.39%	54.38	111.41	104.89%
Other	2.41	2.20	-8.96%	2.29	2.16	-5.56%

In the ten-years-time period analyzed here, the reduction of mortality led to an average increase of the population's longevity in the Swiss cantons of 2.2 years (from 79.30 years in 1997 to 81.50 years in 2006). As HCE in the last year of life is about 5 to 10 times higher than average HCE of survivors (*Zweifel* et al. 1999), the general accentuated reduction of the mortality rate in old age, will most likely affect the HCE age profile of the elderly. Thus, it is important to consider the influence of mortality when testing for a possible steepening of the age profile.

3. Identifying steepening of the HCE age profile

Let us suppose that HCE (h) for each age group (a) in region (r) follows an exponential path over time (t). Furthermore, we include the mortality rates ($m_{a,t,r}$) as an additional explanatory variable. Specifically, we assume that

$$h_{a,t,r} = \alpha_{a,0,r} \cdot \exp\left[\left(\beta_r + \gamma_{a,r} \cdot a\right) \cdot t + \delta \cdot m_{a,t,r}\right] . \qquad (1)$$

Taking the logarithm on both sides of the equation yields:

$$\ln h_{a,t,r} = \ln \alpha_{a,0,r} + \left(\beta_r + \gamma_{a,r} \cdot a\right) \cdot t + \delta \cdot m_{a,t,r} . \qquad (2)$$

In this equation, $\gamma_{a,r}$ measure the age-specific differences to the average HCE growth rate β_r in the region *r*. $\gamma_{a,r}$ will be decisive for determining possible steepening. If $\gamma_{a,r}$ rise with an increase in age, steepening may be present. Note, however, that the mortality rate is also changing in time and age. This in turn will also have an effect on the evaluation of a possible steepening of the HCE age profile.

Steepening in the strict sense of the word means that the HCE age profile increases over time. With a positive age gradient, steepening is present if the mixed derivative of $\ln h_{a,t,r}$ with respect to age and time is positive:

$$\frac{\partial^2 \ln h_{a,t,r}}{\partial a \cdot \partial t} = \gamma_{a,r} + \delta \cdot \frac{\partial^2 m_{a,t,r}}{\partial a \cdot \partial t} > 0 \ . \tag{3}$$

Given the high end-of-life expenditure, HCE is assumed to rise with an increase in the mortality rate, i.e. $\delta > 0$. The compression of mortality to ever higher ages is a well-known secular trend. Technically, this means that $\partial^2 m_{a,t,r} \big/ (\partial a \cdot \partial t) < 0$. With $\delta > 0$, the second summand in (3), then, is negative. This implies that $\gamma_{a,r} > 0$ is a necessary but not sufficient condition for steepening to be present.

Buchner and *Wasem* (2006) proposed three alternative methods for detecting steepening. The first compares per capita HCE between people of age 65 and older and people under 65 years old:

$$\frac{\bar{h}_{65+,t,r}}{\bar{h}_{0-64,t,r}} = \sigma \cdot t \cdot \frac{\bar{h}_{65+,0,r}}{\bar{h}_{0-64,0,r}} \quad \text{with steepening if} \quad \sigma > 0 \ . \tag{4}$$

As far as steepening is concerned, this boils down to a model with two age groups only, the young and the old. Consequently, $\sigma > 0$ is a very crude indicator of steepening.

The second approach assumes a linear trend over time for HCE at each age:

$$\frac{h_{a,t,r}}{h_{0,t,r}} = \mu + \kappa_a \cdot t \quad \text{with steepening if} \quad \kappa_a > 0 \ \text{and} \ \frac{\partial \kappa_a}{\partial a} > 0 \ . \tag{5}$$

Two problems arise with this specification. Firstly, empirical evidences suggests that growth of per capita HCE is exponential not linear in time. Secondly, (5) does not allow for age-specific constants, again contradicting empirical fact.

The third alternative assumes that the health care profile is exponential in both time and age according to:

$$\frac{h_{a,t,r}}{h_{0,t,r}} = \tau + \exp(\upsilon_t \cdot a) \quad \text{with steepening if} \quad \upsilon_t > 0 \ \text{and} \ \frac{\partial \upsilon_t}{\partial t} > 0 \ . \tag{6}$$

Again, this specification appears to be too restrictive.

Buchner and *Wasem* (2006) were bound to inflexible functional forms as they had access to one HCE time series of 18 years only.

By comparison, the large dataset of the present study with 25 regions allows us to model the HCE age profile quite flexibly and to take into account time and mortality rates. We will also run regressions where we do not include the mortality rate as an explanatory variable. Although this yields biased coefficient estimates (the error term is correlated with the explanatory variables age and time, as they also determine mortality), we can gain some additional information on steepening, by comparing the corresponding coefficients for regressions with and without the mortality rates, as well as on the influence of mortality on the HCE age profile.

We will analyze the change of the age gradient for the age groups older than 50. A less strict test for steepening is the relative growth of HCE for ages 51 and older compared to ages 0-50. We will report on further approaches to testing for steepening of the HCE age profile.

4. Analysis of total health care expenditure

The econometric model is specified as follows:

$$\begin{aligned}\ln h_{a,t,r} &= \ln \alpha_{1,0,1} + \theta \cdot d_{sex} + \sum_{r=2}^{25} \kappa_r \cdot d_r + \sum_{a=2}^{20} \mu_a \cdot d_a \\ &+ \beta \cdot t + \sum_{a=11}^{20} \gamma_a \cdot d_a \cdot t + \sum_{i=1}^{4} \phi_i \cdot \left(m_{a,t,r}\right)^i + \varepsilon_{a,r,t}\end{aligned}, \qquad (7)$$

where the dependent variable $h_{a,t,r}$ is the average HCE at age *a* and time *t* in the canton *r* differentiated with respect to men and women (we suppressed the subscript for the sex). $\ln \alpha_{1,0,1}$ is a constant for the first age group (0-5) of women in the initial year in the benchmark canton Aargau (reference group when all other dummy variables are set to zero). d_{sex} is a dummy variable for the sex, which is assumed to be zero for women and one for men. The coefficient θ then measures the difference in HCE between men and women. d_r are dummies for the cantons except for Aargau; κ_r indicates the HCE differences to the benchmark canton. d_a are dummies for the age classes, and μ_a denotes the difference in HCE between age class *a* and the first age class.

We address steepening first by using the growth rate of HCE for all people of age 50 or younger as the benchmark. The coefficient β in (7) corresponds to this growth rate. The coefficients γ_a, $a = 11, 12, .., 20$, then measure the difference to β for the age groups older than 50 years. Secondly, we consider the change in the HCE age gradient for the people of age 50+ by calculating $\gamma_{a+1} - \gamma_a$. Steepening is present if $\gamma_{a+1} - \gamma_a > 0$, i.e., the growth rate of HCE in a given age group is larger than that in the next younger age group. This again is confined to the 50+ age groups.

Finally, the effect of the mortality rate on HCE is captured by a polynomial function of power four and $\varepsilon_{a,r,t}$ is the error term in the estimation.

The estimation results for equation (7), controlled for possible heteroskedasticity of the error term, are presented in Table 4. The constant indicates the logarithm of HCE in 2006 SFr. of the youngest female age group (girls aged 0 to 5) in Aargau in 1997. Transforming the constant (abstracting from the smearing factor) gives 693 SFr. Men on average incur 21.6 percent lower HCE than women. The estimated respective differences in HCE between cantons *r*2, … , *r*20 and the benchmark region Aargau follow the figures given in Table 2. The coefficients for the age group (*a*2, …, *a*20) show the well-known pattern with strongly rising HCE beyond age 50. The age group 96+ incurs 3.7 times ($\approx \exp(2.1676 - 0.8489)$) higher average HCE compared to the age group 46-50.

The coefficients for the effect of mortality are significant. The effect of mortality on HCE is positive, as expected. Over all age classes, the mortality rate is 0.8 percent and increases HCE by 8.2 percent; beyond the age of 50 the average mortality rate is 2.6 percent, contributing 27.2 percent to overall HCE. These results indicate a strong positive impact of mortality on the age profile of HCE, adding to the findings of the red herring literature (see *Zweifel* et al., 1999).

The estimated annual growth rate of real HCE between 1997 and 2006 was 3.23 percent for the people of age 50 or younger. The coefficients γ_a are significantly positive for most age groups, indicating that the HCE growth rates in the age groups older than 50 years are larger than those for people of age 50 or younger. The differences in the growth rate are in the range 0.9 and 1.6 percentage points. For the age groups 51-55, 91-95 and 96+-year-olds, the coefficient is significantly negative, indicating that we can rule out that steepening occurs in these age classes.

Table 4: Explaining ln (HCE) over time

Variable	Coefficient	Std.err.	Variable	Coefficient	Std.err.
Constant	6.5409*	0.0140	Sex	-0.2432*	0.0064
cant2	-0.2095*	0.0119	cant14	-0.1187*	0.0133
cant3	0.1406*	0.0106	cant15	-0.0032	0.0112
cant4	0.2498*	0.0103	cant16	-0.0236	0.0111
cant5	0.0441*	0.0102	cant17	0.0151	0.0101
cant6	0.1376*	0.0116	cant18	-0.0662*	0.0102
cant7	0.4845*	0.0106	cant19	0.2286	0.0105
cant8	-0.0805*	0.0128	cant20	0.0161	0.0111
cant9	-0.0827*	0.0108	cant21	-0.1486*	0.0117
cant10	0.1963*	0.0131	cant22	0.3211*	0.0112
cant11	-0.1027*	0.0107	cant23	0.0301*	0.0106
cant12	0.2363*	0.0110	cant24	-0.0394*	0.0116
cant13	-0.1430*	0.0129	cant25	0.1083*	0.0099
age			**age**		
6-10	-0.2763*	0.0157	56-60	1.1866*	0.0153
11-15	-0.2441*	0.0128	61-65	1.4152*	0.0186
16-20	0.0987*	0.0114	66-70	1.4461*	0.0226
21-25	0.2973*	0.0136	71-75	1.6532*	0.0295
26-30	0.4582*	0.0167	76-80	1.6242*	0.0435
31-35	0.5707*	0.0157	81-85	1.7179*	0.0672
36-40	0.5853*	0.0124	86-90	1.6448*	0.0960
41-45	0.7278*	0.0112	91-95	1.9345*	0.1170
46-50	0.8489*	0.0111	96+	2.1676*	0.1362
51-55	1.1196*	0.0141			
t	0.0323*	0.0010			
age · t			**age · t**		
51-55 · t	-0.0045*	0.0015	76-80 · t	0.0168*	0.0019
56-60 · t	0.0091*	0.0017	81-85 · t	0.0069*	0.0021
61-65 · t	0.0023	0.0021	86-90 · t	0.0121*	0.0022
66-70 · t	0.0148*	0.0023	91-95 · t	-0.0102*	0.0029
71-75 · t	0.0077*	0.0021	96+ · t	-0.0128*	0.0046
M	10.1661*	1.0694	m^3	51.7701*	6.4451
M^2	-36.4680*	3.9354	m^4	-24.2620*	3.6035
Number of observations		10,000	R^2	0,974	

*** significant at the 99% confidence level
** significant at the 95% confidence level
* significant at the 90% confidence level

A second test for steepening considers the change of the age gradient. The difference $\gamma_{a+1} - \gamma_a$ is positive four times and negative five times; except for the oldest group, the difference is significant for all age groups according to an F-test. Hence, we cannot confirm steepening as a general pattern in the older age groups.

In the last section, we argued that the change in the age gradient is intertwined with the change in the mortality rate. In order to test for the influence of the mortality rate, we re-estimated equation (7) but omitted the mortality rate. The results are presented in Table 5.

Table 5: Estimation results for ln (HCE) when the mortality rate is not included as an explanatory variable (the coefficients for the cantons are not presented)

Variable	Coefficient	Std. err.	Variable	Coefficient	Std. err.
Constant	6.5317**	0.0136	sex	-0.2013**	0.0035
Age			**age**		
6-10	-0.2852**	0.0145	56-60	1.2355**	0.0139
11-15	-0.2527**	0.0118	61-65	1.4991**	0.0164
16-20	0.0931**	0.0109	66-70	1.5864**	0.0183
21-25	0.2937**	0.0135	71-75	1.8909**	0.0179
26-30	0.4544**	0.0169	76-80	2.0119**	0.0161
31-35	0.5675**	0.0158	81-85	2.3260**	0.0160
36-40	0.5841**	0.0122	86-90	2.4952**	0.0152
41-45	0.7317**	0.0107	91-95	2.8888**	0.0217
46-50	0.8607**	0.0104	96+	3.1189**	0.0312
51-55	1.1466**	0.0134			
t	0.0320**	0.0010			
age t			**age · t**		
51-55 · t	-0.0049**	0.0016	76-80 · t	0.0083**	0.0022
56-60 · t	0.0082**	0.0017	81-85 · t	-0.0022	0.0020
61-65 · t	0.0005	0.0022	86-90 · t	0.0044**	0.0019
66-70 · t	0.0114**	0.0025	91-95 · t	-0.0116**	0.0028
71-75 · t	0.0013	0.0025	96+ · t	-0.0145**	0.0042
Number of observations	10,000		R^2	0.9722	

*** significant at the 99% confidence level
** significant at the 95% confidence level
* significant at the 90% confidence level

As we expected from equation (3), the coefficients for $d_a \cdot t$ decrease when mortality is not included as an explanatory variable. For four age groups, the coefficient remains significantly positive, indicating steepening; but the effects are rather small. Not including mortality in the regression significantly increases the coefficient for the age dummies in old age. This again shows that mortality is an important factor for determining the age profile of HCE.

We also analyzed a linear trend over time and confirmed the results of the logarithmic specification. Furthermore, when we capture age as a categorical variable and specify a polynomial function which we combine with time to test for steepening – similarly to the third approach by Buchner and Wasem – the test outcome is negative.

Equation (7) does not weight the cantonal per capita HCE at age *a* with the respective population size, which may give small cantons too much weight. However, using total HCE and adding the population size as an independent variable does not changes the results.

We observe not only differences in the level of cantonal per capita HCE, but also in the extent they change over time. Similarly we may also have differences in the change of the age profile across cantons. Thus, we extended our estimation to include the following variables referring to the passage of time.

$$t \cdot \left(\beta + \rho_r \cdot d_r + \sum_{r=2}^{25} d_r \cdot \sum_{a=11}^{20} \gamma_{a,r} \cdot d_a \right)$$

Here, $\beta + \rho_r$ is the average HCE growth rate for the people of age 50 or younger in canton *r*. $\beta + \rho_r$ will serve as the benchmark for the test of steepening. Using the estimated coefficients β, ρ_r and $\gamma_{a,r}$ and their standard errors, we calculated the difference for the older age groups in the HCE growth rate and its significance. Table 6 presents the results.

The first column indicates large differences in the HCE growth rate for the population below 50 across the cantons. The largest growth rate (5.37 percent) is observed for the small canton of Glarus in the centre, while the even smaller canton of Jura in the northwest has the lowest annual growth rate (0.69 percent). The correlation between the level and the baseline growth rate of HCE is negative ($r = -0.235$), but is not significant.

In cantons where per capita HCE growth rate for the young population is low, the coefficients for steepening tend to be positive (for example, the cantons Jura and Fribourg). Similarly, in the cantons with low level of HCE (see Table 2), the steepening coefficients are positive as well. By comparison, high cost cantons such as Basel-Stadt and Genève tend to have a lower growth rate in the old age groups compared to the baseline growth. In Zurich, the biggest canton, people of age 50 or younger experienced an average HCE growth rate. Only one older age group (76-80) incurred significantly higher HCE growth.

Steepening in the strict sense, i.e. a general increase in the age gradient for people of age 51 or older, is not present in the data, as the difference in the coefficients $\gamma_{a+1,r} - \gamma_{a,r}$ shows no robust pattern. By and large, the cantonal results do not support the steepening claim either.

5. Steepening in components of health care expenditure?

Table 7 presents the regression results of equation (7) with and without mortality rates for the components of HCE. With regard to the impact of mortality on HCE, a significant difference between components of acute care and long-term care arises. Whereas mortality has a major effect on the age profile of acute care, its impact on long-term care is only minor. It is then not surprising that age has a marked effect on HCE (see the sizeable coefficient of the age dummies for home and nursing home care in Table 7). This is similar to the findings of *Werblow* et al. (2007), who report significant age effects for long-term care when controlling for proximity to death.

Home care expenditures for people of age 50 or younger increased by 10.92 percent per year over the ten years in question. The growth rate is lower for the older age groups. Steepening is not present at all in the demand for home care, despite the observation in Table 3 that the ratio in per capita expenditure between the old and the young increased between 1997 and 2006.

Nursing home expenditure is different. From 1997 on, the under-51-year-olds decreased their average expenditure at an annual rate of 26 percent. With the exception of the 51-55 age group all over-51-years-olds experienced a positive growth in average nursing home expenditure. Still, steepening in the strict sense (an increase in the age gradients) again does not exist for old age groups.

Turning to acute care, a differentiated pattern regarding steepening arises. All outpatient care components (AC, Drugs, HOP and Other) mostly show a positive sign for γ_a, except for the two oldest age groups. The average growth rate of expenditure for the young people substantially differs between components of outpatient care. It is lowest in ambulatory care (1.86 percent), followed by sundry services (2.49 percent), drugs (3.08 percent) and hospital outpatient care (5.87 percent). The difference in growth for older age groups is more or less constant across components. A robust pattern of increasing age coefficients cannot be found.

Steepening can be ruled out for hospital inpatient care, where all γ_a are significantly negative. The baseline growth rate is 3.92 percent, comparable to the overall baseline growth of 3.23 percent.

Table 6: The difference in the HCE growth rate between the young (0-50) and the older age groups (51-55, 56-60, .., 96+) – regression results

	T	51-55	56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95	96+
Aargau	4.08% ***	-0.25%	1.43%***	1.03%***	2.39%***	1.44%***	2.34%***	0.46%*	0.66%**	-1.89%***	-1.66%***
Appenzell	4.48% ***	-0.12%	0.96%	0.27%	1.77%*	1.28%	1.78%***	-0.51%*	0.17%	-2.81%***	-2.58%***
Baselland	3.55% ***	-1.50%***	0.08%	-0.63%**	1.12%*	0.29%	1.36%***	0.28%	0.36%	-3.28%***	-4.68%***
Basel-Stadt	3.38% ***	-0.77%	0.40%	-0.76%	0.40%	-0.70%**	0.49%	-0.26%*	0.13%	-3.04%***	-3.09%***
Bern	4.54% ***	-0.18%	1.53%***	1.00%	2.63%***	1.56%***	2.52%***	0.88%**	1.36%***	-1.40%***	-1.27%***
Fribourg	1.60% ***	0.19%	1.79%***	1.39%	1.84%***	1.53%***	1.92%***	1.42%***	1.82%***	1.56%**	0.81%
Genève	2.46% ***	-1.64%***	-0.40%**	-1.55%***	0.26%	-0.57%*	1.14%**	1.14%**	2.04%***	-0.56%**	-1.29%***
Glarus	5.37% ***	-1.78%***	-0.54%*	-1.92%***	-0.35%	-1.31%***	-0.66%**	-2.69%***	-1.90%***	-3.88%***	-7.11%***
Graubünden	3.90% ***	0.06%	1.97%***	1.08%**	2.30%**	1.20%**	2.58%***	0.84%*	1.33%***	-1.77%***	-2.41%***
Jura	0.67% ***	0.01%	1.83%***	1.46%**	2.06%**	2.05%***	2.90%***	3.74%***	4.52%***	3.86%***	3.41%**
Luzern	3.35% ***	0.38%	2.22%***	1.72%***	3.04%***	2.52%***	3.42%***	2.87%***	3.38%***	1.04%*	0.67%
Neuchâtel	2.63% ***	0.12%	1.00%**	0.39%	1.46%**	0.53%	1.91%***	1.07%*	2.38%***	0.82%	2.02%***
Nidwalden	2.65% ***	0.05%	1.84%***	1.38%**	2.00%***	1.71%***	1.65%***	1.04%*	2.12%***	0.80%	0.82%
Obwalden	2.51% ***	-0.52%	1.64%***	1.18%**	2.17%***	2.35%***	2.74%***	2.01%***	3.28%***	2.02%***	-0.44%
Schaffhausen	3.54% ***	-0.21%	1.90%***	0.88%	2.27%***	1.00%**	2.40%***	0.54%	0.87%	-1.72%***	0.13%
Schwyz	3.96% ***	-0.49%	0.85%	0.48%	1.54%***	1.41%**	1.68%***	1.02%**	1.97%***	0.25%	-2.18%***
Solothurn	3.93% ***	-0.51%*	1.34%***	0.58%	1.96%***	1.29%**	2.06%***	0.94%**	1.20%**	-1.95%***	-2.18%***
St. Gallen	4.49% ***	-0.47%*	0.76%	-0.02%	1.10%*	0.28%	0.97%**	-0.49%**	0.24%	-1.85%***	-1.57%***
Ticino	2.47% ***	-0.20%	1.74%***	1.25%**	2.82%***	2.10%***	3.18%***	2.12%***	1.54%***	-1.72%***	-3.57%***
Thurgau	2.83% ***	-0.38%	1.33%**	0.48%	1.77%**	1.19%*	1.92%***	0.28%	0.33%	-2.32%***	-2.37%***
Uri	2.76% ***	0.17%	1.80%***	1.37%**	2.74%***	1.95%***	3.26%***	2.54%***	2.62%***	0.04%	2.06%**
Vaud	2.56% ***	-1.04%***	0.70%	0.10%	1.59%***	0.77%	1.84%***	0.79%	1.42%***	-1.27%***	-0.75%*
Valais	2.69% ***	-0.26%	1.57%***	0.97%	1.41%**	0.86%	1.83%***	1.56%	2.12%***	0.09%	0.18%
Zug	2.87% ***	-0.33%	1.50%***	1.13%**	2.73%***	1.80%***	3.20%***	3.22%***	2.91%***	1.26%	1.09%
Zürich	3.48% ***	-1.50%***	-0.07%	-0.90%***	0.90%	-0.13%	1.25%***	0.13%	0.98%**	-1.49%***	-0.95%**

*** significant at the 99% confidence level, ** significant at the 95% confidence level, * significant at the 90% confidence level

Table 7: Steepening in the components of HCE – regression results

	Ambulatory Care		Drugs		Hospital Inpatient Care		Hospital Outpatient Care		Home Care		Nursing Home Care		Other	
	with m	without m	with m	without m	with m	without m	with m	without m	with m	without m	with m	without m	with m	without m
a2	-0.4131 ***	-0.4208 ***	-0.3065 ***	-0.3092 ***	-0.6175 ***	-0.6303 ***	-0.0252	-0.0389 *	-0.6585 ***	-0.6584 ***	-0.0221	-0.0170	0.4304 ***	0.4200 ***
a3	-0.4930 ***	-0.5004 ***	-0.3207 ***	-0.3233 ***	-0.3314 ***	-0.3438 ***	-0.0078	-0.0210	-0.1380	-0.1380	1.2725 ***	1.2774 ***	0.6622 ***	0.6521 ***
a4	-0.2930 ***	-0.2978 ***	0.1120 ***	0.1103 ***	0.4634 ***	0.4552 ***	0.1429 ***	0.1342 ***	0.9395 ***	0.9395 ***	2.4444 ***	2.4476 ***	0.9186 ***	0.9120 ***
a5	-0.1857 ***	-0.1888 ***	0.3160 ***	0.3149 ***	0.7926 ***	0.7874 ***	0.3716 ***	0.3661 ***	1.8547 ***	1.8547 ***	3.4797 ***	3.4818 ***	1.0520 ***	1.0478 ***
a6	-0.0475 ***	-0.0508 ***	0.4827 ***	0.4816 ***	0.9871 ***	0.9816 ***	0.5583 ***	0.5525 ***	2.4203 ***	2.4203 ***	4.1902 ***	4.1923 ***	1.1443 ***	1.1399 ***
a7	0.0564 ***	0.0536 ***	0.6793 ***	0.6784 ***	1.0540 ***	1.0492 ***	0.6800 ***	0.6749 ***	2.7634 ***	2.7634 ***	4.9682 ***	4.9701 ***	1.2372 ***	1.2334 ***
a8	0.0865 ***	0.0855 ***	0.8082 ***	0.8079 ***	0.9690 ***	0.9672 ***	0.7194 ***	0.7175 ***	3.1072 ***	3.1072 ***	5.6400 ***	5.6407 ***	1.2199 ***	1.2185 ***
a9	0.2196 ***	0.2230 ***	1.0452 ***	1.0463 ***	1.0784 ***	1.0840 ***	0.8275 ***	0.8334 ***	3.7430 ***	3.7430 ***	6.6075 ***	6.6053 ***	1.3189 ***	1.3235 ***
a10	0.3027 ***	0.3129 ***	1.2386 ***	1.2421 ***	1.2128 ***	1.2300 ***	0.9214 ***	0.9397 ***	4.0664 ***	4.0664 ***	7.0653 ***	7.0585 ***	1.4023 ***	1.4162 ***
a11	0.4964 ***	0.5198 ***	1.5642 ***	1.5723 ***	1.5598 ***	1.5989 ***	1.1687 ***	1.2103 ***	4.8239 ***	4.8239 ***	6.7889 ***	6.7733 ***	1.6284 ***	1.6602 ***
a12	0.4946 ***	0.5370 ***	1.6928 ***	1.7076 ***	1.6865 ***	1.7575 ***	1.1968 ***	1.2725 ***	5.2093 ***	5.2095 ***	7.3049 ***	7.2765 ***	1.5950 ***	1.6529 ***
a13	0.6697 ***	0.7424 ***	1.9760 ***	2.0014 ***	1.9753 ***	2.0975 ***	1.3444 ***	1.4744 ***	5.7767 ***	5.7772 ***	7.7839 ***	7.7348 ***	1.7210 ***	1.8206 ***
a14	0.6061 ***	0.7283 ***	2.0091 ***	2.0520 ***	2.0891 ***	2.2949 ***	1.3509 ***	1.5695 ***	6.2589 ***	6.2607 ***	8.5104 ***	8.4270 ***	1.5824 ***	1.7504 ***
a15	0.7287 ***	0.9372 ***	2.2262 ***	2.3002 ***	2.3349 ***	2.6873 ***	1.3559 ***	1.7293 ***	7.0653 ***	7.0705 ***	9.5480 ***	9.4031 ***	1.6601 ***	1.9485 ***
a16	0.5944 ***	0.9387 ***	2.1962 ***	2.3203 ***	2.2744 ***	2.8597 ***	0.9775 ***	1.5951 ***	7.6423 ***	7.6575 ***	10.4639 ***	10.2174 ***	1.3885 ***	1.8696 ***
a17	0.4993 ***	1.0527 ***	2.2481 ***	2.4539 ***	2.2086 ***	3.1613 ***	0.6130 ***	1.6103 ***	8.3422 ***	8.3872 ***	11.5286 ***	11.1090 ***	1.1874 ***	1.9760 ***
a18	0.1446	0.9571 ***	2.0430 ***	2.3618 ***	1.8249 ***	3.2560 ***	0.0128	1.4913 ***	8.6546 ***	8.7747 ***	12.4120 ***	11.7342 ***	0.7984 ***	1.9919 ***
a19	0.0361	1.0308 ***	1.9969 ***	2.4190 ***	1.5772 ***	3.3935 ***	-0.2698	1.5748 ***	8.9723 ***	9.2123 ***	13.4508 ***	12.5157 ***	0.6324 **	2.1314 ***
a20	-0.1285	0.9561 ***	1.7604 ***	2.2643 ***	1.2605 **	3.2471 ***	-0.7841 *	1.1488 ***	8.9047 ***	9.1657 ***	13.8533 ***	12.9177 ***	0.6084	2.0362 ***
t	0.0186 ***	0.0184 ***	0.0308 ***	0.0307 ***	0.0392 ***	0.0388 ***	0.0587 ***	0.0583 ***	0.1092 ***	0.1092 ***	-0.2641 ***	-0.2640 ***	0.0252 ***	0.0249 ***
at11	-0.0018	-0.0022	0.0030	0.0029	-0.0161 ***	-0.0166 ***	-0.0028	-0.0034	-0.0272	-0.0272	0.2314 ***	0.2316 ***	-0.0128 ***	-0.0132 ***
at12	0.0125 ***	0.0118 ***	0.0167 ***	0.0165 ***	-0.0081 **	-0.0093 ***	0.0136 ***	0.0122 ***	-0.0039	-0.0039	0.2612 ***	0.2617 ***	0.0053 **	0.0043 **
at13	0.0054 ***	0.0039 **	0.0076 ***	0.0071 ***	-0.0186 ***	-0.0212 ***	0.0139 ***	0.0111 ***	-0.0204	-0.0204	0.3155 ***	0.3166 ***	0.0008 **	-0.0014
at14	0.0215 ***	0.0185 ***	0.0219 ***	0.0208 ***	-0.0086 **	-0.0138 ***	0.0201 ***	0.0147 ***	-0.0253 *	-0.0254 *	0.3184 ***	0.3206 ***	0.0206 ***	0.0163 ***
at15	0.0156 ***	0.0100 ***	0.0147 ***	0.0127 ***	-0.0168 ***	-0.0264 ***	0.0248 ***	0.0146 ***	-0.0474 ***	-0.0476 ***	0.2918 ***	0.2959 ***	0.0104 ***	0.0024 **
at16	0.0253 ***	0.0175 ***	0.0242 ***	0.0212 ***	-0.0072	-0.0207 ***	0.0445 ***	0.0304 ***	-0.0374 ***	-0.0380 ***	0.2963 ***	0.3023 ***	0.0260 ***	0.0148 ***
at17	0.0167 ***	0.0078 ***	0.0191 ***	0.0155 ***	-0.0202 ***	-0.0360 ***	0.0243 ***	0.0080 *	-0.0382 **	-0.0398 ***	0.2981 ***	0.3058 ***	0.0148 ***	0.0015 **
at18	0.0196 ***	0.0105 ***	0.0271 ***	0.0228 ***	-0.0203 ***	-0.0377 ***	0.0010	-0.0162 ***	-0.0227	-0.0263 *	0.3111 ***	0.3213 ***	0.0038 **	-0.0110 *
at19	-0.0019	-0.0068	0.0146 ***	0.0113 ***	-0.0413 ***	-0.0528 ***	-0.0574 ***	-0.0680 ***	-0.0378 **	-0.0422 ***	0.2925 ***	0.3008 ***	-0.0454 ***	-0.0536 ***
at20	-0.0018	-0.0090	0.0211 ***	0.0149 **	-0.0525 ***	-0.0639 ***	-0.0607 ***	-0.0647 ***	-0.0255	-0.0250	0.3027 ***	0.2991 ***	-0.0680 ***	-0.0605 ***
m	8.7602 ***		3.0309 ***		14.6653 ***		15.6421 ***		-0.0365		-5.7997 *		11.9167 ***	
m^2	-26.6948 ***		-6.8636		-40.5014 ***		-46.4707 ***		8.0112		8.8592		-30.0595 **	
m^3	34.8057 ***		6.3887		49.9276 **		62.4522 **		-19.1895		-2.7397		29.8424 **	
m^4	-15.1688 ***		-1.3148		-21.6636 **		-30.7609 *		11.3473		-0.0875		-11.4279	
R^2	0.8900	0.883	0.9730	0.973	0.9110	0.906	0.7720	0.759	0.8	0.8	0.828	0.828	0.715	0.72

*** significant at the 99% confidence level, ** significant at the 95% confidence level, * significant at the 90% confidence level

6. Conclusion

If per capita health care expenditure (HCE) of the elderly grows faster than that of younger people, the age profile of per capita HCE becomes steeper. More precisely, steepening of the expenditure profile means that the age gradient of HCE increases over time, possibly with an accentuation in old age.

This paper addresses steepening, analyzing Swiss social health insurance data in the 26 cantons over the time period from 1997 to 2006. The study incorporates mortality rates, a variable that has a marked impact on the age profile of HCE. At the aggregate national level, we find an average real growth rate of 3.23 percent in per capita HCE of the population under 50. Older age groups experience a slightly higher growth rate, the difference ranging between 0.9 and 1.6 percentage points. For the very old, of age 91 or older, the growth rate is significantly lower than 3.23 percent. Although we find higher growth rates for older age groups on average, a steepening of the age profile in the strict sense of an increasing age gradient cannot be observed.

The higher mortality rate explains a significant share of the high HCE of older age groups. When we include age-specific mortality rates into the regression, the coefficients for steepening increase, as expected.

At the cantonal level, large differences in the growth rate of per capita HCE for the young population arise, ranging from 0.69 percent to 5.37 percent. In cantons with low baseline growth or a low level of HCE, the growth rates for older age groups tend to be higher, while high cost cantons experience a lower growth rate of per capita HCE for older age groups compared to the population under 50. Again, a general increase in the age gradient cannot be found in the age groups older than 51.

A decomposition of HCE reveals the following effects: In hospital inpatient care and home care, growth rates for older age groups are significantly lower than for the people of age 50 or younger. For nursing home care, ambulatory care, hospital outpatient care and prescription drugs, growth is higher in old age. However, a robust pattern of increasing age coefficients in old age over time cannot be detected.

In summary, our results for the Swiss cantons provide no evidence for relevant steepening effects of age profiles for either total, or the components, of HCE over time. The call for considering steepening effects in projections of future HCE, put forward by *Buchner* and *Wasem* (2006), thus is unwarranted.

7. References

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