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Time to death and health expenditure of the Czech health care system

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Abstract:
Growing concern about future sustainability of public budgets in the context of population ageing has given rise to a large debate on the role of age in the context of health care expenditure. Growing evidence on the so called death related costs hypothesis arguing that the positive relationship between age of the cohort and related health care expenditure is the result of growing probability of death changes in an important manner the results of the projections. The aim of this paper is to explore the importance of the death related costs hypothesis in the Czech health expenditure data and the impact of the hypothesis on the projection of the financial sustainability of the Czech health care system.

Keywords: health care, last year of life, financial sustainability

JEL: H51

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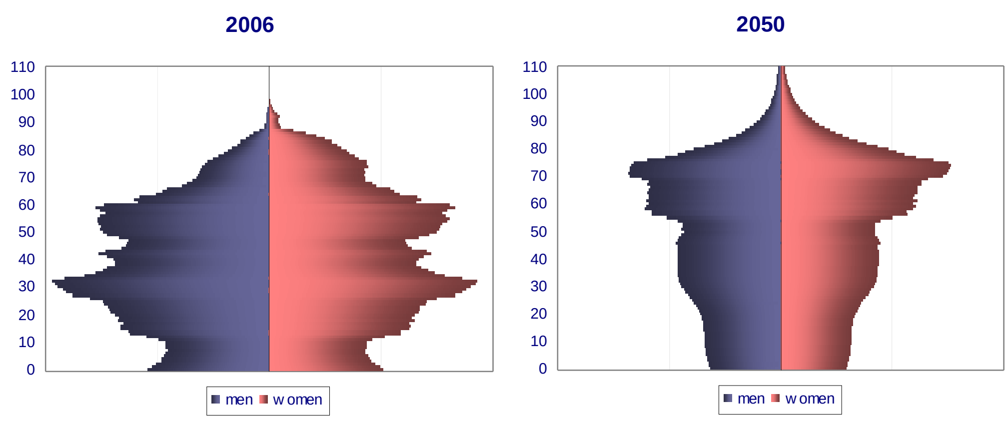
List of abbreviations

DRC	Death related costs
HCE	Health care expenditure
SHA	System of health accounts
VZP ČR	Všeobecná zdravotní pojišťovna České republiky (General Health Insurance Company of the Czech Republic)

Introduction

Growing concern about future sustainability of public health care systems has induced numerous economists to simulate changes in future spending on health care related with population ageing. The ageing problem which is the consequence of falling fertility rates coupled with increasing life expectancy has become one of the important topics in numerous developed countries where the systems of pensions and health care are extremely vulnerable to demographic changes. The Czech Republic whose pension system is based on the pay-as-you-go basis and whose health care system is financed from 91 % from public spending is extremely sensitive to changes in demographic distribution of the population. Yet the ageing problem is well visible in the Czech Republic as well. In 2050 the number of the 80+ in the Czech Republic is supposed to increase almost three times (Eurostat). After the baby-boom of the seventies the number of the new-born has decreased almost continuously. As a consequence of this development, the most common age of a person living in the Czech Republic in 2050 will grow to more than seventy years.

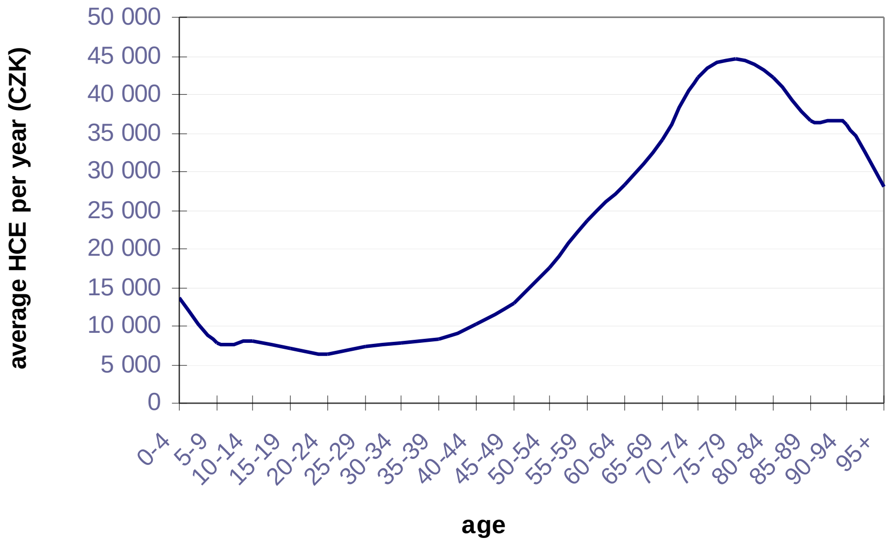
Graph No. 1: Age pyramids for the Czech Republic 2006 and 2050



Source: Czech Statistical Office and demographic prediction of Eurostat (2008)

The age pyramids (Graph No. 1) show an important change in the proportion of the elderly in the population. The most important age cohort in 2006 aged about 30 years will be 80 years old in 2050 shifting the average age of the population. A quick look at an age related health care costs profile (Graph No. 2), which shows average annual health care expenditure (HCE) by age categories, could easily lead to a conclusion that as health care costs are rising with age population ageing will lead to huge increases in health care spending in the future. We can see that the health care costs are higher in the childhood, then declining until the age of 25, since that age growing almost exponentially until 80 and then declining again.

Graph No. 2: Age-related health care costs profile of Czech men, 2007 (acute care)



Source: System of Health Accounts 2008, Czech Statistical Office

The relationship between the age of a cohort and related health care expenditures has been for a long time perceived as a causal relationship indicating the growth of need for the health care when the individual grows older. The death related costs hypothesis has proposed an alternative explanation. When the individual grows older his probability of death is growing (as everybody has to die once). As the death of a person is usually accompanied by a costly attempt to save her life we might find a positive correlation between age and health care costs in the health care system as a whole. The so called death related costs hypothesis is thus based on o high correlation between costly attempts to save the life of a person and the lack of success of the attempt – the case of death. We can thus presume that if the individual is dying his health care expenditures will probably grow.

The death related costs hypothesis has been tested in numerous studies all over the World by means of econometric methods. In the seminal paper called Ageing of population and health care expenditure: a red herring? (1999)

Zweifel, Felder and Meiers presented a hypothesis that "per capita health care expenditure is independent of population ageing" (p. 486). They used data about 6000 and 8000 deceased Swiss individuals from two major Swiss sickness funds respectively and they found insignificant effect of age on the health care costs for the individuals aged 65 +. In 2004 Seshamani and Gray found also a much bigger importance of the proximity of death then the effect of age. In a recent paper Werblow, Felder and Zweifel (2007) studied the effects of the death related costs in different components of health care expenditure finding a weak age effect among the long term care patients. The conclusion of this paper states that "most components of health care expenditure are driven not by age but by closeness to death." (p.1125)

The Ageing Working Group of the European Commission decided to include the death related costs effect in the projection of the health care costs of 2006, the OECD model of 2006 includes the death related costs effect as well. Unfortunately the lack of the data has been proven as an important problem for most of the health care costs simulations. The exceptional quality of the databases of the Czech insurance funds has enabled us to draw one of the most complex simulations of the effect of the death related costs that can be useful for all the countries where the data about the death related costs are not affordable. We hope that the Czech case could serve as a model situation for future health care costs simulations.

In the first part of the paper we test the death related costs hypothesis in the Czech data, in the second part we model the effect of the death related costs hypothesis on public health expenditure projection in the Czech Republic.

The death related costs hypothesis in the Czech data

Data

We used the data on health care expenditures of the biggest Czech health insurance fund (General Health Insurance Company, VZP ČR) in 2004, the sample included 6 990 901 individuals. The sample was restricted to individuals with positive or zero health expenditures (negative expenditures result from correction mechanisms within the fund), 35 433 observations were excluded from the sample. The sample finally included 6 955 468 individuals, 252 802 of them died within the following 3 years resulting in maximum time to death of the non survivors of 12 quarters of the year.

Unlike in other countries there are no deductibles in the Czech health care system. Moreover most of the enrolees are registered to GPs that are paid by capitation payments resulting in nonzero expenditures for 99.33 % of the enrolees. The age of the individuals is grouped into 18 five year categories in line with the system of the redistribution of the premiums.

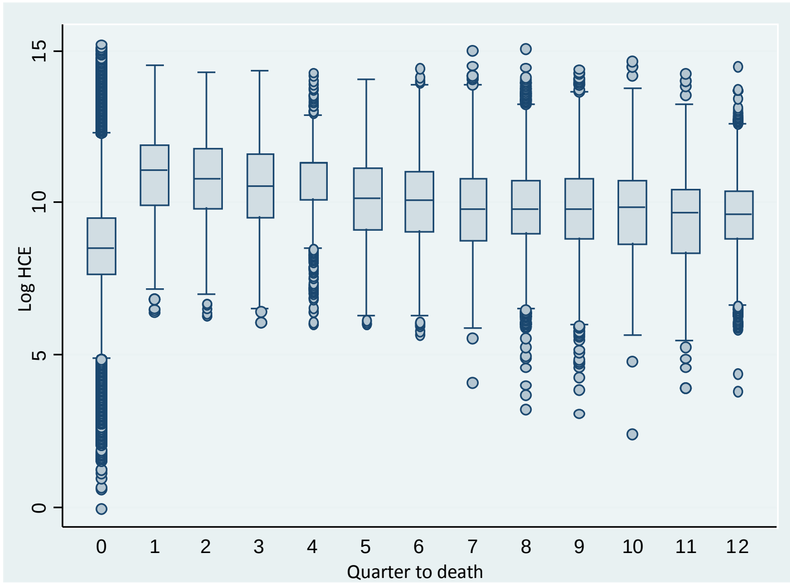
Table 1. Descriptive statistics

	Deceased (n = 252 802)		Survivors (n = 6 702 666)	
	Mean	SE	Mean	SE
share of women	0.51	0.50	0.51	0.50
age category (5 year categories, 1 to 18)	14.89	2.69	8.48	4.36
quarters to death (quarters of year)	6.39	3.48	.	.
Long term care (CZK)	12 142	42 527	1 800	12 305
Pharmaceuticals (CZK)	6 569	20 467	1 553	6 854
Acute care except pharmaceuticals (CZK)	38 154	107 665	10 500	45 728
Total HCE (CZK)	56 865	126 599	13 854	50 994

Average HCE in 2004 was four times higher for those who were going to die within the following three years, for long term care even 6.2 times higher, but the average age of the dying individuals was between 65 and 70 years compared to that of the survivors of 35 to 40 years (Table 1).

The box-plot (Graph No. 3) can best illustrate the variance of the health care costs for survivors and the deceased. In the box-plot the bottom of the filled box shows the first quartile, the line inside the box shows the median and the top of the box shows the third quartile. The outliers are defined as observations that are by more then 1.5 the inter-quartile range far from the box. The category 0 shows all the individuals in the sample that didn't die. Other numbers show time to death in quarters of the year.

Graph No. 3: Box-plot of the log HCE in 2004



Source: General Health Insurance Company (VZP ČR) database, own calculation

We can see that the median as well as the first and third quartiles of the log HCE are higher for the deceased however the highest outliers can be found in the survivor's category.

Methods

We do not use the two part model that has become a standard in the death related costs studies (see Werblow, Felder and Zweifel, 2007 and others) as we do not face the problem of the sample selection bias. The Czech health care system where the enrolees do not pay any deductible and where 92.5 % of the population is registered to GPs paid by capitation schemes (source: Institute of Health Information and Statistics of the Czech Republic (ÚZIS)) having thus minimum annual expenditure of 396 CZK does not face the problem of the lack of the data on health expenditure. In line with Werblow, Felder and Zweifel (2007) we use the OLS with robust standard errors and the GLM model with family gamma and logarithmic link. The problem of the linear models in the context of the health expenditures data that are highly skewed to the right and heteroscedastic has been largely discussed in the literature. The use of the log transformation of the HCE data that have approximately lognormal distribution is connected with the problem of retransformation, however OLS without transformation suffers from lack of robustness. The GLM models do not face the problem of retransformation but they can suffer substantial precision losses (Deb, Manning, Norton, 2006). According to Lumley, Diehr, Emerson and Chen (2002) the use of the OLS without transformation is justifiable in large public health data sets.

The dependent variable is total HCE in 2004 in CZK reported by the insurance fund. For the explanatory variables we use the set of dummy variables for the age categories, sex and quarters to death up to the number of 12. Both survivors and deceased are included in the estimation. We estimate the following equation:

$$(1)\ HCE_i = a + b.sex_i + \sum_{j=1}^{18} c_k age\ category_{i,k} + \sum_{l=1}^{12} d_l quarter\ to\ death_{i,l} + e_i\ ,$$

where j describes the age category and l time to death in quarters of year for individual i.

Results

We find significant effects of both age and death in both models; the effect of death being more pronounced than age. The R^2 of the OLS model is low but standard in health care costs analysis using demographic variables mostly. Based on the results we cannot reject the death related costs hypothesis in the Czech data.

Table 2 Estimation results

	glm HCE		OLS HCE	
	Coef.	Std. Err.	Coef.	Std. Err.
sex	0.101**	0.005	316**	33
age1	-1.015**	0.022	-19324**	164
age2	-1.499**	0.022	-23328**	152
age3	-1.438**	0.021	-22860**	153
age4	-1.514**	0.021	-23365**	152
age5	-1.509**	0.02	-23382**	151
age6	-1.239**	0.02	-21273**	153
age7	-1.386**	0.02	-22357**	152
age8	-1.226**	0.02	-21308**	154
age9	-0.957**	0.02	-18514**	163
age10	-0.646**	0.02	-14609**	174
age11	-0.676**	0.02	-14819**	157
age12	-0.295**	0.02	-7830**	166
age13	-0.257**	0.02	-6579**	168
age14	-0.001	0.021	664**	193
age15	-0.07**	0.021	-1841**	170
age16	-0.008	0.022	-227	175
age18	-0.287**	0.035	-9396**	230
1 quarter to death	1.666**	0.29	109776**	8755
2 quarters to death	2.073**	0.271	103777**	10990
3 quarters to death	1.481**	0.226	69765**	6447
4 quarters to death	1.571**	0.163	61075**	2890
5 quarters to death	1.053**	0.144	41866**	2618
6 quarters to death	1.126**	0.124	42875**	2633
7 quarters to death	0.908**	0.095	31154**	1816
8 quarters to death	0.778**	0.075	25269**	1207
9 quarters to death	0.697**	0.045	22943**	591
10 quarters to death	0.301**	0.048	8445**	424
11 quarters to death	0.218**	0.047	5792**	401
12 quarters to death	0.732**	0.044	26000**	923
_cons	10.259**	0.018	29833**	149
R^2			0.0464	
AIC	20.1496			
BIC	-1.75e+07			
number of observations	1 408 528[1]		6 955 468	

** Significant at the1% significance level

[1] A random subsample was used for the ease of estimation for the GLM specification.

Projection of the health care system financial sustainability

Data

We use the costs profiles reported by all the insurance funds to the Czech statistical office in 2006 which are collected mainly for the aim of the redistribution of the premiums between the insurance funds. The data are in the structure of five year categories. For the use of the projection they were smoothed by the kernel regression with Gaussian kernel.

The costs profiles of the deceased individuals in 2006 were collected from the biggest insurance fund in the Czech Republic (VZP ČR) reporting the multiple of the average costs of the deceased individuals based on the average costs in every five year category. The costs profile of the deceased individuals was smoothed by the means of the kernel regression as well.

The demographic prediction used in the model is the Eurostat 2008 no migration demographic projection for the Czech Republic. The demographic projection reports numbers of men and women in one year age categories in every year since 2050. The number of the deceased individuals was computed using the probability of death in every year category.

The demographic prediction by Eurostat ends in the category of 80 +, we had to lengthen the prediction until 110 for the model. We used the exponential shape of the decrease in the number of surviving individuals.

The baseline scenario

As the baseline scenario we use the pure ageing scenario methodology used by the European commission (2006). The basic simulation of the future health care spending starts with an age related health care costs profile that is applied to the demographic prediction of the population. The average health care costs for an individual of age j and sex k in 2006 are multiplied by the number of individuals of age j and sex k in every year of the demographic projection. The spending in a particular year without taking into account the growing unit costs can be described by the following equation:

(2) $\cos ts_t = \sum_{j=1}^{110} \sum_{k=1}^{2} c_{j,k} \cdot pop_{j,k,t}$

where $c_{j,k}$ are the costs per capita for each age and sex category that are given by the initial year of the prediction – year 2006 and where the $pop_{j,k,t}$ stands for number of the individuals in defined age and sex categories in year t given by the demographic prediction. We take the assumption of the unit costs growth equal to the GDP per capita growth. This assumption can be thought as the real price stability of the health care sector and is used both in the European Commission model (2006) and the OECD model (2006). The costs computed by multiplying the average costs for each age and sex category by the number of the individuals in those categories for every year are multiplied by the share of the GDP per capita in every single year to the initial GDP per capita. The final health care costs can thus be described by the following equation:

$$(3)\ \ costs\ in\ current\ prices_t = costs_t \cdot \frac{GDP\ per\ capita\ in\ current\ prices_t}{GDP\ per\ capita\ in\ current\ prices_{t=0}}$$

We use the long term macroeconomic prediction of the Ministry of finance for the prediction of future participation rate, GDP deflator and productivity growth. The GDP in the model is growing at the rate of the change in the productivity multiplied by the number of workers. We thus do not model any change in the capital-labour ratio. We can describe the method by the following equations:

$$(4)\ \ GDP\ in\ current\ prices_t = GDPdeflator_t \cdot GDP_t$$

$$(5)\ \ GDP_t = GDP_{t-1} \cdot \Delta\Big(\ prod_t \cdot (1-u_t) \cdot \sum_{i=1}^{110}\sum_{j=1}^{2} N_{j,k,t} \cdot participation\ rate_{j,k,t} - prod_{t-1} \cdot (1-u_{t-1}) \cdot \sum_{i=1}^{110}\sum_{j=1}^{2} N_{j,k,t-1} \cdot participation\ rate_{j,k,t-1}\Big)$$

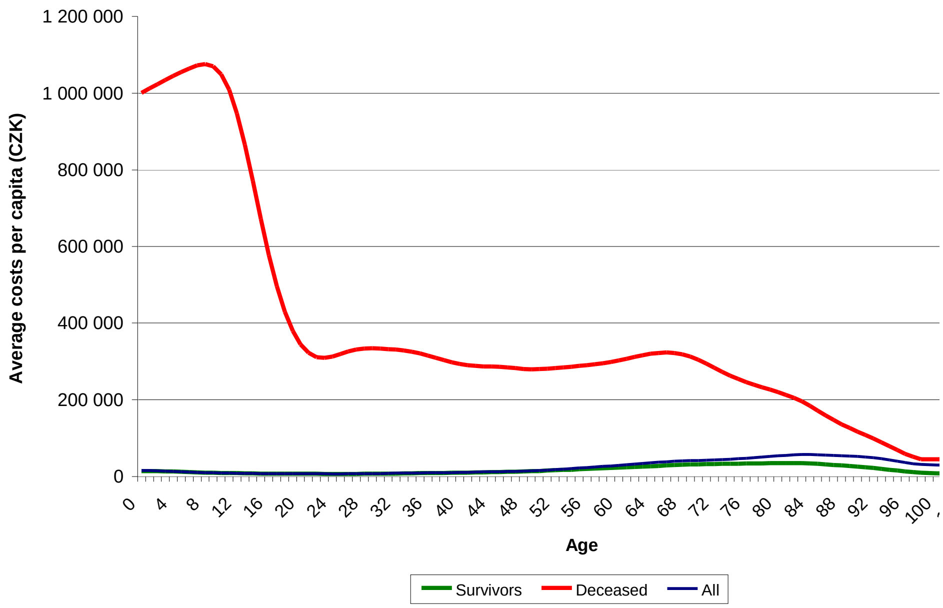
, where for every year the GDP_t stands for GDP in constant prices, $prod_t$ stands for productivity, u_t for unemployment rate and $N_{j,k,t}$ for the number of individuals of age j and sex k in the demographic prediction.

State and local budgets expenditure that is not age related such as investment in hospitals and other, which represented in 2006 11.7 % of public health expenditure (source: Institute of Health Information and Statistics) is growing at the GDP per capita rate.

The death related costs scenario

For the death related costs scenario we divide the population more than we did in the baseline scenario. We use four health care costs profiles: surviving males, surviving females, deceasing males and deceasing females. The difference between the age related health care costs profiles is shown on the graph No. 4.

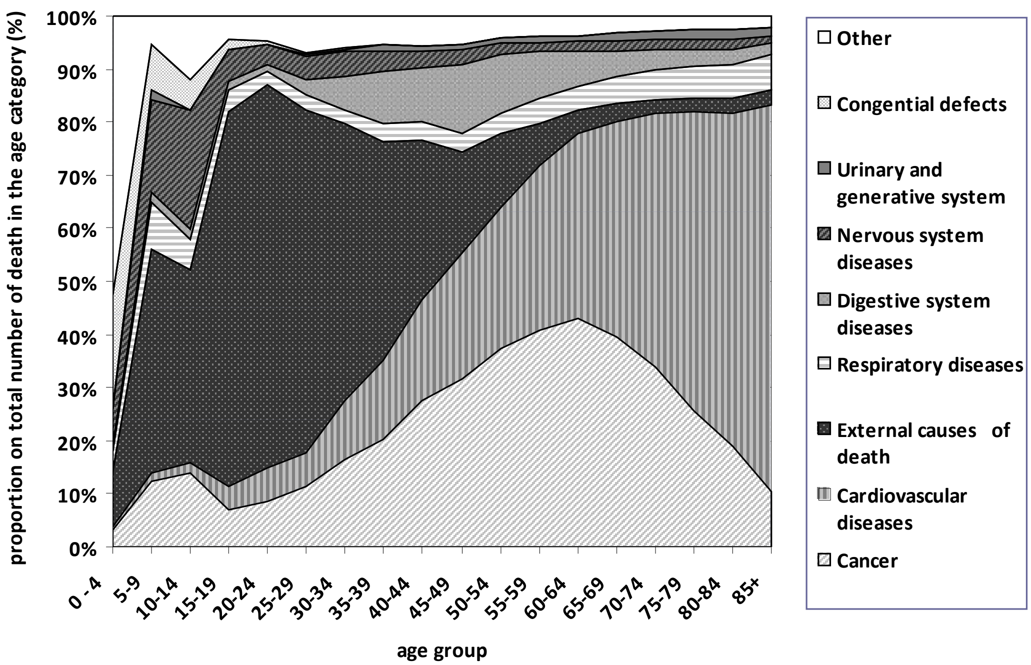
Graph No. 4: The age related health care costs profiles, survivors and deceased (acute care, men, 2006)



Source: VZP ČR database and System of health accounts (Czech statistical office), 2006, own calculation

The HCE of the deceasing individuals are partly related to the diagnosis individuals are dying at in different ages (see Graph No. 5). The health care costs are very high for children dying mostly because of congenital defects and due to very high motivation to save the life of the child. Between the age of 20 to 40 years individuals die mostly because of external causes including accidents and others. The bulk of costs at the age of 65 is related to the bulk of cancers at that age that are very costly. After the age of 65 the main diagnosis of death is gradually becoming the cardiovascular diseases for which the costs in the last year of life are lower however we cannot rule out the hypothesis that the motivation for saving the life of the elderly individual is dropping off.

Graph No. 5: Main causes of death in the Czech Republic (2005)



Source: Czech Statistical Office, www.czso.cz

The construction of the scenario is similar to the basic scenario with the difference that more health care costs profiles are taken into account. We added the costs profiles of the deceased males and females. We can describe the model by the following equation and then equation (2):

$$(6)\ \cos ts_t = \sum_{j=1}^{110} \sum_{k=1}^{2} \sum_{l=0}^{1} c_{j,k,l} \cdot pop_{j,k,l,t},$$

where the $c_{j,k,l}$ states for the costs per capita for an individual of age j, sex k and the status of a deceased person: l = 0 for survivors, l = 1 for the deceased in the year t. The $c_{j,k,l}$ are given by the initial year 2006.

The health status of the population

As proposed in the literature, the age related health care costs profiles need not remain stable over time. If the health status of the population improved in line with increasing life expectancy we may assume changes in the health care costs profiles too. According to the compression of morbidity hypothesis proposed by Fries in 1980, the growing life expectancy will be accompanied by improvements in the health status of the population. Even more than additional years of life gained by the growth of life expectancy will be spent in good health. Until now we assumed the “expansion of morbidity” scenario that has been proposed already in 1977 by Grunenberg. According to the scenario the number of years of life spent in good health will remain constant and all the additional years of life will be spent in bad health due to chronic illnesses. The “dynamic equilibrium” scenario where additional years of life are translated one to one into the years spent in good health has been described by Manton in 1982.

The European commission has proposed a methodology to model these three hypotheses about the health status of the population in health care expenditure projections. The hypothesis about the health status of the population are translated into the age related health care costs profiles which is shifted to higher ages in line with increases of the life expectancy. When translated into the age related health care costs profiles the methodology assumes that the health status is directly related to the health care costs (i.e. healthier means less costly which in reality need not be truth). According to the constant health scenario additional years of life that result from growing life expectancy will be lived in good health (the dynamic equilibrium hypothesis). The age related health care costs profiles are shifted on the right by the change in life expectancy. According to the improved health scenario people will care more about their health-status and the technological progress will unable them to gain two times more years in good health than the years gained by the growing life expectancy (compression of morbidity). The age related costs profiles are shifted by two times the change in life expectancy. The pure ageing scenario, which is the baseline, models the expansion of morbidity scenario leaving the health care costs profiles stable over the projected period.

For every year we obtain the change in life expectancy by subtracting the life expectancy of the year 2006 from the life expectancy in year t for an individual of age k and sex j:

(7) $\Delta e_{j,k,t} = e_{j,k,t} - e_{j,k,2006}$,

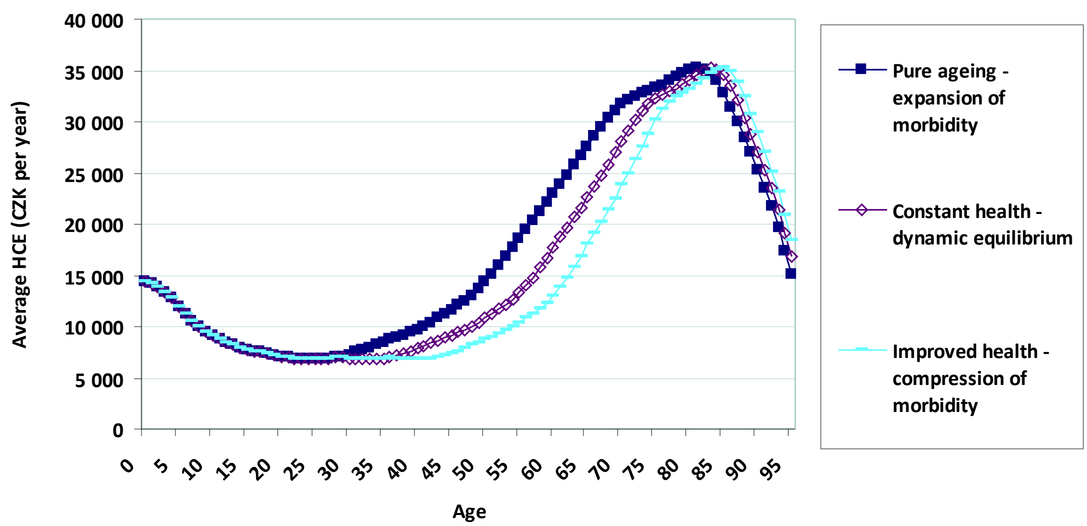
where $e_{j,k,t}$ stands for life expectancy for an individual of age j and sex k in year t. The costs per capita of an individual aged j in the year t are calculated as costs of an individual aged j minus the change in life expectancy (or minus two times the change in life expectancy for improved health scenario) in the initial year of the projection. The method can be described by the following formulas:

The constant health scenario: (8) $c_{j,k,t} = c_{j-\Delta e_{j,k,t},k,2006}$

The improved health scenario: (9) $c_{j,k,t} = c_{j-2\Delta e_{j,k,t},k,2006}$

The costs per capita thus follow the biological age of the person, not the actual age. We do not shift the costs profile as a whole because there is no reason to assume that the costs of care for children would follow the biological age and remain higher for longer part of the life than they are now. We shift the costs profile from the point of the minimum average costs (approximately age 30) (see Graph No. 6).

Graph No. 6: The health care costs profile of the acute care for men in 2050



Source: System of health accounts, own calculation

The total costs and the share of costs on GDP are then calculated using the same methodology as we have already described in the preceding sections.

For the death related costs scenario we do not shift the costs profile of the deceased individuals.

Results

The results of the scenarios are summarized in Table 2:

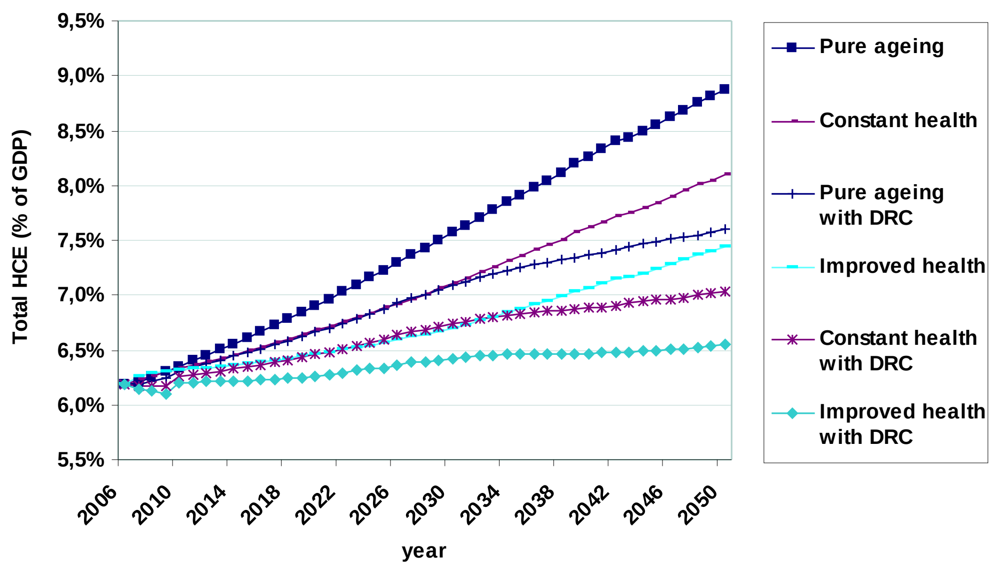
Table 3. Projection results, percentage of GDP[2]

	2025	2050
Pure ageing	7,23%	8,87%
Pure ageing with death related costs	6,87%	7,60%
Constant health	6,88%	8,09%
Constant health with death related costs	6,59%	7,04%
Improved health	6,57%	7,44%
Improved health with death related costs	6,34%	6,55%

In the pure ageing scenario without death related costs the HCE would increase between 2006 and 2050 by 43 %. When the death related costs are taken into account the increase is reduced to 23 %. If we take into account other hypothesis about the health status of the population, namely the improved health scenario, we end with an increase by only 5.8 % (Table 2).

The time path of the scenarios is shown on Graph No. 7.

Graph No. 7: Expenditure of the Czech public health care system, % GDP



[2] In 2006 the public health expenditure reached 6.19 % of GDP

Conclusion

The factor of death proved to be significant for health care expenditure in the Czech Republic by both GLM and OLS methods. Including the death related costs effect according to which health expenditure is postponed to higher age in line with the postponement of death in the projections of future health care spending changes in an important manner the results of the predictions. If moreover the compression of morbidity is taken into account almost no change of health care expenditure is projected in relation with the ageing of the population. Yet these optimistic scenarios are not supported by current trends in health care spending in most of the developed World where the trend of health care expenditure is definitely increasing. The conclusion that we can draw from these facts is or that other factors than population ageing are important for health expenditure such as technological progress or growing expectations of individuals or that the optimistic expectations of compression of morbidity and postponement of health care costs in line with postponement of death are not realistic.

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