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NEW EVIDENCE ON THE POPULATION AGEING AND HEALTH CARE EXPENDITURE FOR THE HUNGARIAN ELDERLY IN THE LAST YEAR OF LIFE

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Abstract: *The aim of the present research is to explore the extent to which age and time to death explain health care expenditure. The study is based on individual-level data of the entire Hungarian population aged 65+ deceased during a full calendar year. Based on the results of the performed regression analysis it can be stated that health expenditures are explained both by age and by the time to death, but the explanatory power of the remaining time to death is greater. The relationship between age and the health care expenditure is a negative one, the spending declines as a function of age, the most costly patients are those who die younger. The practical significance of this result is far from negligible. If time to death and not age is what explains the increase of health care costs, then future demographical aging will not have as much of an impact on health spending as previously predicted.*

Key-words: Demographic Aging, Health Care Expenditure, Time to Death, Health System, Inpatient Care, Outpatient Care, Publicly-financed Drug Prescriptions

1. Introduction

For policy makers and researchers the sustainability of future health care systems represents a topic of growing interest. There is a concern that demographic aging could create major economic pressures on health care systems. Increasing numbers of people are reaching old age, and their relative weight in the population will be greater than ever before. The undergoing dramatic changes of the age structure of the Hungarian population and of many

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other countries in Europe but also all over the world will have social and economic consequences to which the society must respond. It is expected that aging will become a global problem in the near future (Wan et al., 2016). Unfortunately, Hungary is among the oldest European societies, as after Romania, Bulgaria and Croatia the population decline caused by aging was the largest. Although we already have some certainty about the fact that demographic aging will increase the cost of health care, it is still unclear how severe the burden on the health system will be.

For decades, there has been a debate among analysts about the reasons why health spending is increasing with age. And the answer was: health deteriorates with age, and health care costs rise accordingly. In recent years, however, a paradigm shift can be observed among researchers who approached the subject, as it is recognized that the most resource-intensive period over the life-span is the end of life. Although there are some differences in the results, researchers agree that during an individual's life, most of the health care costs is accumulated in the last months before death, regardless of the individual's age at the time of death. Lately more and more studies are arguing that population aging will not have as severe consequences as previously thought, because the most significant cost occurs due to the proximity of death, and not due to old age as a condition.

The newer approach in the literature states that health expenditure does not depend on the time elapsed since birth, but on the time remaining until death. This means, when life expectancy is taken into account, health care costs do not (or only slightly) increase with age. With other words the average cost of health increases as a function of age only because, with demographic aging, the number of people closer to death increases. As life expectancy increases over time, the age-related curve of health care costs will become less steep, as in the future, 65-year-olds will not be at the same stage of their life cycle as those of a similar age a few decades earlier.

Westerhout (2014) distinguishes between a strong and a weak version of the theory. In the strictest version of the theory, life expectancy until death completely takes over the role of age as an explanatory variable. Age is thus irrelevant in explaining the increase in health expenditure (Zweifel et al., 1999, 2004; Felder et al., 2000, 2010). According to the standard approach, increasing life expectancy adds high-cost years to the age structure of health care expenditures, resulting in an increase in the average cost. In contrast, the theory of time to death argues that an increase in life expectancy shifts the age structure of health expenditure to the right by adding low-spending years, resulting in a decrease in average health expenditure.

In my opinion, the strong version may be too strict, as it is difficult to link all health expenditure only to life expectancy until death. That is, the increase in health care costs may begin years, possibly even decades, before death occurs (see, e.g., Seshamani and Gray, 2004b). Non-fatal diseases are related to age and not to the time remaining until death.

A weak version of the theory is more acceptable to me, because it does not deny the impact of age on health care expenditures, which are determined by both age and time to death. Several studies have found evidence for this version of the theory (McGrail et al., 2000; de Meijer et al., 2011; Yang et al.,, 2003; Breyer et al., 2012). In this version, the time remaining until death is the main explanatory factor for health costs in the last stage of life, and for the period before it, age is decisive.

The aim of the present research is to explore the extent to which age and time to death explain health care expenditure. In Hungary, but also in other countries of Eastern Europe there is an important knowledge gap in this topic that I aim to address in the current study. Based on individual-level data, health expenditures incurred before death have not yet been investigated in the area. For this reasons this work can be considered as a niche research that contributes to a better understanding of the impact of demographic aging on the healthcare systems in the region.

The study is based on individual-level data of the entire Hungarian population aged 65+ deceased during a full calendar year. I conducted the research on elderly individuals who had less than one year left until death. I chose this population because I assume that in their case, the high health spending at the end of life occurs most markedly, and thus the theory of time to death should be valid. But even in this case, it would take unrealistically high costs in the last years of life to prove that age does not play a role in explaining health care expenditures. If we realistically measure near-death health expenditures, per capita costs cannot be explained solely as a function of life expectancy until death, so age should also play a role. To explore the factors that affect health care expenditures I use regression analysis. The empirical equation includes the age of the analyzed individuals and their life expectancy until death as explanatory variables, so the model is suitable to quantify the impact of aging on health care costs.

2. Description of the database and methods

The data used for the research were filtered from the health insurance database managed by the National Health Care Service Center of Hungary and includes the elderly individuals (people over the age of 65), who died during 2014. The total cohort included 95 850 persons. This database comprises the pseudonymised personal care data of the entire Hungarian population with insurance. In Hungary, the situation is particularly fortunate, thanks to the single-payer insurance system, so the database is complete. Due to the universal coverage of the insurance system and to the large number of cases, I was able to draw system-level conclusions.

Of the total population I excluded from this database those who died during January 2014 because to these individuals it was not possible to assign a full monthly expenditure for this month. The final database includes a total of 87 331 research subjects from the total of 95 850 individuals, with 8 519 people dying in January.

I determined the time remaining until death for each individual by calculating how many days elapsed between 31.01.2014 and the date of death. So the time to death was measured in days, the values of the indicator vary between 1 and 334 days.

The health care expenditures included in the study cover 4 categories of benefits: outpatient care, acute inpatient care, chronic inpatient care, and prescription drugs. The analyzed expenditures are therefore limited to specialist care. In addition to the specialist care expenses, I also included in the analysis the social security benefit of medicines purchased under outpatient care. The data of primary care are not included in the database of National Health care Service Center, so I did not have access to this information. However, it should be mentioned, that general practitioner funding in Hungary is per capita based, so public expenditures do not depend on the volume of activity. Furthermore, it may also be worth mentioning that 80% of drug prescriptions are prescribed by general practitioners, so their activity can be relatively well modeled by drug costs.

In the case of each individual, I needed in a monthly breakdown the number of points for outpatient care, the weights of acute inpatient care, the number of nursing days of chronic inpatient care and the publicly-supported value of drug use.

For each social insurance identification number, the points of outpatient services were aggregated for the month January 2014. For institutions providing outpatient care (including lab diagnostics, CT and MRI), financing is based on performance principles. All interventions, medical procedures have a funding point value and a code. The points reflect the cost ratios between each intervention, these are the basis for funding.

For the weights of acute inpatient it was necessary to allocate the HBCS (Homogeneous Disease Groups i.e a local adaptation of DRGs) weight of the entire case pro rata temporis, since a nursing case could last for more than 31 days (January 2014). The same method was used to determine the number of bed days of chronic inpatient care to be taken into account for the given month prior death. In order to determine the funding basis for chronic care, the number of days per month needed to be multiplied by the weights of the specialized tasks. As a final step, it was necessary to summarize the care episodes by social insurance identification number of each individual, as there could be several episodes linked to the same identifier (either because the patient was admitted multiple times during the given month, or because the hospital case was divided between several departmental episodes).

In order to aggregate for every individual the points of outpatient care, the weights of acute inpatient care and the weighted nursing days of chronic inpatient care, it was necessary to transform them into forints (Hungarian currency). For this purpose I used the predetermined, nationwide standard fee which represents the bases of financing for the individual cases of therapy.

I supplemented the database with the social security benefit of medicines purchased under outpatient care. For every prescription were available the full price and the amount of price supported by the National Health Insurance Fund. The only task here was to aggregate the values by social insurance identification numbers, since the same patient could have obtained multiple prescriptions within the month.

3. Analysis of the impact of age and time to death on health care expenses

The aim of the study is to identify how important age and time to death are in explaining health care expenditure. Based on the literature review it can be assumed that time to death is a better explanatory variable than age. To test this hypothesis, I performed a linear regression calculation. In the model I have included the January 2014 healthcare expenditures as a dependent variable, and the explanatory variables were age and time to death (TTD) expressed in days.

The regression analysis performed yielded the following results:

Table 1: Descriptive Statistics

	Mean	Std. Deviation	N
Health care expenditures	9,564910E4	3,8155518E5	87331
Age	80,20	8,321	87331
TTD (days)	166,40	99,235	87331

Source: own calculation

The mean age of the analyzed cohort was 80.2 years, and there were an average of 166.4 days left until death (Table 1).

Table 2: Pearson's correlation matrix

		Health care expenditures	Age	TTD (days)
Pearson Correlation	Health care expenditures	1,000	-,092	-,144
	Age	-,092	1,000	-,014
	TTD (days)	-,144	-,014	1,000
Sig. (1-tailed)	Health care expenditures	.	,000	,000
	Age	,000	.	,000
	TTD (days)	,000	,000	.
N	Health care expenditures	87331	87331	87331
	Age	87331	87331	87331
	TTD (days)	87331	87331	87331

Source: own calculation

From the correlation matrix (Table 2), it can be seen that there is a weak, negative relationship between the two independent variables (age and time to death) and health expenditure (dependent variable) (correlation coefficients: -0.092, -0.144). Higher values of the time to death are associated with lower values of health care expenditures, and with age, health care expenses decrease.

Table 3: Summary of the regression model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,172[a]	,030	,030	3,7587162E5

a. Predictors: (Constant), TTD (days), Age

b. Dependent Variable: Health care expenditures

Source: own calculation

Table 4: ANOVA table of the regression model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3,762E14	2	1,881E14	1331,503	,000[a]
	Residual	1,234E16	87328	1,413E11		
	Total	1,271E16	87330			

a. Predictors: (Constant), TTD (days), Age

b. Dependent Variable: Health care expenditures

Source: own calculation

The square of the multiple correlation coefficient is 0.03, the model's explanatory power is low (Table 3). The *F*-test has a significance level of 0.000 <0.05, so the model has some explanatory power, even if it is small (Table 4).

Table 5: Estimation of regression coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	533436,286	12537,749		42,546	,000
	Age	-4297,489	152,864	-,094	-28,113	,000
	TTD (days)	-559,768	12,818	-,146	-43,669	,000

Dependent Variable: Health care expenditures

Source: own calculation

The *t*-test of the coefficients has a significance level of 0.000 <0.05 (Table 5). Since both independent variables (age and time remaining until death) as well as the constant are significant, all of them can be included in the model:

Health expenditure = 533,436.286 – 559.768 * remaining time to death – 4297.489 * age

The time to death variable has a greater explanatory power than age, since the standardized coefficient (beta) of this variable is higher (-0.146 against the -0.094 value for age).

The partial correlation coefficients were as follows:

Age: 0.008648

Time to death: 0.020592

$R^2 = 0.02924$

Partial determination coefficients:

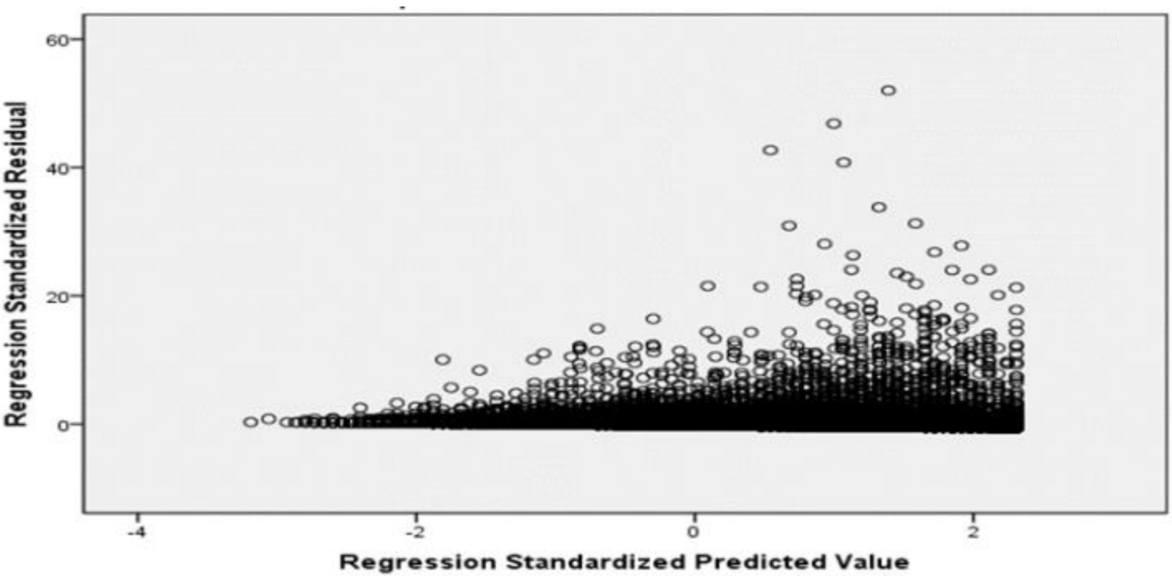
Age: 0.296

Time to death: 0.704

Based on these results, it can be concluded that health expenditures are explained in 29.6% by age and in 70.4% by the time left to death.

It can be read from the scatterplot (Figure 1) that the variance of the residues is not constant, i.e. there is heteroscedasticity.

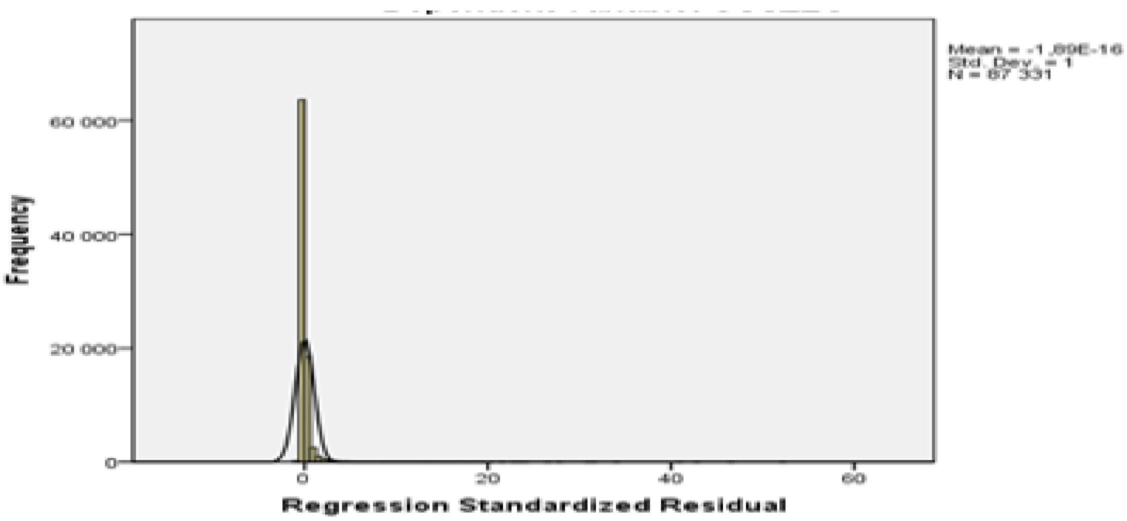
Figure 1: Scatterplot



Source: own calculation

Logarithmization would have helped solving the problem of heteroscedasticity, but it would spoil the interpretation. Logarithmization has often been used in health econometrics because it improves the normality of the dependent variable and thus the credibility of the model. Although the normality condition is better met due to the transformation, but the process causes problems when transforming back the variables.

Figure 2: Histogram of standardized residuals



Source: own calculation

The distribution of residues was plotted using the histogram (Figure 2). The error terms must follow a normal distribution, this condition is indeed fulfilled according to the figure, because the mean is close to 0 (-1.89 * 10-16) and the standard deviation is 1.

4. Methodological notes

I did not use the two-part model, which consists of a probit and an OLS regression, and is used in most studies analyzing near-death health care expenditures (Werblow et al., 2007 and others) because I did not face bias due to sampling.

The bias caused by the sample selection occurs when the research is carried out on the data of a health insurance fund and the expenses of the persons who are not insured with this given fund are equaled to zero. However, this does not rule out the possibility that individuals insured at another fund have used health services, so their expenses are not actually zero. A research which is limited to the expenditures of policyholders of a certain health insurance fund examine a non-representative population sample, i.e., over-represent those who have no expenditures (Seshamani, Gray, 2004).

However, the database used in this study includes the health care expenditures of every person over the age of 65 who died in 2014, so I did not perform the analyzes on the basis of a sample. The coverage of health insurance in Hungary was 95.2% in 2014, so the population included in the analysis can be considered representative. Therefore, I did not face any problems caused by data gaps during the analysis.

The use of linear models (such as OLS) in the analysis of health expenditures is problematic because the data show a high degree of skewness and heteroscedasticity. The logarithmic transformation of health expenditures helps to meet the normality condition of the models, will cause problems with the retransformation. OLS regression without data transformation, on the other hand, has no robustness (it does not give the best unbiased estimate when error terms do not follow a normal distribution). Lumley et al. (2002) found that the use of OLS without transformation is justified on large health databases even when the normality conditions are not met. They argue that it is widely, but incorrectly believed that the t-test and linear regression apply only to normally distributed dependent variables. When non-normally distributed data are analyzed, non-parametric tests are therefore considered appropriate.

However, nonparametric tests use rankings instead of original data. Thus, original data, measured on a metric scale, will be "dumbed down" as only their magnitude relationships are taken into account. Nonparametric tests rank the data according to which is higher than the other, but these rankings no longer reflect to what extent it is higher. Therefore, nonparametric tests were not used in the analysis.

The t-test and the linear regression compare the means of the outcome variables for different subjects. In very small samples, the comparisons will be valid if the outcome variable is normally distributed, however, the great utility of these methods stems from the fact that they are valid for any distribution in case of large samples (Lumley et al., 2002).

This conclusion is also stated by the Central Limit Theorem: if the value of any element of a population is determined by the sum of many random effects, then the distribution of the population can be considered approximately normal. In nature, many variables follow a normal distribution. In the present case, it can be stated that health expenditures are impacted by the average effect of a very high number of factors (the functioning of many genes affects its value, but other factors, such as environmental effects or eating habits, etc.).

Therefore, the applied OLS regression can be considered as a robust method in the analysis of health expenditure.

The value of R^2 is low, but it is considered standard when analyzing health expenditures because mainly demographic variables are used (Pavloková, 2009).

5. Discussion and conclusions

Based on the results of the performed analysis it can be stated that health expenditures are explained both by age and by the time to death, but the explanatory power of the remaining time to death is greater. An interesting result of the analysis shows that the relationship between age and the health care expenditure is a negative one, the spending declines as a function of age, the most costly patients are those who die younger. The practical significance of this result is far from negligible. If time to death and not age is what explains the increase of health care costs, then future demographical aging will not have as much of an impact on health spending as previously predicted.

The results of this research are consistent with most of the studies addressing this topic (e.g., Zwifel et al.,, 2004, McGrail et al., 2000; de Meijer et al., 2011; Yang et al., 2004; Breyer et al., 2012), which suggest that the explanatory power of age decreases, if “time to death” is included in the regression model as an explanatory variable.

I found evidence for a weak version of the time to death theory according to which the time to death is the main explanatory factor of the evolution of health expenditures. However, the effect of age, although much weaker, is not negligible.

The literature for neighboring countries is rather scarce. However, Pavloková’s (2010) analysis performed on data from the Czech Republic also concluded that if the time lag of near-death health care costs due to longer life expectancy is taken into account, the explanatory power of age will be lower.

The importance of “time to death” research depends on the intended use of their results. They are of great importance in predicting future health care costs affected by demographic aging. Naive predictions of health care expenditures that do not take into account the time remaining until death strongly overestimate the expected impact of population aging (Zweifel et al., 2004). My results also show that ignoring the high costs associated with death clearly runs the risk of placing too much emphasis on population aging when we want to estimate future health care expenditures. However, I agree with de Meijer et al. (2009) conclusion, according to which if the degree of disability and morbidity are taken into consideration as explanatory variables in the model, the effect of time to death becomes insignificant. Although this assumption could not be tested within the boundaries of the database, the conclusion is that life expectancy until death is nothing more than a substitute for morbidity and disability, so if the latter are taken into account in the model, the time to death becomes an unnecessary variable.

In my opinion, the positive relationship between age and health expenditure observed in previous cross-sectional research is due to the simple fact that the proportion of those in the last year or months of their lives is much higher among those aged 80 compared to those aged 65.

Forecasts that use life expectancy to death rather than morbidity/disability to estimate costs assume that an increase in life expectancy only postpones disability to older ages. Thus, the hypothesis of expansion of morbidity and compression of morbidity are not considered. Therefore, in the case of compression of morbidity, such a model also overestimates the impact of aging on health care costs. My opinion is that because the expenditure declines as age increases, the current and future increase of health care spending is explained by other factors such as: social changes, behavioral changes, technological development in health care, the Baumol mechanism (Ke et al., 2011), in welfare societies the population's desire to use newer, more effective, and possibly more expensive health technologies, and so on. As a result, medical treatment is moving further and further away from the necessary and sufficient therapies in the classical sense. My results are at some extent similar to the studies of Seshamani and Gray (2004a, 2004b) and Brockmann (2002). The authors when examining the relationship between age and the health care cost of the last period of life, showed that this relationship is not monotonic, but the near-death cost increases between the ages of 65 and 80 and then begins to. This negative correlation is caused by the combined effect of several factors: (i) the oldest are characterized by different and less costly diseases; (ii) the proportion of hospital admissions varies with age, as older people prefer home care over institutional care; (iii) physicians tend to devote scarce resources mainly to the treatment of younger people whose lives are considered to be of higher value.

Consequently, per capita health expenditure is not necessarily affected by longer life expectancy. The expected increase in mortality rates is not a driver of future increases in health care spending. Although age matters for individuals who are not in the final phase of their life, even in this case, the time has come to consider life expectancy until death in predictions.

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