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Pre- and Pro crises Financing and Inequalities in Mortality Amenable to Health Care between Small Areas of Hungary: The Last 12 Years

Introduction

Mortality amenable to health care traditionally high in Hungary, and its territorial inequalities are known to be large mirroring significant in equalities in health care provision and access to services. Our project is to investigate these inequalities in three different economic periods: in the pre-crisis period which is characterised stagnating public health spending, small increase of out-of- pocket spending and moderate level of investment into health care. The second ("crises") period is characterised huge increase in out-of-pocket expenditure while the third one is moderately increasing public health spending and massive investment Table 1).

Table 1

Change in health care spending in Hungary in absolute values (USD on purchasing parity) from public and out-of-pocket sources, 2005-2008, 2009-2012, 2013-2016 and investment into the health care sector (billion HUF)

	2008/2005	**2009/2012**	**2016/2013**
total spending*	1,02	1,18	1,08
spending from public resource*	1,01	1,13	1,09
out-of-pocket spending*	1,04	1,32	1,05
Investment into health care (Billion HUF), yearly average**	41,3	40,6	74,1

Sources: *OECD online statistics **Hungarian Statistical Yearbook, 2018

Looking at more closely, the moderately growing out-of-pocket expenditure was directed toward purchasing private services. From statistics of the Hungarian Central Statistical Office (not shown here) on health accounts revealed that through the periods studied households spent a comparable amount on specialized out-patient services (including diagnostic procedures and testing) than for medications. More detailed data on household expenditures (Table 2) proves that the major feature of the period 2012-16 was the increase of health care cost occurred in connection with out-patient services. Spending on these services increase by 176% among the poorest 10 percent of household, while their overall household income increases only by 56%,

Table 2

Rate of expenditures of households in the period 2013-16 compared to the period 2010-12 (=1,00)

	together	**1st decile**	2nd decile	**3th decile**	4th decile	**5th decile**	6th decile	**7th decile**	8th decile	**9th decile**	10th decile
Household income	**1,56**	**1,51**	1,45	**1,49**	1,51	**1,53**	1,56	**1,63**	1,62	**1,62**	1,57
Health spending altogether	**1,61**	**1,69**	1,45	**1,44**	1,50	**1,72**	1,52	**1,55**	1,70	**1,71**	1,60
Spending on medicine	**1,55**	**1,67**	1,45	**1,40**	1,42	**1,66**	1,46	**1,48**	1,65	**1,68**	1,55
Spending on out-patient care	**2,06**	**2,76**	2,51	**2,58**	2,29	**2,23**	1,87	**2,13**	2,23	**2,00**	1,89
Health spending compared to household income	1,03	1,12	1,00	0,96	1,00	1,13	0,97	0,95	1,05	1,06	1,02

Source: HCSO online statistics

Based on these statistics, we assume that morality inequalities in small area level has widened between the first and the second, and also between the second and the third periods. We also assume, that inequalities grew parallel with income and medical service availability also plays an important role.

Methods

First, indirectly age-standardized mortality rates of mortality amenable for health care was calculated for the 197 (NUTS4 level) small areas (administrative units) of Hungary for the pre-crises, crises and post-crises periods defined above. For measuring amenable mortality, we used the list of Nolte and McKee (2010).

In order to measure the force of accessibility to services, we designed the "Center" proxy variable. By this variable we denote those NUTS4 level administrative units in which the centre of the NUTS3 level unit is located. In these centres availability of medical services is known to be better.
We obtained area level income (as average tax paid) for the year 2009.
In order to evaluate if mortality rates diverged or converged, we obtained Beta-convergence measure and to test the role of income, we performed its conditional version. Convergence and divergence are studied by applying the concepts of different econometric techniques (standard OLS, weighted OLS, and spatial regression methods) to test for absolute and conditional beta-convergence in mortality. The concept of beta-convergence relates the change in mortality rates to the initial level implying an inverse correlation between the starting values and the rates of change. In these models a common steady state in economic development results from the law of diminishing returns of capital inputs. Similarly, health status convergence across regions could be caused by diminishing returns to factor inputs in a regional health production function (Gächter-Theurl, 2011). For absolute beta convergence the following statistical model has been fitted:

$$ln\left(\frac{y_{i,T}}{y_{i,0}}\right) = \alpha + \beta \cdot \ln\left(y_{i,0}\right) + \varepsilon_i,\ \varepsilon = N(0,\sigma^2)$$

where $y_{i,T}$ is the age standardized mortality ratio in subregion i at time T and $y_{i,0}$ is an initial level mortality ratio in subregion i, β is regression coefficient, its sign indicates whether regions are converging or diverging, while ε_i represent the error term, and α is intercept parameter.
Conditional beta convergence is just an extension of the former equation.

In every case the error term of OLS models showed strong significant autocorrelation measured by Moran index, therefore the independence assumption was not fulfilled. Different type of spatial regression models (Golgher and Voss, 2016, Elhorst 2010) were used separately for males, females and total in order to eliminate autocorrelation and to obtain unbiased estimation. In males the spatial error, while in females the spatial durbin model described best manner the underlying spatial processes. Spatially lagged errors model (SEM) is specified by the following equations:

$$ln\left(\frac{y_{i,T}}{y_{i,0}}\right) = \alpha + \beta \cdot \ln\left(y_{i,0}\right) + \gamma \cdot z_{i,0} + u_i,\ u_i = \lambda W u_i,\ \ \varepsilon = N(0,\sigma^2)$$

where λ is the coefficient expressing the average strength of spatial correlation among the error terms (conditional on *W*) and W is the spatial weight matrix representing the spatial interactions of neighbour influences among the residuals. Here spatial weight matrix is row-standardized, neighbourhood relationship based on first order queen contiguity.
The spatial Durbin model (SDM) is given as:

$$ln\left(\frac{y_{i,T}}{y_{i,0}}\right) = \rho W \cdot ln\left(\frac{y_{i,T}}{y_{i,0}}\right) + \ \alpha + \beta \cdot \ln\left(y_{i,0}\right) + \gamma \cdot z_{i,0} + W \cdot z_{i,0}\xi + e_i,\ \ \varepsilon = N(0,\sigma^2)$$

where ρ is the coefficient for the endogenous variable $Wln\left(\frac{y_{i,T}}{y_{i,0}}\right)$, a variable representing the function of neighbouring values of the dependent variable. $Wz_{i,0}$ is a spatially lagged independent variable, ξ is its coeffici[1]ent vector.

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[1] Gächter, Martin – Theurl, Engelbert (2011): Health status convergence at the local level:
empirical evidence from Austria. International Journal for Equity in Health 2011, 10:34
http://www.equityhealthj.com/content/10/1/34

Golger, André Braz – Voss, Paul R. (2016): How to Interpret the Coefficients of Spatial Models: Spillovers, Direct and Indirect Effects. Spatial Demography, 4:175–205

Elhorst, Paul J. (2010): Applied Spatial Econometrics: Raising the Bar. Spatial Economic Analysis, 51(1): 9-28.

Results

The indirectly SMR for small areas for the crises period are shown in Figures 1 (males) and Figure 2 (females).

Figure 1

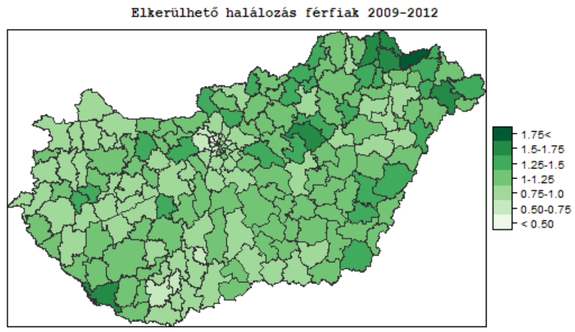
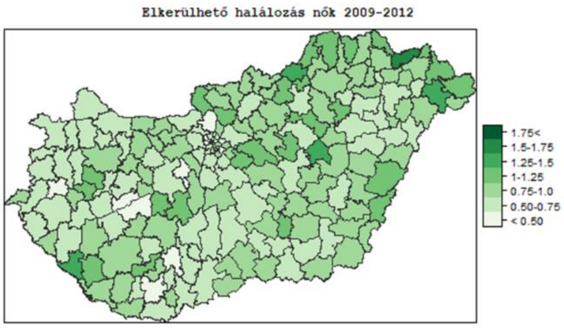


Figure 2



As simple dispersion measures for the ASDR, for rate ratios we found increasing inequalities among women both between the first and second, and the second and third periods (3,0; 3,2; 3,6). For men an increase (4,0 to 4,9) was followed by a decrease (to 4,5). Standard deviation, however, showed continuous increase both for men and women.

As the result of the regression models we focus only on the estimations of conditional models of amenable mortality for males and females. In the extended models we included two exogenous variables: the income tax and the dummy variable "Centre".

For men, the spatial error model (Table 3), for women, the spatial Durbin model (Table 4) proved the best model indicated by the lowest AIC (Akaike Information Criterion) values.

Table 3

Variables	Unconditional models			Conditional models		
	OLS	Weighted OLS	Spatial Error	OLS	Weighted OLS	Spatial Error
Intercept	0.006 (0.008)	-0.002 (0.008)	0.007 (0.012)	0.788 (0.462)	0.846* 0.409	0.892† 0.513
SMR$_{t0}$	-0.099* (0.041)	-0.051 (0.038)	-0.118* (0.046)	-0.211*** 0.054	-0.184*** 0.052	-0.220*** 0.058
Income				-0.104† (0.063)	-0.111* 0.055	-0.118† 0.070
CENTR				-0.046 (0.029)	-0.052** 0.019	-0.036 0.028
λ			0.272**			0.219*
Moran *I*	0.123**			0.094*		
F statistics	5.971*	1.825		6.000***	7.39	
LMerr	7.789**			4.507*		
LMlag	6.455**			4.08*		
RLMerr	3.574†			0.444		
RLMlag	2.239			0.016		
AIC	-259.927	-245.222	**-264.75**	**-267.565**	-260.812	**269.71**
Adjusted/pseudo R^2	0.025	0.009	0.063	0.071	0.089	0.104
N	197	197	197	197	197	197

Convergence parameters for each model did not differ significantly, except for women, where the effect estimated by the spatial Durbin model was twice that of OLS and weighted OLS. More precisely, the growth rate of mortality depends more strongly on the initial values of mortality.

The more complex model for women implies that the growth rate in mortality depends not only on the initial level of mortality but also on the average initial value of neighbouring localities. Among the exogenous explanatory variables, "income" accelerated the decrease of mortality for males only at 10 percent level in error model, but was not significant in any female model.

The "Center variable" was only significant in the weighted models, for males and females both.

Table 4

Variables	Unconditional models			Conditional models		
	OLS	Weighted OLS	Spatial Durbin	OLS	Weighted OLS	Spatial Durbin
Intercept	0.015 (0.011)	-0.002 0.010	0.007 (0.011)	0.660 (0.544)	0.555 (0.428)	-0.870 (0.749)
SMR_{t0}	-0.193** (0.059)	-0.117* (0.053)	-0.374*** (0.068)	-0.280*** (0.068)	-0.228*** (0.064)	-0.440*** 0.073
Income				-0.086 (0.074)	-0.071 (0.057)	-0.173 0.114
Centr				-0.047 (0.036)	-0.060* (0.023)	-0.039 0.036
$W * \text{SMR}_{t0}$			0.457*** (0.101)			0.539*** 0.121
$W *$ Income						0.295* 0.147
$W *$ Centr						-0.058 0.069
λ						
ρ			0.213† (0.103)			0.218* (0.103)
Moran *I*	0.101*			0.109**		
F statistics	10.9**	4.83*	-	6.284***	6.831***	-
LMerr	5.238***			6.093***		
LMlag	1.939			2.167		
RLMerr	20.52***			16.538***		
RLMlag	17.22***			12.612***		
AIC	-165.476	-174.508	**-183.162**	−169.128	**-185.566**	-182.9
Adjusted/pseudo R^2	0.048	0.019	0.151	0.075	0.082	0.184
N	197	197	197	197	197	197

Discussion

The seemingly contradicting results for processes of convergence or divergence are likely interpreted as follows. Most of the (relatively) high mortality areas showed converging movement toward the mean mortality level whereas some smaller groups of high-mortality areas (with relatively numerous population) moved away further from the mean. These areas can be identified as "Punoki", "Ózdi" and "Záhonyi" small areas, all of them located in the Northern Eastern boundary region.

In this preliminary analysis we presented the very first step of our analytical plan. As it was raised in the introduction, the uneven distribution of health care capacities can be largely responsible for the inequalities in amenable mortality in small area level, and this assumption was reinforced by the regression results, though only though the results connected to a crude measure of density of medical services.

The recent paper is the first piece on reporting on our project "Patients' pathway in the Hungarian health care" (Funded by the National Research Development and Innovation Office). In this research programme we aim to describe the role of health care provision in terms of capacity, accessibility and some quality feature of care in amenable mortality. In this first attempt we outlined the major tendencies of amenable morality at NUTS4 level. In the first step we tried to consider the role of income in the convergence process. In the coming steps we are also going to examine the role of the differences in health care provision using sophisticated indicators of it and also the role of investment into health care infrastructure.