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Roots In Health Disparities Among European Regions

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Abstract
Study Design: This is a descriptive and prediction approach to MINDEX.
Methods: We use factor analysis to measure MINDEX and blocks of predictors (competitiveness and urbanization of regions). Multiple regressions to predict the key dependent variables are used to predict the validity of the measurement model.
Results: Competitive and urbanized regions have a better health status. Even if one controls for these two families of factors, the country context counts significantly from the statistical point of view. Five categories of countries influence the health patterns of regional populations in the EU.
Conclusion: The key contribution of the article is to validate the new index by descriptive and predictive analysis.

Keywords: social, human, cultural, natural, built, financial and political

Introduction

Is there a health capital at the level of territorial units? The inventory made at the local community level [1] does not include health status among the seven forms of community capital (social, human, cultural, natural, built, financial and political) but only in the series of problems that may arise, related to poverty and health. Health could, however, be included in the series of capabilities that define human capital. And it is effectively included later in the series of defining capabilities for human capital [2]. Such capital can be identified for the population not only at the level of the localized community but also for regions, states, networks of localities, etc. Implicitly, such a conception is also adopted in the case of the Human Development Index promoted by UNDP since the 1990s [3]. Along with education and economic or material capital, health status, estimated by life expectancy at birth, is included as an essential component of the human development index at the societal level. What if you don't have an estimate of life expectancy at birth for the reference territories? In this case, we would like to estimate the health status capital by NUTS-type regions (from the French nomenclature des unites territorials statistiques) of level 3 in the European Union. EUROSTAT data give estimates of life expectancy (LE) for NUTS 2 tier 2 regions [4] but not for NUTS 3. The substitute that can be used, and we have resorted to in this case, was to identify a set of indicators strongly associated with life expectancy at birth but for which calculation data are available at NUTS 3 level. These are standardized mortality ratio (SMR), under-five mortality rates (Under5R), and overall mortality rate (GMR). From these indices, we generated a synthetic mortality index (MINDEX) that integrates the three indices.

In addition, it is important to be able to specify the validity of the mentioned indicators. To what extent can we explain the changes in population health status between NUTS 3 regions by reference to MRS and associated indicators such as overall mortality rate and under-5 mortality rate? If we calculate a mortality index as a factor score that aggregates SMR, overall mortality rate (GMR) and under-five mortality rate (Under5R), is this summary index (MINDEX) an appropriate measure of health status at NUTS 3 level? We will give such validation our interest in the material that follows. The focus will be on predictive or nomological validation [5] given by the ability of different indicators to predict the values of the new health status index. The enterprise deserves to be carried out to better understand the significance of different measures of population health status at the regional level. Once the quality of human life asocial and health status has been measured by MINDEX and associated indices, successive aggregations through population-weighted averages of the region can be switched to estimates for higher measurement levels, NUTS level 2 or national, if the initial estimate was made correctly for NUTS 3.

Methods

The complexity of population health phenomena obliges the use of multiple indicators to measure the health status of the population. As already mentioned, in the introduction, to achieve this requirement we have added to the SMR index two more indices related to the general mortality rate (GMR), and the mortality rate of children under 5 years (Under5R). The mortality index we use (MINDEX) is a factorial score resulting from the aggregation of the three mentioned indicators (SMR, GMR and Under5R). The three indicators measure the same latent factor, namely the health status of the population at NUTS level 3 (KMO=0.595). The factor score coefficients are close to 0.499 for SMR, 0.448 for GMR and 0.415 for Under5R. To estimate MRS at the NUTS 3 level, we used appropriate EUROSTAT data available for 2019, before the COVID-19 crisis. That index is calculated as the percentage ratio between the mortality observed at the level of the unit of interest and that expected under the assumption that the mortality rates at the level of that unit are the same as those recorded at the level of a reference territorial unit, the same for all the units of interest that we want to be compared. In this case, we applied the mortality rates at the European Union level for the five-year age groups, from 2019, to the population figures on NUTS 3, by five-year age segments. Adding up the expected death figures for age groups in the same region yielded the total number of deaths that would be expected there if mortality rates were those at the EU level. The MRS for a given region resulted from multiplying by 100 the ratio between the number of observed deaths and those expected for the region of interest. The other two indicators - GMR and Under5R - are calculated, for 2019, also using EUROSTAT data. In the validation analyses, we used both the MINDEX toothed index and the mentioned component indicators.

A first validation of health indices determined by reference to mortality is performed descriptively, followed by predictive validation, by multiple regression analysis. We present them below, not before specifying the starting assumptions. We expect regional health status to vary relative to three reference frameworks - socio-economic competitiveness, density and different national contexts of competitiveness and density. The first hypothesis (H1) argues that caeteris paribus, mortality indices tend to be lower in regions competitive by their economic performance, education, net migration and employment, integrated as such by a factorial score calculated for NUTS 3 regions in 2019. The second hypothesis (H2) supports the idea that mortality is lower in regions with a high level of urbanization due to the rural-intermediate-urban character of the region, population density and the presence of the country's capital city within the reference region. The third hypothesis (H3) argues that there are specific national contexts beyond competitiveness and urbanization that matter in determining the health status of the population. The three hypotheses specify three frameworks or environments for conditioning the health status of the population at the level of regions, namely the frameworks of competitiveness, urbanization and national society. The idea for this framework for conditioning the health status of regional populations comes from a previous approach in which the three mentioned characteristics have already been operationalized and applied in estimating the variations of the regional human development index. In addition, a good measurement of health status at the regional level can help inform policies to reduce territorial disparities in population health status [6].

From the previously formulated hypotheses, it follows that the measurement of the health status of the population is thought together with the determinants of this state. Linking them, as far as the data we have at the NUTS 3 level allows, will essentially be done through multiple regression models as a technical way of relating determinants and outcomes of health status. Unfortunately, we do not have data on health care as a direct determinant of population health, nor regional morbidity indicators at the NUTS 3 level. To test the sensitivity of the analysis model [7] to changes in methodology, we will slightly vary the series of predictors in multiple regression analyses. To the extent that minor changes do not lead to major changes in the series of results, I shall consider that there is an additional argument in favour of the fidelity of the model of analysis adopted. Next comes the descriptive part given by the intersection of mortality index (MINDEX) with life expectancy at birth (LifeExpect) aggregated at the country level. MINDEX country averages are calculated as national averages by weighting that index with the population of the region. By comparing the country values of the newly calculated mortality index with life expectancy at birth, we will obtain the first information on the validity of the mortality index. A strong negative relationship between the two measurements is expected and a first indication of how EU countries are clustered in terms of their health status. Later we will present the prediction results of MINDEX and its component indices. In the next section, we discuss the net country effect on mortality indices. In conclusion, we summarize the main findings.

Results

As expected, even with nationwide data, the increase in life expectancy at birth is accompanied by a decrease in the mortality index. The worst health status is recorded in former communist countries, with the status of New Member States in the European Union (EU). Especially in Bulgaria, Romania, Hungary had the worst health status in 2019, in terms of high mortality index and low life expectancy at birth. Slovakia, Hungary and Poland also have a problematic health situation, placed in the same quadrant of high mortality and low life expectancy at birth. They are also from the category of new EU Member States.

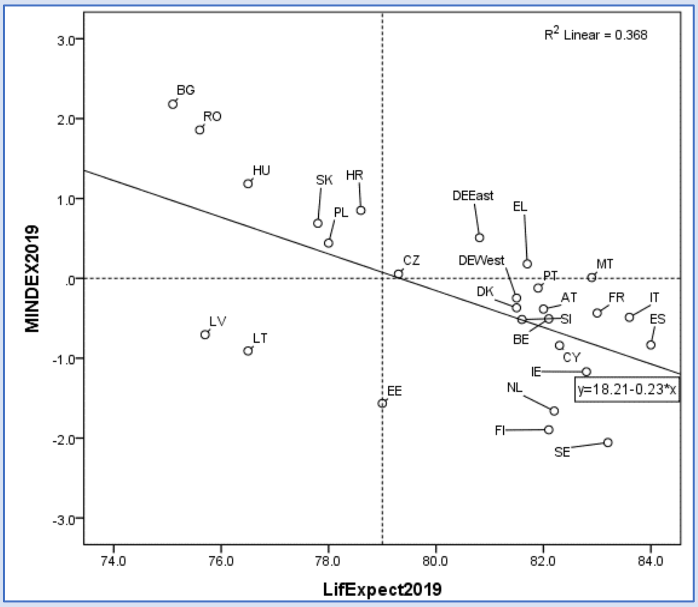

Figure 1: A spreadsheet diagram of the EU countries by life expectancy and index of mortality 2019.
Data source: *EUROSTAT. Own computations. Values for East (DEEast) and West (DEWest) Germany were computed by the author, knowing what the NUTS 3 about each of the two German regions.*

At the opposite end, with low mortality and increased life expectancy at birth, are old EU Member States. In this category, three groupings are distinguished. The first grouping consists of or close Nordic countries, namely Sweden, Finland, the Netherlands and Ireland. Spain, Italy and France form a second grouping, predominantly located in the South, with high life expectancy at birth, but with mortality rates close to the EU average. Denmark, West Germany and Austria form a third grouping, with high life expectancy at birth but mortality rates close to the European average. Otherwise, there are specific situations, and groupings with a small number of countries. Latvia and Lithuania, for example, have low mortality but relatively low life expectancy at birth. The regions of East Germany are in worse health than those of West Germany, but better than those of Bulgaria, Romania and Hungary, for example. We will see if country groupings maintain a similar configuration when the country effect can be isolated or controlled by multiple regression. Assumptions 1 and 2, mentioned in the methodology section, are supported by multiple regression analysis when the dependent variable is MINDEX. Competitiveness and high-level urbanization tend to lead to lower regional mortality (Table 1).

Table 1: Predicting health status at NUTS 3 level.

Predictors	Mortality Index 2019 NUTS3		Standardized Mortality Ratio 2019 NUTS 3		Under 5 Years Old Mortality Rate 2019 NUTS3		General Mortality Rate 2019 NUTS3	
	Coeff	P>t	Coeff	P>t	Coeff	P>t	Coeff	P>t
Competitiveness NUS2	-0.136	0.000	-0.970	0.566	-0.159	0.000	0.264	0.054
Urbanization NUTS 3	-0.221	0.000	-1.595	0.011	-0.019	0.064	-0.982	0.000

SE	-1.913	0.000	-99.843	0.000	-0.119	0.002	-2.442	0.000
FI	-1.788	0.000	-100.595	0.000	-0.198	0.000	-1.238	0.001
NL	-1.309	0.000	-97.639	0.000	0.302	0.000	-1.810	0.000
IE	-1.174	0.000	-8.902	0.001	-0.196	0.001	-4.608	0.000
LT	-0.920	0.000	-100.984	0.000	-0.157	0.149	3.268	0.000
DK	-0.228	0.044	4.134	0.134	-0.055	0.394	-1.220	0.016
SI	-0.474	0.001	2.531	0.380	-0.206	0.074	-1.546	0.000
FR	-0.372	0.000	-13.952	0.000	0.074	0.022	-1.476	0.000
AT	-0.610	0.000	-5.485	0.014	-0.156	0.012	-2.007	0.000
ES	-0.721	0.000	-16.682	0.000	-0.191	0.000	-1.593	0.000
IT	-0.553	0.000	-13.038	0.001	-0.412	0.000	0.369	0.243
BE	-0.172	0.079	-3.600	0.095	0.098	0.211	-1.267	0.000
EL	0.042	0.688	-2.667	0.392	-0.041	0.537	0.651	0.041
PT	-0.040	0.774	-1.500	0.690	-0.218	0.005	1.169	0.021
CZ	-0.007	0.945	21.735	0.000	-0.193	0.000	-0.494	0.082
PL	0.378	0.000	27.969	0.000	0.013	0.800	-0.084	0.772
GDR	0.492	0.000	6.588	0.000	0.082	0.000	1.707	0.000
SK	0.527	0.024	32.513	0.000	0.261	0.240	-1.105	0.010
HR	0.931	0.000	34.378	0.000	0.012	0.934	2.459	0.000
HU	1.252	0.000	51.776	0.000	0.035	0.685	2.812	0.000
RO	1.605	0.000	50.581	0.000	0.393	0.000	2.737	0.000
BG	2.307	0.000	66.068	0.000	0.350	0.009	5.931	0.000
_Constant	0.077	0.065	99.829	0.000	0.763	0.000	11.371	0.000
R2	0.756		0.888		0.408		0.602	
N	1106		1106		1106		1106	

Data source: *EUROSTAT. Own computations. OLS regressions in STATA 16. Robust standard errors. Colinearity effects, identified by VIF command in STATA, were avoided by eliminating dummies of counties generating VIF that are higher than 4. Very small countries like MT, EE, LV, CY were eliminated from the series of country predictors. West Germany was also eliminated from the list of predictors to avoid collinearity. Shadow marks significant coefficients for p<0.05. Urbanization and competitiveness are factor scores in a separate PCA. Urbanization factor aggregates urbanity of NUTS 3, density, and having not the capital city of the country in the reference NUTS region. All the variables for the factor score competitiveness are measured at the NUTS 2 level. It aggregates regional competitiveness, education of the population of more than 25 years old, net migration rate, and NEET measures the percentage of people 15-29 years old that are neither in employment nor in education institutions.*

On the component indices of MINDEX, the impact is differentiated. It is not clear why the standardized mortality rate (SMR) is not lower in regions with increased competitiveness (the corresponding regression coefficient is not statistically significant). It is also unclear why increased regional competitiveness tends to lead to a higher overall mortality rate. Both deviations from theoretical expectations seem to confirm the idea that measuring by multiple indicators (such as MINDEX) is better than measuring health by single indicators. Of the three mortality indices, the one that comes closest to the synthetic index pattern (MINDEX) is the standardized mortality ratio. The other two (Under5R and GMR) are more affected by the age structure of the population, uncontrolled in the regression equation in Table 1 to avoid collinearity effects. But what if we replace, in the regression model, synthetic indices related to competitiveness and urbanization with the main component indicators of the factorial score? In other words, to test the sensitivity of the analysis model (Treiman 2014) to methodological changes in work, we replace the factorial score of competitiveness with the gross domestic product per capita, the level of education and net migration, and the factorial score of urbanization with the degree of urbanization of the NUTS 3 region (1 urban, 2 intermediate, 3 rural). We have made this change and present the results of the analysis in Table 1 of the Annex. The results appear of identical significance when MINDEX is considered as a dependent variable. Even if we replace the factorial scores in the predictors with the component indicators, the meaning of the relationships remains the same. MINDEX tends to be lower for NUTS 3 where economic development, education stock and migratory attraction are higher and urbanization higher. For SMR, the only statistically significant predictor in the new Annex 1 variance is education level. The higher the education level of the population in the NUTS 3 region, the lower the MRS. The mortality of children under 5 tends to be lower for more economically and socially developed regions.

What is the country's effect on the health of the population if we keep under control, relatively constant, the values of competitiveness and urbanization? This question is answered by all the data in Table 1 and Annex 1 of the article.

With the analysis in Table 1, country groupings, as a type of effect on health, appear clearer but consistent with the predictions in the bivariate analysis (Figure 1). The new EU Member States appear as two groupings with significant mortality bias effects. Bulgaria, Romania, Hungary and Croatia are the countries with the maximum effect of poor health, followed by Slovakia, Poland and the former German Democratic Republic. As in the bivariate analysis (Figure 1), in the multivariate analysis appears a precisely defined grouping of countries with maximum positive impact on health, consisting of Nordic countries or close to them, namely Sweden, Finland, Ireland and the Netherlands. Also, with a positive impact on health are grouped separately the southern countries, Italy and Spain, but also those close to them, also from the Old EU Member States, respectively France and Austria. Belgium, Portugal, Greece and the Czech Republic appear as countries without a specific significant effect on health. Replacing the two predictors related to competitiveness and urbanization with key component indicators (compare Table 1 in the article with Table 1 in the Annex) does not lead to major changes in the configuration of country effects on mortality indicators. In extreme groupings of countries that contribute to increased mortality (BG, RO, HU, HR, GDR, PL) or to its reduction (SE, FI, NL, IE) no major changes occur in the series of regression coefficients for MINDEX prediction. The exception is the case of Slovakia, where we no longer record, in Annex 1, a significant increase in mortality. However, there are cases of changes in coefficients in some intermediate cases. Denmark, for example, in the new Annex 1 run no longer appears as a significant predictor for mortality reduction.

Annex 1: An alternative model to predicting health status at NUTS 3 level.

Predictors	Mortality Index 2019 NUTS3		Standardized Mortality Ratio 2019 NUTS 3		Under 5 Years Old Mortality Rate 2019 NUTS3		General Mortality Rate 2019 NUTS3	
	Coeff.	P>t	Coefficient	P>t	Coeff.	P>t	Coeff.	P>t
GDP per Capita % UE Average 2019, NUTS2	-0.003	0.000	0.024	0.154	-0.002	0.000	-0.008	0.000
Tertiary Educ.2018 NUTS2	-0.021	0.000	-0.775	0.000	-0.006	0.001	-0.021	0.081
Net Migration Rate 2018 NUTS2	-0.022	0.000	-0.090	0.489	-0.007	0.008	-0.069	0.000
Urban (1)- Rural (3) Classify. NUTS 3	0.101	0.000	0.468	0.432	-0.040	0.001	0.766	0.000
SE	-1.510	0.000	-90.625	0.000	-0.012	0.777	-1.543	0.000
FI	-1.466	0.000	-89.902	0.000	-0.089	0.145	-0.904	0.044
NL	-1.258	0.000	-92.541	0.000	0.257	0.000	-1.644	0.000
IE	-0.382	0.028	3.441	0.176	0.309	0.002	-4.180	0.000
LT	-0.889	0.000	-90.606	0.000	-0.094	0.372	2.331	0.000
DK	0.047	0.714	11.582	0.002	0.110	0.166	-1.250	0.024
SI	-0.495	0.001	6.899	0.020	-0.227	0.054	-1.851	0.000
FR	-0.274	0.000	-7.927	0.004	0.158	0.000	-1.870	0.000
AT	-0.466	0.000	-3.164	0.092	-0.062	0.270	-1.947	0.000
ES	-0.634	0.000	-10.071	0.000	-0.120	0.001	-2.003	0.000
IT	-0.728	0.000	-18.223	0.000	-0.290	0.000	-0.917	0.000
BE	-0.024	0.820	5.140	0.099	0.167	0.043	-1.504	0.000
EL	-0.106	0.263	-0.158	0.957	-0.035	0.588	-0.363	0.188
PT	-0.263	0.055	-2.116	0.457	-0.181	0.006	-0.208	0.685
CZ	-0.264	0.002	19.087	0.000	-0.203	0.000	-1.623	0.000
PL	0.151	0.033	31.440	0.000	0.047	0.170	-1.760	0.000
GDR	0.461	0.000	6.357	0.000	0.027	0.007	1.892	0.000
SK	0.243	0.235	30.628	0.000	0.297	0.157	-2.704	0.000

HR	0.734	0.001	35.368	0.000	0.127	0.351	0.651	0.187
HU	0.979	0.000	49.337	0.000	0.079	0.296	1.260	0.000
RO	1.288	0.000	45.558	0.000	0.569	0.000	0.356	0.305
BG	2.172	0.000	68.906	0.000	0.481	0.000	4.242	0.000
_cons	0.859	0.000	117.590	0.000	1.187	0.000	11.798	0.000
R2	0.771		0.897		0.428		0.552	
N	1149		1149		1149		1149	

Data Source: *EUROSTAT. Own computations. OLS regressions in STATA 16. Robust standard errors. Colinearity effects, identified by VIF command in STATA, were avoided by eliminating dummies of counties generating VIF that are higher than 4. Very small countries like MT, EE, LV, and CY were eliminated from country predictors. West Germany was also eliminated from the list of predictors to avoid collinearity. Shadow marks significant coefficients for p<0.05.*

Discussion

The health status of the population is strongly structured at the level of NUTS 3 European regions. The essential reference frameworks in structuring it appear to be strongly associated with urbanization, competitiveness and the large geographical-historical groupings of nation-states. If health status is no longer measured cumulatively, by several mortality indicators, regularity is no longer maintained. This finding follows the recommendation to use the composite mortality index (MINDEX) as the preferred measurement for regional health status, compared to single, non-cumulative indices, such as SMR, the overall mortality rate has mortality rates of children under five years of age. The urbanization and increased competitiveness of regions induce, caeteris paribus, better health. The country's effect on the health status of the population remains significant and strongly differentiated. What was behind this regularity is likely the state of health services associated with the type of health culture, both aspects were not measured directly in the analysis. These country effects on the health status of regional populations allow five types of countries to be distinguished. At one extreme are Nordic countries or close to them with very good regional health, such as Sweden, Finland, the Netherlands and Ireland. At the opposite pole, with poor health and, implicitly, high mortality, are regions from the former communist countries – Bulgaria, Romania, Hungary, Croatia, Slovakia, the former German Democratic Republic and Poland. Between the two extremes already mentioned, we have identified a grouping of states with regions that do not have a significant impact on health (Belgium, Greece, Portugal and the Czech Republic). A grouping of southern (Italy, Spain) and western (France and Austria) countries stands out for regions with health status significantly above the European average. In the analysis, we also identified a grouping of three small countries with good health status (Denmark, Slovenia and Latvia).

The mortality index (MINDEX), factorial aggregation of three indicators (SMR, GMR, Under5R) proves to be valid and consistent (faithful). External or predictive validity is given by the significant and interpretable impact of competitiveness, urbanization and membership of regions to EU national frameworks in determining the MINDEX composite index. The Economic and Social Competitiveness Index (used in the regressions in Table 1) is calculated as a factorial score from variables measured at the NUTS 2 level. Country average values of MINDEX are calculated by aggregating regional values. It follows that MINDEX validation also involved multilevel analyses that proved useful. An additional argument in favour of MINDEX as a synthetic health index resulted from the stability of the prediction model of MINDEX chir even under conditions of minor modification of the list of predictors.

Conclusion

Of course, problems remain to be solved. In particular, the degree of specification of the multiple regression model can be increased by adding predictors such as the quality of health services at the national level, the type of medical culture of the population in a national or regional context, etc.

Declarations

Conflicts of Interest

No conflict of interest.

Data Availability

All the data that are used for this article are public, being downloaded from the EUROSTAT site.

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