EU INTEGRATION, HEALTH STANDARDS AND ECONOMIC DEVELOPMENT

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Abstract
Health is one of the most important assets for human beings, since it allows people to fully use their capacity. Poor or compromised health reduces the well-being of individuals, by affecting their future incomes, wealth and consumption. For policy implications, it is notorious how health can affect not just the economic outcomes of a person, but of an entire country. Keeping this view in mind, the aim of the paper is to analyze clusters and distances among the EU's Member States in terms of health standards, by using the Self-Organizing Map (SOM) artificial neural network methodology.

Key words: Health, Human capital, Development

JEL codes: H1, I1, O1

1. Introduction

Less developed economies have generally shown to achieve poorer health standards than those in advanced countries. The effect of income differences on health performance is one the most debated questions in literature. In order to investigate this further, one needs to assess the objective of policies aimed at increasing health levels of countries. In this respect, a number of programmes are designed to reduce morbility and mortality of the population. In addition, a secondary goal of these policies is to increase the level of economic development by improving health standards. For example, the report of the WHO's Commission on Macroeconomics and Health (2001) states: «*Improving the health and longevity of the poor is an end in itself, a fundamental goal of economic development. But it is also a means to achieving the other development goals relating to poverty reduction. The linkages of health to poverty reduction and to long-term economic growth are powerful, much stronger than is generally understood. The burden of disease in some low-income regions [...] stands as a stark barrier to economic growth and therefore must be addressed frontally and centrally in any comprehensive development strategy*».
Economists have identified several channels by which health may impact on the output of an economy. To give an example, a healthier population is generally more productive, since people in good health may work hardly, longer and be more concentrated. Furthermore, improvement in health standards is an indirect incentive for investing in education. Such an investment will be most likely amortized during a longer working life. Finally, healthy students tend to have lower rates of absenteeism and a better cognitive performance, thereby succeeding in achieving higher education standards, all else being equal.

In accordance with the prevailing literature, our hypothesis is that health represents one of the main factors of human development. The major objective of this work is to examine the existence of clusters and distances among the EU's Member States with respect to health services provided to people. In this regard, a brief overview of the relevant literature on the relation between health and economic outcomes is provided (see par. 2). In the second section, a data analysis is performed using a Self-Organizing Map (SOM) neural network methodology, in order to identify multidimensional similarities and gaps among the EU's Member States (see par. 3). Finally, brief concluding remarks are made on the main results achieved by the analysis (see par. 4).

2. Health and economic outcomes

Most studies examining the relation between health and economic outcomes – both at the micro and macroeconomic level – are based on two distinct typologies of indicators: input and output of national health services.

Inputs are usually considered to be both economic and non-economic factors affecting an individual's health during his entire life, such as health expenses, physicians and nurses density in population, beds availability in hospitals, etc. As far as outputs are concerned, scholars usually consider a number of different features that are related to inputs and personal genetic information (mortality, morbility, life expectancy at birth, etc.).

A second strand of research has tried to the question whether, and to what extent, health disparities have an impact on income differences, by examining input and output data at the aggregate level rather than the individual. The first pioneering works on this subject (see, for example, World Bank 1980, Hicks 1979 and Wheeler 1980) drew some preliminary conclusions highlighting the importance of health in growth and development dynamics. More recently, Barro (1997), among others, showed how an increase in life expectancy is correlated with economic growth: using data relative to the period after the Second World War, he found that an increase of 10% in life expectancy may raise economic growth by an annual 0,4%. According to Fogel (1997), the growth of the amount of calories available on average per worker in the past two centuries has played a non-neglectable role in rising GDP growth rates in countries like the United Kingdom and France. Similar conclusions to the studies of Barro and Fogel were also reached in Bloom and Williamson (1998), Gallup and Sachs (2001), Arora (2001) and Bhargava *et al.* (2001). Though primarily focused on econometric estimations, all the works reviewed above show how health may impact strongly on economic trends.

3. Health standards in the UE: a non-linear clustering through SOM Neural Networks

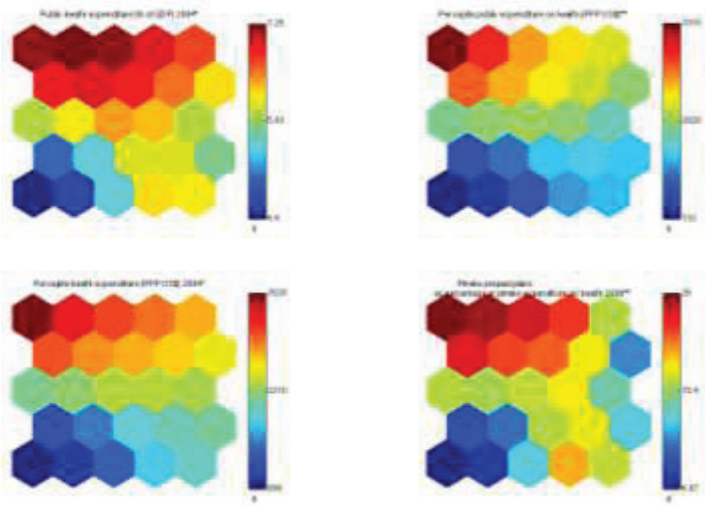
In this paragraph, we discuss the results of a data analysis based on a SOM, used to better identify clusters and gaps among the EU's Member States in terms of health standards. A SOM is a type of artificial neural network that is trained using unsupervised learning to derive a low-dimensional (typically two-dimensional), discretized representation of the input space of training samples, called a map. This makes SOM useful for visualizing low-dimensional views of high-dimensional data, similarly to multidimensional scaling. The model was first described as an artificial neural network by Finnish professor Teuvo Kohonen (1995), after whom was named "Kohonen map". Like most artificial neural networks, SOMs operate in two modes: training and mapping. Training builds the map by using input examples. It is a competitive process, also called vector quantization. Mapping automatically classifies a new input vector. This spatial organizing process, used for important statistic features of input data, is also known as feature mapping. SOM creates feature mappings by means of an unsupervised learning technique.

For the aim of this paper, we considered a set of 21 variables for each of the 27 EU's Member States (see tab. 1). The observations refer to the most recent year available (mainly 2006). At any rate, the variables show a certain degree of stability in the last five years.
The positions found by the Kohonen map for the countries considered, with respect to the agglomerations produced by the SOM Neural Network, show two main results.
In connection with the variables used in this study, some well-defined groups are formed (see Fig. 1):
- Group 1, comprising Eastern European countries. In particular, Bulgaria, Estonia, Latvia, Poland and Romania belong to the same codebook, while Lithuania, Cyprus, Slovakia, Hungary and Czech Republic constitute a second subgroup. Slovenia, instead, is an outlier with respect to the other countries, and locates close to Mediterranean countries;
- Group 2, including some Mediterranean countries, such as Portugal, Malta, Spain and Greece. Italy represents an outlier and appears to be as an outpost between Mediterranean countries and Central and Northern European countries;
- Group 3, which comprises the main countries of Central Europe and is located in the top-right part of the Kohonen map;
- Group 4, including countries of continental and non-continental Europe as well as Scandinavia. This group is placed in the top-left part of the Kohonen map.
The location of countries along the directrix which goes from the top to the lower part of the map represents a clear correlation with the overall quality of national health services in the countries considered. However, it must be mentioned that, even within the well-performing countries located in the top part of the map, it is possible to identify two distinct profiles that split the group of continental Europe in two separate branches.

Fig. 1 – Kohonen Map

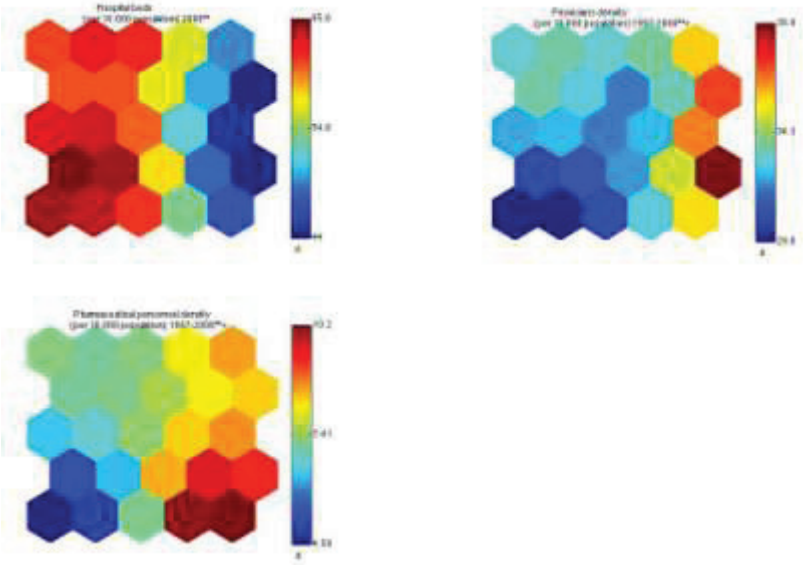
A close examination of the feature mapping highlights a second important aspect: the differences among countries, as evidenced by the identification of groups done before, is based on only a few variables of the whole set used in the analysis. The main distinction may be mainly summarized in terms of current expenses, rather than the provision of basic health care (see Fig. 2, where warm colours are associated with high values).

Fig. 2 –Expenditures on health



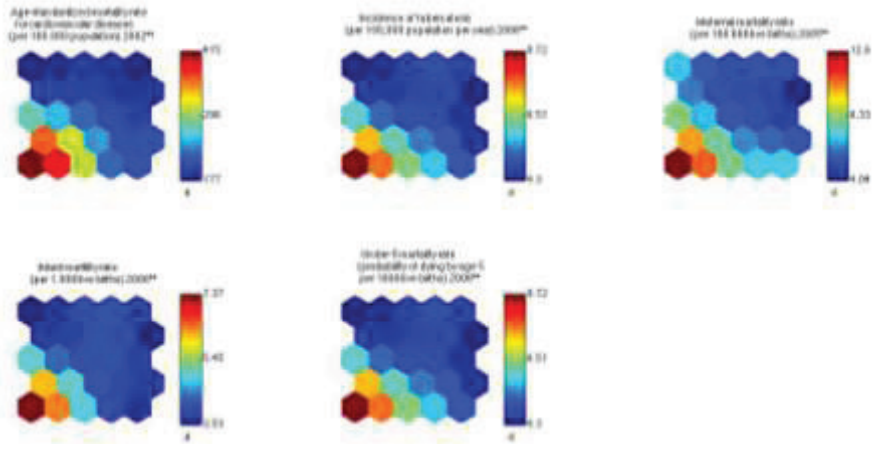
The stock variables, such as beds availability in hospitals or physicians and pharmaceutical personnel density in population (which represent a good proxy for measuring the provision of basic health care), do not allow to distinguish between Western European countries and Eastern European countries (see Fig. 3).

Fig. 3 – Health endowment



However, there are a few output variables, primarily associated with morbility and mortality, that exhibit relatively high values with regard to countries of Eastern Europe (see Fig. 4).

Fig. 4 – Mobility and Mortality



Hence, in this case, the observed differences in output terms may be not due to the provision of basic health care, but rather to investments in health (these investments may actually affect the quality of the provision of basic health care and its effectiveness).

Concluding remarks

Health capital has a significant effect on economic development. For policy implications, it is notorious how health can affect not just the economic outcomes of a person, but of an entire nation. It is important to include investment in health as a macroeconomic policy tool, due to the fact that differences in economic development between countries have been significantly explained by health disparities. This shows that investments in health improve economic development and are among the few feasible options to be used for the elimination of poverty traps.

This paper was aimed at highlighting the distances among the EU's Member States, by focusing the attention on their health standards. By using SOM artificial neural networks, we showed that recently acceded EU countries should reduce the gaps from more advanced countries, especially in terms of health investments. Further investigation is required to better explore the dynamics of the above mentioned phenomena.

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Tab. 1 – Data base

	Public health expenditure (% of GDP) 2004*	Per capita public expenditure on health (PPP US$)**	Private health expenditure (% of GDP) 2004*	Per capita health expenditure (PPP US$) 2004*	Social security expenditure on health as percentage of general public expenditure on health 2006**	Private prepaid plans as percentage of private expenditure on health 2006**	Hospital beds (per 10 000 population) 2006**	Physicians density (per 10 000 population) 1997-2006**+	Physicians density (per 10 000 population) 1997-2006**+	Nurses and midwives to physicians 1997-2006**+	Pharmaceutical personnel density (per 10 000 population) 1997-2006**+	Life expectancy at birth (years) 2000-2005*+	Healthy life expectancy at birth (years) 2003**	Age-standardized mortality rate for cancer (per 100 000 population) 2002**	Age-standardized mortality rate for cardiovascular diseases (per 100 000 population) 2002**	Incidence of tuberculosis (per 100 000 population per year) 2006**	Per capita recorded alcohol consumption (litres of pure alcohol) among adults (>=15 years) 2003**	Prevalence of current tobacco use among adults (>=15 years) (%) 2005**	Population with sustainable access to improved drinking water sources (%) 2006**	Maternal mortality ratio (per 100 000 live births) 2005**	Infant mortality rate (per 1 000 live births) 2006**	Under-5 mortality rate (probability of dying by age 5 per 1000 live births) 2006**
Austria	7.8	2729	2.5	3418	61	22	76	37	66	1.8	6	79.4	71	127	304	4	12.1	43.2	100	4	4	4
Belgium	6.9	2264	3.8	3133	93.6	18.6	53	42	142	3.4	11	78.8	71	148	162	5	10.6	27.1	100	8	4	5
Bulgaria	4.6	441	3.4	671	67.8	0.9	65	346.6	46	183	1	73.5	65	125	454	12	5.9	37.7	99	11	10	12
Cyprus	2.6	759	5.2	1138	0.2	12.3	35	25	49	0.1	2	79.0	69	94	354	4	11.5	31	100	19	3	4
Czech Republic	6.5	1309	0.8	1412	89.4	1.8	84	36	89	2.5	6	75.9	68	177	315	4	13	33.4	100	4	3	4
Denmark	7.1	2612	1.5	2780	0	9.5	35	36	101	2.8	7	77.9	70	167	182	4	11.7	38.8	100	3	3	4
Estonia	4.8	794	1.1	952	84.8	4.1	56	35	70	2.1	7	71.2	64	159	435	6	9	28.1	100	25	5	6
Finland	5.7	1948	1.7	2203	30.3	9.9	70	33	89	2.7	11	78.9	71	115	201	3	9.3	31.7	100	7	3	3
France	8.2	2833	2.3	3040	93.6	61	73	34	80	2.3	11	80.2	72	142	118	5	11.4	31.6	100	8	4	5
Germany	8.2	2548	2.4	3171	87.5	39.9	83	34	80	2.3	6	79.1	72	141	211	5	12	31.8	100	4	4	5
Greece	4.2	1311	3.7	2179	53	2.8	47	50	346	0.7	8	78.9	71	133	258	4	9	39.8	100	3	4	4
Hungary	5.5	978	2.2	1398	90.3	4.1	79	50	93	3	5	72.9	65	203	364	7	13.6	36.3	100	6	6	7
Ireland	5.7	2413	1.5	2618	0.8	38.6	56	29	195	6.6	9	78.4	70	151	314	4	13.7	26.1	100	1	4	4
Italy	6.5	2022	2.2	2414	0.2	4	40	37	72	2	8	80.3	73	134	174	4	8	29.4	100	3	3	4
Latvia	4.0	615	3.1	852	90	2.7	76	31	346	1.8	6	72.0	65	156	482	9	9.6	35	99	10	8	9
Lithuania	4.9	728	1.6	843	84.5	1.3	80	40	77	1.9	6	72.5	63	161	391	9	9.9	34.7	100	11	7	9
Luxembourg	7.3	5233	0.8	5178	78.6	18.9	63	27	96	3.5	9	78.4	72	134	177	4	15.6	28.7	100	12	3	4
Malta	7.0	1419	2.2	1733	0	8.1	76	39	60	1.5	20	79.1	71	124	214	6	6	34.3	100	8	5	6
Netherlands	5.7	2768	3.5	3092	95.1	32.3	50	37	148	3.9	2	79.2	71	135	171	5	9.7	32	100	6	4	5
Poland	4.3	636	1.9	814	83.9	1.9	52	20	52	2.6	6	75.2	66	189	324	7	8.1	35.6	100	8	6	7
Portugal	7.0	1494	2.8	1897	1.1	7.5	37	34	47	1.4	10	77.7	69	140	306	4	11.5	35.8	99	11	3	4
Romania	5.4	483	1.7	435	80.3	13.9	65	19	42	2.2	1	71.9	65	141	479	16	9.7	32.6	88	24	14	16
Slovakia	5.3	913	1.9	1061	85.3	0	68	31	66	2.1	5	74.2	66	170	371	8	10.4	30.9	100	6	7	8
Slovenia	6.6	1507	2.1	1815	91.9	48.6	48	24	80	3.3	5	77.4	69	160	228	8	9.7	26.5	100	6	3	8
Spain	5.7	1793	2.4	2099	6.6	23.6	34	33	76	2.3	9	80.5	73	131	137	4	11.7	33.7	100	4	4	4
Sweden	7.7	2533	1.4	2826	0	1.6	59	33	109	3.3	7	80.5	73	116	176	4	6	22	100	3	3	4
United Kingdom	7.0	2434	1.3	2960	0	7.8	35	25	128	3.5	3	79.0	71	145	182	8	11.8	35.7	100	8	5	6

* Source: OECD
** Source: WHO
+ Data refer to the most recent year available during the period specified