ECONOMETRIC PERSPECTIVE BETWEEN HEALTHCARE SYSTEM AND HUMAN DEVELOPMENT INDEX. AN INTERNATIONAL COMPARATIVE ANALYSIS

Claudiu CICEA[1]

ABSTRACT
The healthcare system is one of the most important sector in social area, especially because it has a great influence over the health status of the population (measured by life expectancy at birth). Furthermore, the healthcare system is a major consumer of human, material and financial resources.
In the following we analyzed the correlation between life expectancy at birth (as a result of health system efficiency) and human development index. No doubt, between these two analyzed variables there is a correlation (as long as the first is a component of the second), but we want to analyze how strong is it, based on correlation coefficient.
It was found that the correlation between the healthcare system and human development index is strong (correlation coefficient was calculated for 0.851).
The connection between health system (measured by the life expectancy at birth) and the human development index is very strong. This fact is based both on empirical perception and on mathematical calculations and comparative international analysis.

KEYWORDS: *life expectancy at birth, healthcare system, human development index*

JEL CLASSIFICATION: *I10, I19, O15*

1. INTRODUCTION

Generally speaking, efficiency requires a comparison between the volume and structure of the efforts and the volume and structure of the effects. This is an easy target in the economic area, where both the efforts and effects can be easily evaluated in a monetary form. Thus, efforts are represented by investment cost, operating expenses etc., while the effects are represented by the total revenue, profit, market share etc.
In the social and cultural area (including education area, health system, public administration etc.) it is more difficult to evaluate the efficiency, because the effects have a very high complexity level (Gillespie, 2007). These effects are manifested in many forms and on very large intervals of time (Bambra, 2006; Alleyne, 2000). Just as an example, the effect of education on the individual takes the entire period of his life. Therefore, in order to evaluate the efficiency in the health system (as part of the social and cultural area) we have to identify all the involved aspects.

2. METHODS

Human development index is an evaluating instrument for the a society's developing level, based on three aspects of the social - cultural environment (McGillivray, 2006): longevity of the population (measured with the help of life expectancy), level of knowledge (quantified by the rate of literacy and school house) and the welfare level (evaluated by GDP per capita).

[1] The Bucharest University of Economic Studies, Romania, claudiu.cicea@man.ase.ro

This indicator illustrates that people and their life should be in the centre of attention when configuring a development plan for a nation (Mahbub, 1995). It can explain how 2 countries with the same income per capita level could have different human development index. For example Vietnam and Pakistan have approximately the same income per capita level, but the life expectancy and the level of education differ a great deal, in favor of Vietnam. Consequently, Vietnam has a more higher human development index than Pakistan.

The human development index is based on three indexes: life expectancy index, educational index and the national gross income (or GDP). We must mention that in 2011, United Nations Development Program has changed the calculation methodology, both for human development index and for its three components (Human Development Reports, 2010). In what follows, we will present both methods in parallel (the method valid until 2011 and the one that is currently valid). In the calculus, we will use only the new methodology. Calculation formulas are as follows:

$$HDI = \frac{1}{3} I_V + \frac{1}{3} I_E + \frac{1}{3} I_{GDP} \quad (1)$$

$$HDI = \sqrt[3]{I_V \times I_E \times I_{VNB}} \quad (2)$$

Where : HDI is the human development index;
I_V – life expectancy index at birth;
I_E – educational index;
I_{VNB} – gross national income index;
I_{GDP} – GDP index.

The first formula represents the (method valid until 2011), the second equation represents (method valid after 2011). In the 2010 year, The United Nation Programme for Development (2010) has stated a new methodology for the human development index calculation.

Computing formulas for these indexes are as follow.

Life expectancy index

$$I_V = \frac{l - l_{min}}{l_{max} - l_{min}} \quad (3)$$

Where : I_V Life expectancy index at birth;
l – Life expectancy at birth for a certain country (expressed in years)
l_{min} and l_{max} – Minimum and Maximum life expectancy at birth, according to the United Nations Organization (I min = 25 years and Imax = 85 years)

According to the new methodology, $l_{min} = 20$ ani respectively $l_{max} = 83.2$ years .

Education Index

$$I_E = \frac{2}{3} i_a + \frac{1}{3} i_s \quad (4)$$

Where : I_E is the education index;
i_a – literacy index;
i_s – school house index.

For the fourth equation the method is valid until 2011.

Every index (both literacy and school house) are computed by the formula:

$$i_a = \frac{r_a - r_{min}}{r_{max} - r_{min}} \quad (5)$$

$$i_s = \frac{r_s - r_{\min}}{r_{\max} - r_{\min}} \quad (6)$$

Where : i_a and i_s stand for literacy and school house index
r_a and r_s – literacy rate and school house rate from a particular country;
r_{min} and r_{max} – minimum level (0 %) and maximum level (100 %) of the two rates.

According to 'The Report on Human Development 2009", the literacy rate represents the percentage out of the total population, over the age of 15, which are able to write and have an ordinary life. The school house rate represents the number of personas that have frequented a level of education (primary, secondary and tertiary) related to the total number of people according to the official age for these levels of education.
It is noticeable that the education index is a value expressed in percentage, established by calculation the average of literacy index and the school house index. To be more accurate the computing methodology disposes of a share of 2/3 for the literacy index and just 1/3 for the school house index. It must be specified that the school house rate does not refer only to primary school, but is a medium value of schooling for all educational forms (primary, gymnasium, academic)
In the present, the education index is calculated following the formula:

$$I_E = \frac{\sqrt{IMAS \times IEAS} - 0}{0.951 - 0} \quad (7)$$

where : IMAS – mean years of schooling index;
IEAS – expected years of schooling index.
For the seventh equation the method is valid until 2011

$$IMAS = \frac{MAS - 0}{13.2 - 0} \quad (8)$$

$$IEAS = \frac{EAS - 0}{20.6 - 0} \quad (9)$$

where : MAS – mean years of schooling (years that a 25 year old person or older has spent in schools);
EAS – expected years of schooling (years that a 5 year old child will spend with his education in his whole life).
Gross national income index (GDP index)

$$I_{PIB} = \frac{\ln Y - \ln Y_{\min}}{\ln Y_{\max} - \ln Y_{\min}} \quad (10)$$

where : I_{PIB} represents the GDP index;
Y – level of GDP per capita in one country
Y_{min} and Y_{max} – minimum and the maximum level of the GDP per capita, according to The Organization of United Nations (ymin=100 USD, ymax=40000 USD)
For the tenth equation, the method is valid until 2011.
In present, the gross national income index replaced the GDP index. The formula is as follow:

$$I_{VNB} = \frac{\ln Y - \ln Y_{\min}}{\ln Y_{\max} - \ln Y_{\min}} \quad (11)$$

where : I_{VNB} represents the VNB index;
Y – level of VNB per capita in one country

$Y_{\min}$ and $Y_{\max}$ – minimum and the maximum level of the VNB per capita, according to The Organization of United Nations (ymin =163 USD, ymax = 108211 USD)
For equation (11), the method is valid until 2011.

3. RESULTS

In the following we present the resulting values for human development index mentioned above. We specify that in certain situations we deepen the analysis by computing the correlation or elasticity coefficients, between different indicators.
We compute the *human development index* for Romania and for all 18 analyzed countries, for year 2008 (according to the new valid methodology).
Romanian life expectancy index
Life expectancy at birth in Romania is 72.8 years (for the year 2008). So, the value of the index is :

$$I_V = \frac{72.8 - 20}{83.2 - 20} = 0.835 \qquad (12)$$

Romanian educational index
For Romania, MAS (mean years of schooling) in 2008 is 10.6 years (United Nation Development Program, 2009), and EAS (estimated years of schooling) is 14.8 years (United Nation Development Program, 2009). As a consequence, educational index is as follow:

$$I_E = \frac{\sqrt{0.803 \times 0.718} - 0}{0.951 - 0} = 0.792 \qquad (13)$$

Romanian VNB index
In Romania, for the year 2008, the VNB was 13380 USD (United Nation Programme for Development, 2009). As a consequence, the VNB index is as follow:

$$I_{VNB} = \frac{\ln 13380 - \ln 163}{\ln 108211 - \ln 163} = 0.678 \qquad (14)$$

Finally, the human development index will have the following value :

$$HDI = \sqrt[3]{0.835 \times 0.792 \times 0.678} \approx 0.765 \qquad (15)$$

In 2008, a detailed situation for the HDI indicator, regarding the 18 analyzed countries, is presented in the following table:

Table 1. Human development index

Country	Life expectancy (years)	Mean years of schooling (MAS)	Expected years of schooling (EAS)	Gross national income per capita (USD)	Life expectancy index	Educational index	Gross national income index	HDI
Belgium	79.8	10.62	15.91	35,379.20	0.946	0.829	0.828	0.865956
Bulgaria	73.3	9.82	13.71	11,375.00	0.843	0.740	0.653	0.741492
Czech Republic	76.6	12.62	15.21	22,886.70	0.896	0.883	0.761	0.844394
Switzerland	81	10.22	15.5	39,207.40	0.965	0.803	0.844	0.867844
Finland	79.7	10.22	17.11	35,944.80	0.945	0.843	0.830	0.871293
France	81.3	10.22	16.1	34,294.90	0.970	0.818	0.823	0.867606

Country	Life expectancy (years)	Mean years of schooling (MAS)	Expected years of schooling (EAS)	Gross national income per capita (USD)	Life expectancy index	Educational index	Gross national income index	HDI
Germany	79.9	12.22	15.61	35,949.50	0.948	0.881	0.830	0.885008
Greece	79.3	10.22	16.51	28,301.80	0.938	0.828	0.794	0.85123
Italy	81.2	9.42	16.31	30,803.00	0.968	0.790	0.807	0.851507
Norway	80.7	12.72	17.3	59,250.30	0.960	0.946	0.907	0.937629
Netherlands	80	11.12	16.7	40,615.10	0.949	0.869	0.849	0.888145
Polond	75.7	9.82	15.21	16,708.50	0.881	0.779	0.713	0.78804
United Kingdom	79.5	9.32	15.91	36,237.40	0.941	0.777	0.832	0.847149
Romania	**72.8**	**10.42**	**14.8**	**13,380.00**	**0.835**	**0.792**	**0.678**	**0.765604**
Spain	80.9	10.12	16.4	30,828.30	0.964	0.822	0.807	0.861165
U.S.A.	79.3	12.42	15.71	46,788.70	0.938	0.891	0.871	0.899559
Sweden	80.9	11.72	15.61	37,777.10	0.964	0.863	0.838	0.88643
Hungary	73.5	11.62	15.31	18,210.80	0.847	0.851	0.726	0.80545

Source: http://hdr.undp.org/en/statistics/

Based on these results, we can construct the following chart :

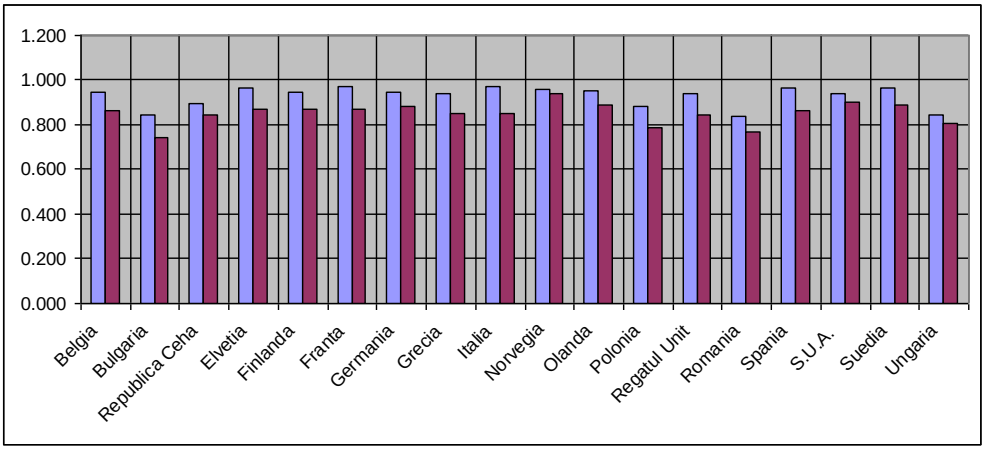

Figure 1. The correlation between life expectancy (healthcare system) – level of human development

Source:Author's calculation

Legend :
- life expectancy index;
- human development index.

Next, with the help of correlation coefficient, we shall analyze the strength of the correlation between the level of the life expectancy (healthcare efficiency level) and the human development level. Using the information presented above, we shall draw the following table :

Table 2. Correlation Coefficient between the life expectancy index and the HDI

Country	**Life expectancy index (X)**	**HDI (Y)**	**X - $\overline{X}$**	**Y - $\overline{Y}$**	**(X- $\overline{X}$)(Y- $\overline{Y}$)**	**(X- $\overline{X}$)^2**	**(Y- $\overline{Y}$)^2**
Belgium	0.946	0.866	0.0183	0.015	0.0003	0.0003	0.0002
Bulgaria	0.843	0.741	-0.0847	-0.110	0.0093	0.0072	0.0121
Czech Republic	0.896	0.844	-0.0317	-0.007	0.0002	0.0010	0.0000
Switzerland	0.965	0.868	0.0373	0.016	0.0006	0.0014	0.0003
Finland	0.945	0.871	0.0173	0.020	0.0003	0.0003	0.0004
France	0.97	0.868	0.0423	0.016	0.0007	0.0018	0.0003
Germany	0.948	0.885	0.0203	0.034	0.0007	0.0004	0.0011
Greece	0.938	0.851	0.0103	0.000	0.0000	0.0001	0.0000
Italy	0.968	0.852	0.0403	0.000	0.0000	0.0016	0.0000
Norway	0.96	0.938	0.0323	0.086	0.0028	0.0010	0.0074
Netherlands	0.949	0.888	0.0213	0.037	0.0008	0.0005	0.0013
Polond	0.881	0.788	-0.0467	-0.063	0.0030	0.0022	0.0040
United Kingdom	0.941	0.847	0.0133	-0.004	-0.0001	0.0002	0.0000
Romania	**0.835**	**0.766**	**-0.0927**	**-0.086**	**0.0080**	**0.0086**	**0.0074**
Spain	0.964	0.861	0.0363	0.010	0.0004	0.0013	0.0001
U.S.A.	0.938	0.900	0.0103	0.048	0.0005	0.0001	0.0023
Sweden	0.964	0.886	0.0363	0.035	0.0013	0.0013	0.0012
Hungary	0.847	0.805	-0.0807	-0.046	0.0037	0.0065	0.0021
Total	16.698	15.3255	0.0000	0.000	0.0324	0.0358	0.0403

Source: Author's calculation

The average values used in the table ($\overline{X}$ and $\overline{Y}$) were computed in this way:

$$\overline{X} = \frac{16.698}{18} = 0.927 \qquad (16)$$

respectively $\overline{Y} = \frac{15.3255}{18} = 0.851 \qquad (17)$

Consequently, the correlation coefficient will have the value of :

$$r = \frac{0.0324}{\sqrt{0.0358} * \sqrt{0.0403}} = \frac{0.0324}{0.0380} = 0.851 \qquad (18)$$

4. CONCLUSIONS

In order to emphasize the relation between healthcare system and human development index, we can analyze the data from figure no. 1 (*The correlation between life expectancy (healthcare system) – level of human development*). We can conclude that human development is strongly correlated

with the life expectancy level (as a result of the healthcare public efficiency). Indeed, the countries which have a well developed healthcare system, characterized by a higher life expectancy at birth (this is the case of Norway, United States, Netherlands) have also a high level of human development index. Furthermore, taking into consideration that the value of the correlation coefficient between human development index and life expectancy index is higher than 0.75 (r = 0.851), we may admit that the interdependence between the healthcare public system (which is a fundamental determinant of life expectancy) and the human development level is very strong.

The healthcare activity efficiency in a macro-systemic vision is very complex, especially thanks to the difficulty of the effect evaluation (Gittell, 2009). More precisely, the effects registered at a society level (the economical growth and development, the improvement of the standard of living and of the human development index etc.) are the result of the conjugated action of more systems: educational, economical, sanitary, cultural and political. Without pretending to solve the entire problem of the healthcare activity efficiency at the society level, we consider that through the presented connections and correlations, we managed to outline a comprising image of the healthcare system influence over different macro-social and macro-economical phenomena.

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