MEASUREMENT OF HEALTH CARE SYSTEM EFFICIENCY

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The aim of the paper is presentation of construction of 2 measures (indicators) of health care system effectiveness and, also, the results of studies in this area conducted in OECD countries. We’ve also elaborated the matrix of correlation coefficients for specific socio-economic factors. Basing on this, we’ve evaluated the relations between the health care expenditure and selected indicators of health status. We’ve used data coming from the WHO, Bloomberg and Eurostat. We’ve hypothesized that expenditure on health correlate negatively with PYLL. Potential Years of Life Lost (PYLL) estimate of the average years a person would have lived if he or she had not died prematurely. Existing of this correlation should result in incorporation of this factor into the health care system’s efficiency measure to assure the proper diagnosis of the efficiency. Results, obtained during research, especially Pearson correlation coefficient seem to proof the validity of assumption, that the diagnosis of the health system’s overall effectiveness should contain a component of Potential Years of Life Lost (PYLL).

Keywords: health system, efficiency, health care.
JEL codes: I14, I15, P46, R51.

1. Introduction

The health care system has, generally, three groups of objectives: the health status of the population, the responsiveness, and equity (World …, 2000). The degree of the achievement of these objectives is connected to the effectiveness of the system as a whole. The analysis of efficiency was set in train by Pareto, for whom allocation techniques are effective, if there is not possible to switch to a different allocation, which would brighten the position of some people without harming the other (Begg, 2003).

In the light of that, the efficiency of the health care system is the multidimensional and very intricate concept, which can be assessed on the macroeconomic level – the level of health system, or microeconomic level – as the efficiency of health care units. The efficiency of the health system's means the efficiency, effectiveness or profitability, and from the economic perspective – of the relationship between effects and expenditures (Krot, 2012). The analysis of the technical and allocative efficiency as well as the organizational efficiency, was the scope of the interest of many author, first of all M. Farrell, Debreu and T. C. Koompans (Koompans, 1951; Nojszewska, 2011).
Most popular definition of efficiency are “input- and output-oriented”. That means, we should be directed to maximizing outputs, when inputs are fixed, or, minimize inputs, when outputs are fixed. In both cases, there is an assumption, that quality can’t be lower (Burgess, 2012). E. Nojszewska (2011) claims, that the efficiency can be defined as the relation of the stated objectives to the resources used, which corresponds to the concepts of both economic cost effectiveness and value for money in accounting.

This definitions are close to the notion of “technical efficiency”, which denotes producing the maximum amount of output from a given amount of input, or alternatively producing a given output with minimum quantities of inputs (Farrell, 1957; Hollingsworth, 1999). Ergo, the efficiency can be measured by using the function of health production, especially by estimating the production frontier (Ogloblin, 2011).

It’s naturally, that health care system efficiency has become a field of international comparisons. This has created an impulse to develop analysis using econometric methods (Papanicolas, 2013), which can be divided into two groups: non-parametric and parametric methods (Hollingsworth, 2003) but generally focusing on physical health or particular health conditions (Moran, 2013).

According to (Joumard, 2008; Nojszewska, 2011) in the light of empirical studies, the health care effectiveness, which depends on various factors, should be assessed on the basis of the three groups of factors. The first group includes the resources of the health system (per capita), the second is connected with lifestyle, the third consists of economic and social factors.

The relationship between the level of country’s socio-economic development, the inputs of the health care system (the volume and the structure of health care expenditure, number of physicians, hospital beds etc.) and the outcomes of the system, expressed by various measures of health care status, is generally proven in the literature (Pożdziöch, 2000). That’s way we’ve focused on the evaluation of the effectiveness of outputs, measured with chosen health care socio-economic indicators (Figure 1).

<table>
<thead>
<tr>
<th>Factors measured:</th>
<th>Effectiveness of outcomes:</th>
<th>Effectiveness of outputs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• physical units,</td>
<td>• increase of LE, HLY</td>
<td>• number of patients,</td>
</tr>
<tr>
<td>• monetary units</td>
<td>• equity of access to health care services</td>
<td>• number of health care services</td>
</tr>
</tbody>
</table>

Figure 1. Factors of effectiveness in health care system’s assessment

The aim of the paper is presentation of construction of 2 measures (indicators) of health care system effectiveness and, also, the results of studies in this area conducted in OECD countries. We’ve also elaborated the matrix of correlation coefficients for specific socio-economic factors. Basing on this, we’ve evaluated the rela-
tions between the health care expenditure and the indicators of state of health. We’ve used the data coming from the WHO, Bloomberg and Eurostat.

We’ve hypothesize that expenditure on health correlate negatively with PYLL. For the proper diagnosis of the efficiency PYLL should be a component of health care system’s efficiency measure. Potential Years of Life Lost (PYLL) estimate of the average years a person would have lived if he or she had not died prematurely.

2. The construction of health care indicators

Since the beginning of the 20th century social indicators was elaborated. The construction of such indicators is similar to the structure of the scale (Ostasiewicz, 2011) where the quantified feature is defined as a function of directly observable characteristics. The assessment of health care system’s quality, effectiveness or efficiency is constructed as the sum, or weighted sum, of selected features.

In one of the first research, three characteristics – health status (ZD), responsiveness (WR) and finance (F) – were adopted as the basic components of the measure for the quality of the health system’s functioning. This methodology which was proposed and presented by experts from the World Health Organization in 2000, as the overall health indicator (WHO, 2000).

The superior feature is the health status of the population (ZD), which is considered to be the most important with weight equal to 0.5. The weight 0.25 is granted to other two components- responsiveness (WR) and fairness in finance (F). In this way the following indicator of the health system performance was obtained (J):

\[
J = \frac{1}{2} ZD + \frac{1}{4} WR + \frac{1}{4} F
\]  

The weight equal to 0.5 assigned to “health” characteristic also need to be split – 0.25 is attributed to the overall health status (ZD_p) and 0.25 to the equity of distribution of the health status among individual members of the society (ZD_s). As a result, the health status level is defined as follows:

\[
ZD = \frac{1}{4} ZD_p + \frac{1}{4} ZD_s
\]  

The level of health status ZD_p is calculated using DALE(Disability-Adjusted Life Expectancy). To analyze the distribution of health status equity, the empirical data is needed, and this distribution is defined as:

\[
ZD_s = 1 - \frac{\sum_{i=1}^{k} \sum_{j=1}^{k} \left| s_i - \bar{s}_j \right|^3}{2k^2 \bar{s}^{0.5}}
\]

when: \( s_i \) – the expected survival time of a child \( i \), \( \bar{s} \) – the average survival time in the population of children under age 5 years (WHO, 2000).
System’s responsiveness (WR), determines the patient's feel during the treatment, but also the interaction between the health care system and population. This characteristic can estimated with a questionnaire concerning the patient experience and satisfaction:

\[ WR = \frac{1}{8} WR_p + \frac{1}{8} WR_s \]  \hspace{1cm} (4)

when: \( WR_p \) – responsiveness of the system, \( WR_s \) – the distribution of the responsiveness.

The overall indicator accepted to the health care system quality assessment, is in that case, defined as follow (Ucieklak-Jeż, 2006):

\[ J = \left( \frac{1}{4} ZD_p + \frac{1}{4} ZD_s \right) + \left( \frac{1}{8} WR_p + \frac{1}{8} WR_s \right) + \frac{1}{4} F \]  \hspace{1cm} (5)

In 2013, the new indicator of health care system efficiency (elaborated by Bloomberg’ researchers) has been proposed, as well as the ranking of countries constructed basing upon the proposed measure. The data used for research came from the World Bank, the International Monetary Fund and the World Health Organization. Countries, which took part in this study can be called “comparable” in the context of: population (more than five million people), life expectancy of the population (at least seventy years) and gross domestic product (GDP) (at least 5000 USD).

Three characteristics: health status (Zb), health care cost, as a percentage of GDP per capita (Kb) (indirect costs) and health care costs per capita (Kp) (direct costs) have been adopted as the basic components of the indicator.

The health status of the population, pending the construction of the indicator, was considered to be the most important component, with weight equal to 0.6. Direct health care costs was granted with weight equal 0.3 weight and indirect with weight equal to 0.1. As the result, the following form of the health care sector’s efficiency indicator was obtained:

\[ E_{BL} = \frac{6}{10} Z_B + \frac{3}{10} K_B + \frac{1}{10} K_p \]  \hspace{1cm} (6)
3. Results of the research of the effectiveness of health systems functioning in OECD countries

Evaluation of the quality of the health care system using the indicator created by the WHO, has been conducted in 191 countries. That has enabled the construction of ranking the effectiveness. The relationship between the health status and health care system inputs (productive factors) employed for the production of health, was the main evaluating aspect. The selected countries have taken following places: France – 1, Poland – 50 place, while Lithuania – 73.

![Diagram](image)

Figure 2. Relationship between health status of the population and the efficiency measures

Analyzing the graph of population’s health status in the EU countries and the assessment of efficiency (Figure 2), it can be noted that there are countries, where people enjoy good health while the health system in is considered inefficient. What is important, the effectiveness of the health care system is connected to the expenditure on health per capita, particularly when expenditure are relatively low (below 80 USD p. c.) – in this case, system just can’t work well (Evans, 2011).

Table 2 presents the results for 17 European population, out of over 50 countries, which have been surveyed by Bloomberg, with a ranking the health care system effectiveness.
<table>
<thead>
<tr>
<th>Member state</th>
<th>Life expectancy</th>
<th>Health care expenditures as a percentage of GDP (per capita)</th>
<th>Health care expenditures per capita (USD)</th>
<th>Rank</th>
<th>Efficiency score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>81.8</td>
<td>8.9</td>
<td>5,939</td>
<td>7</td>
<td>66.0</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>74.2</td>
<td>7.5</td>
<td>522</td>
<td>41</td>
<td>37.0</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>77.9</td>
<td>8.1</td>
<td>1,507</td>
<td>24</td>
<td>48.9</td>
</tr>
<tr>
<td>Denmark</td>
<td>79.8</td>
<td>11.8</td>
<td>6,648</td>
<td>38</td>
<td>38.1</td>
</tr>
<tr>
<td>Finland</td>
<td>80.5</td>
<td>9.4</td>
<td>4,325</td>
<td>23</td>
<td>49.5</td>
</tr>
<tr>
<td>France</td>
<td>81.7</td>
<td>12.5</td>
<td>4,952</td>
<td>19</td>
<td>52.3</td>
</tr>
<tr>
<td>Germany</td>
<td>80.7</td>
<td>11.7</td>
<td>4,875</td>
<td>30</td>
<td>45.5</td>
</tr>
<tr>
<td>Hungary</td>
<td>74.9</td>
<td>8.6</td>
<td>1,085</td>
<td>38</td>
<td>38.1</td>
</tr>
<tr>
<td>Italy</td>
<td>82.1</td>
<td>10.4</td>
<td>3,436</td>
<td>6</td>
<td>66.1</td>
</tr>
<tr>
<td>Netherlands</td>
<td>81.2</td>
<td>13.0</td>
<td>5,995</td>
<td>25</td>
<td>48.5</td>
</tr>
<tr>
<td>Poland</td>
<td>76.7</td>
<td>7.1</td>
<td>899</td>
<td>21</td>
<td>50.6</td>
</tr>
<tr>
<td>Portugal</td>
<td>80.7</td>
<td>11.4</td>
<td>2,311</td>
<td>27</td>
<td>47.2</td>
</tr>
<tr>
<td>Romania</td>
<td>74.5</td>
<td>6.3</td>
<td>500</td>
<td>33</td>
<td>44.9</td>
</tr>
<tr>
<td>Slovakia</td>
<td>76.0</td>
<td>9.1</td>
<td>1,534</td>
<td>36</td>
<td>44.1</td>
</tr>
<tr>
<td>Spain</td>
<td>82.3</td>
<td>10.4</td>
<td>3,027</td>
<td>5</td>
<td>68.3</td>
</tr>
<tr>
<td>Sweden</td>
<td>81.8</td>
<td>9.6</td>
<td>5,331</td>
<td>10</td>
<td>62.6</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>80.8</td>
<td>9.4</td>
<td>3,609</td>
<td>14</td>
<td>55.7</td>
</tr>
</tbody>
</table>

Source: www.bloomberg.com

European countries, which have been evaluated due to the effectiveness of the health system have taken the following places: Spain – 5th, Italy – 6th, Austria – 7th, and Poland 21th place.

4. The impact of social-economic variables on health indicators

In order to investigate the direction and strength of the relationship among the financial resources (expenditures) and health status indicators for given population, the linear correlation coefficients (Pearson’s correlation) among variables, has been calculated. For the analysis, we’ve chosen several variables:

- $X_1$ – total expenditure on health, % of gross domestic product (GDP),
- $X_2$ – total health expenditure per capita, USD PPP,
- $X_3$ – public health expenditure per capita, USD PPP,
- $X_4$ – out-of-pocket expenditure on health, % of total expenditure on health,
- $X_5$ – out-of-pocket expenditure on health per capita, USD PPP,
- $X_6$ – life expectancy at birth, female population,
- $X_7$ – life expectancy at birth, male population,
- $X_8$ – infant mortality rate, deaths per 1 000 live births,
- $X_9$ – potential years of life lost (PYLL), all causes, female population,
- $X_{10}$ – potential years of life lost (PYLL), all causes, male population,
- $X_{11}$ – healthy life years at birth (HLY), female population,
- $X_{12}$ – healthy life years at birth (HLY), male population.
Table 2. Pearson’s correlation coefficients matrix

<table>
<thead>
<tr>
<th>Scale</th>
<th>$X_1$</th>
<th>$X_2$</th>
<th>$X_3$</th>
<th>$X_4$</th>
<th>$X_5$</th>
<th>$X_6$</th>
<th>$X_7$</th>
<th>$X_8$</th>
<th>$X_9$</th>
<th>$X_{10}$</th>
<th>$X_{11}$</th>
<th>$X_{12}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X_1$</td>
<td>1.00</td>
<td>0.66</td>
<td>0.69</td>
<td>−0.42</td>
<td>0.34</td>
<td>0.41</td>
<td>0.54</td>
<td>−0.09</td>
<td>−0.38</td>
<td>−0.58</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td>$X_2$</td>
<td>1.00</td>
<td>0.95</td>
<td>−0.52</td>
<td>0.33</td>
<td>0.43</td>
<td>0.61</td>
<td>−0.16</td>
<td>−0.53</td>
<td>−0.75</td>
<td>0.25</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>$X_3$</td>
<td>1.00</td>
<td>−0.56</td>
<td>0.23</td>
<td>0.39</td>
<td>0.58</td>
<td>−0.21</td>
<td>−0.49</td>
<td>−0.72</td>
<td>0.22</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_4$</td>
<td>1.00</td>
<td>0.47</td>
<td>−0.25</td>
<td>−0.31</td>
<td>0.12</td>
<td>0.20</td>
<td>0.38</td>
<td>−0.06</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_5$</td>
<td>1.00</td>
<td>0.28</td>
<td>0.38</td>
<td>−0.12</td>
<td>−0.43</td>
<td>−0.44</td>
<td>0.23</td>
<td>0.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_6$</td>
<td>1.00</td>
<td>0.91</td>
<td>−0.67</td>
<td>−0.70</td>
<td>−0.59</td>
<td>0.32</td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_7$</td>
<td>1.00</td>
<td>−0.58</td>
<td>−0.79</td>
<td>−0.80</td>
<td>0.44</td>
<td>0.32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_8$</td>
<td></td>
<td>1.00</td>
<td>0.39</td>
<td>0.23</td>
<td>−0.13</td>
<td>−0.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_9$</td>
<td></td>
<td></td>
<td>1.00</td>
<td>0.82</td>
<td>−0.44</td>
<td>−0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_{10}$</td>
<td>1.00</td>
<td>−0.50</td>
<td>0.03</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_{11}$</td>
<td>1.00</td>
<td></td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_{12}$</td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

The matrix of Pearson’s correlation coefficients for selected socio-economic factors (Table 2) shows, that total expenditure on health, measured with the percentage of gross domestic product ($X_1$) and total health expenditure per capita in USD PPP ($X_2$), and public health expenditure per capita ($X_3$) have positive influence on life expectancy, and, on the other hand, influence negatively the potential years of life lost (PYLL) for male population ($X_{10}$). This relationship is not so important in case of female population.

5. Conclusions

1. The method of measuring the efficiency of the health sector have developed significantly in recent years. Despite that, research on the effectiveness of the health system functioning are carried out rarely, because the definition of the relationship among financing, organization of health care system and health status of the population is extremely complex..

2. Indicators and rankings of health care effectiveness, presented in this paper vary considerably in methodology. Bloomberg’s ranking is very simplified, yet, unfortunately, is based on life expectancy as a major factor in health assessment process. The research conducted by Bloomerg has shown, that American health care system is surprisingly inefficient (46 place in ranking). Life expectancy in USA is relatively high (78.7), comparable to other high-developed countries. However the cost of health care are extremely high (17.6% PKB) (OECD, 2013). Most of countries, especially high-developed face extremely fast increase in health care spending. However the cost of health care are extremely high (17.6% PKB) (OECD, 2013). Most of countries, especially high-developed face extremely fast increase in health care spending.

3. Results, obtained during research, especially Pearson correlation coefficient seem to proof the validity of assumption, that the diagnosis of the health system’s overall effectiveness, should contain a component of Potential Years of Life Lost, PYLL.
4. The method developed by WHO is often criticized in the literature. There are opinions that indicate from the area of finance should not be the basis for evaluation. The second suspicion is the fact that accepted ranks does not fully reflect the importance of individual factors. Undoubtedly, there is also the problem of data’s quality and its comparability (Richardson, 2003; Williams, 2001).

5. We should emphasize, that there are many factors, which may influence the population’s state of health. Environment, lifestyle, genetic structure, according to the concept of fields of health, created by Lalond, may have definitely greater impact (90%) than reconstructive medicine, which represent vast majority of expenditures. That’s way it is very difficult to catch the unclear relationship among different factors (Lalonde, 1981).

References


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Santrauka


Raktiniai žodžiai: efektyvumas, sveikatos sistema, sveikatos priežiūra.

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