PERFORMANCE MEASUREMENT
OF HEALTHCARE SYSTEMS IN EUROPE

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Introduction
National healthcare management systems play an important role in helping people maintain and improve their health. In the last decade, the European healthcare systems have faced a number of challenges (Papanicolas and Smith, 2013): a) the increasing cost of healthcare service delivery; b) the population ageing associated to the rise of chronic diseases and, as a consequence, to a growing demand for healthcare; c) the lack of equity in accessing to healthcare service; d) an uneven distribution across regions of healthcare professionals.

In addition, the economic turnaround and budget restrictions in the public sector have reduced the amount of financial resources available and challenged the sustainability of national healthcare systems and the possibility to delivery high quality healthcare service and provide universal access.

Since the early 2000s, governments have launched a number of initiatives to face the new challenges and strengthen the healthcare systems. In particular, the selection of performance indicators and the proper design of measurement frameworks have become a major concern of policy makers. Measuring the performance of the healthcare systems is useful to better understand how they work in order to identify good and bad practices, and, finally, effective strategies to improve them.

The Methodology
Unfortunately speaking about performance of healthcare there is little agreement on the philosophy of measurement, on what to measure (Loeb, 2004).

Nevertheless we can distinguish several levels to measure performance in healthcare.

For instance at macro level Goncharuk (2016) proposed several socioeconomic efficiency criteria to measure performance of the healthcare system that could be calculated using public data of World Health Organization.

On the micro level traditional parametric and non-parametric methods can be used to measure performance in healthcare. So, Alsharf (2017) used several models of the Data envelopment analysis to measure performance of hospitals. At the level of individual health facilities the performance measurement is an important tool of performance management (Alsharf, 2015). Mannion and Braithwaite (2012) recommend striving to balance effective performance measurement and management against the potential drawbacks and adverse consequences. Any national performance measures need to be piloted and carefully evaluated to assess potential benefits and pitfalls. However Purbey et al. (2007) found that the measurement of performance of a healthcare organization is still an unresolved issue. A performance measurement
system should be sensitive to changes in the external and internal environment of an organization. They proposed framework measures performance from a multi and interrelated perspective, namely efficiency, effectiveness and flexibility.

Indeed, one measure (efficiency, effectiveness, quality or flexibility) is not enough to measure performance of healthcare at any level. So to do it we should combine various measures.

Many tools and guidelines have been suggested by international agencies and researchers to help healthcare system policy makers and decision-makers to monitor and evaluate health systems performance, and conduct benchmarking studies both at the national and international level (World Health Organization, 2010). However, performance assessment and benchmarking methods in the healthcare are still in their early stages of development. This paper implements Data Envelopment Analysis (DEA) to calculate an index to measure efficiency of healthcare systems, and combine together a number of health quality indices to develop an effectiveness index. These performance measurements are used to conduct a benchmarking study relative to 32 European countries in 2011 and 2014.

DEA is a non-parametric method that measures the relative efficiency of several units denominated decision making units (DMUs) by implementing the same number of linear programming models, one for every unit under examination (Charnes et al., 1978). Efficiency is measured by computing the distance of a DMU from an envelopment frontier generated as a set of linear combinations of the input and output measurements of the DMUs belonging to the production possibility set.

The algorithm proposed by Tone (2001) is adopted to calculate efficiency, as it provides a more accurate efficiency measurement than the basic radial model. In this model (Slack-Based Measure model, SBM-model), the input and output slack variables \( s^- \) and \( s^+ \) are utilized to obtain a measurement of the deviation of a DMU from the envelopment frontier. Assume that there are \( n \) homogeneous DMUs to be evaluated having input and output matrices \( X=(x_{ij}) \in \mathbb{R}^{m \times n} \) and \( Y=(y_{ij}) \in \mathbb{R}^{s \times n} \) with \( X>0 \) and \( Y>0 \). Inputs and outputs of DMU \( k \) \((x_k, y_k)\) can be described as follows:

\[
x_k = X \lambda + s^- \quad y_k = Y \lambda - s^+ , \quad \lambda \geq 0
\]  

where \( s^- \) and \( s^+ \) are respectively input and output slack variables, and \( \lambda \) is a nonnegative vector in \( \mathbb{R}^n \). When output is increased by \( s^+ \) and/or input is decreased by \( s^- \) DMU \( k \) can achieve full efficiency. For an input oriented and constant returns to scale, in the SBM-model the efficiency of a DMU \( (x_k, y_k) \) can be measured by solving the following fractional program:

\[
\rho^* = \min \rho = 1 - \frac{1}{m} \sum_{i=1}^{m} \frac{s_i^-}{x_{ik}}
\]

s.t. \[
\sum_{j=1}^{n} x_{ij} \lambda_j + s_i^- = x_{ik} \quad \sum_{j=1}^{n} y_{ij} \lambda_j - s_r^+ = y_{rk} \quad \lambda_j \geq 0, \quad s_i^- \geq 0, \quad s_r^+ \geq 0, \quad i = 1, 2, ..., m, \quad r = 1, 2, ..., s, \quad j = 1, 2, ..., n
\]
Variables $s^-$ and $s^+$ measure the distance of $\text{DMU}_k$ inputs and outputs from inputs $X_\lambda$ and outputs $Y_\lambda$ of a virtual unit. When $s_k^+=s_k^-=0 \rho^*=1$ and DMU$_k$ is efficient.

The Data
The healthcare systems of the following 32 European countries were considered in the study: Austria (CO1), Belgium (CO2), Bulgaria (CO3), Croatia (CO4), Cyprus (CO5), Czech Republic (CO6), Denmark (CO7), Estonia (CO8), Finland (CO9), France (CO10), Germany (CO11), Greece (CO12), Iceland (CO14), Ireland (CO15), Italy (CO16), Latvia (CO17), Lithuania (CO18), Luxembourg (CO19), Malta (CO20), Netherlands (CO21), Norway (CO22), Poland (CO23), Portugal (CO24), Romania (CO25), Slovakia (CO26), Slovenia (CO27), Spain (CO28), Sweden (CO29), Switzerland (CO30), Ukraine (C31), United Kingdom (CO32). Data used to measure inputs and outputs in 2011 and 2014 were retrieved from the EUROSTAT database (see Table 1).

<table>
<thead>
<tr>
<th>code</th>
<th>type</th>
<th>description</th>
<th>measuring unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>input</td>
<td>medical doctors (practicing)</td>
<td>no. of units</td>
</tr>
<tr>
<td>I2</td>
<td>input</td>
<td>nurses, midwives, healthcare assistants (practicing)</td>
<td>no. of units</td>
</tr>
<tr>
<td>I3</td>
<td>input</td>
<td>available beds in hospitals</td>
<td>no. of units</td>
</tr>
<tr>
<td>O1</td>
<td>output (good)</td>
<td>healthy life years in absolute value at birth (both males and females)</td>
<td>no. of years</td>
</tr>
<tr>
<td>O2</td>
<td>output (good)</td>
<td>life expectancy in absolute value at birth (both males and females)</td>
<td>no. of years</td>
</tr>
<tr>
<td>O3</td>
<td>output (good)</td>
<td>population</td>
<td>no. of units</td>
</tr>
</tbody>
</table>

The Results
Two indices have been calculated to carry on the benchmarking study, respectively the first to measure efficiency and the second to measure effectiveness (see Table 2). Efficiency is defined as the capability of the healthcare system to deliver health service to a fixed amount of beneficiaries with the lowest amount of inputs, while effectiveness is defined as the capability of the healthcare system to provide people with the highest health benefits.

<table>
<thead>
<tr>
<th>index</th>
<th>method</th>
<th>variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>efficiency</td>
<td>DEA (input oriented)</td>
<td>I1, I2, I3, O3</td>
</tr>
<tr>
<td>effectiveness</td>
<td>geometric mean</td>
<td>O1, O2</td>
</tr>
</tbody>
</table>

Figures 1 and 2 show the efficiency and effectiveness scores achieved by the healthcare systems in 2011 and 2014. The healthcare systems differ to a large extent as to their efficiency score. Additionally, the plot of efficiency measurements indicates that for most countries there were no changes from 2011 to 2014.
Results indicate that the European healthcare systems generally suffer a certain stickiness that probably hinders any efficiency improvement. On the contrary, the analysis of the effectiveness indicator (top line) reveals a more articulated and dynamic situation. Changes in the measurement of effectiveness affected national healthcare systems differently passing from 2011 to 2014.

Conclusions and Discussion

According to results of this study we can formulate the following conclusions.

Surprisingly, the most efficient healthcare system in Europe during 2011-2014 period have been and remain Irish, Polish and Portugal systems. These countries better than other use material and human resources to ensure a healthy population. Relatively highest efficiency of Polish healthcare system is confirmed by other recent studies (e.g. Goncharuk, 2017). In addition, within three years Sweden jumped up by almost 50% and has also reached a group of leaders and its health system has become relatively efficient.

It may also seem strange, but the most inefficient healthcare systems in Europe are in Lithuania, Norway, Switzerland, Germany and Austria. These countries spend more on medical doctors, nurses, midwives, healthcare assistants and available beds in hospitals per capita than others in Europe.

However, more resources can be justified if there is an effect in the form of lower mortality and morbidity. The effectiveness should reflect this.

Effectiveness proved to be more dynamic than efficiency. Between 2011 and 2014 two countries made a fantastic breakthrough in effectiveness of healthcare: Slovenia by over 100% and Cyprus by 200%. So now these countries have relatively highest healthy life years and life expectation together with the lowest infant mortality.

Comparing the efficiency and effectiveness scores, we identified a group of countries with the least successful healthcare systems. It includes Romania, Ukraine and Bulgaria. These countries need to implement healthcare reforms aimed at reducing resource intensity and increasing the quality of medical services.
The study showed that comparing efficiency and effectiveness (quality) of healthcare helps to identify the real leaders, but most importantly it enables to find the most problematic countries that need reform of healthcare sector.

References


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Keywords: healthcare, performance measurement, efficiency, effectiveness, Europe