ECONOMICS & Sociology

lo Storto, C., Goncharuk, A. G. (2017). Efficiency vs Effectiveness: a Benchmarking Study on European Healthcare Systems. *Economics and Sociology*, *10*(3), 102-115. doi:10.14254/2071-789X.2017/10-3/8

EFFICIENCY VS EFFECTIVENESS: A BENCHMARKING STUDY ON EUROPEAN HEALTHCARE SYSTEMS

Corrado lo Storto,
University of Naples Federico II, Naples, Italy,
E-mail: corrado.lostorto@unina.it

Anatoliy G. Goncharuk,
International Humanitarian University,
Odessa, Ukraine,
E-mail: agg@ua.fm

Received: February, 2017
1st Revision: April, 2017
Accepted: August, 2017

DOI: 10.14254/2071-789X.2017/10-3/8

ABSTRACT. This paper illustrates a benchmarking study concerning the healthcare systems in 32 European countries as of 2011 and 2014. Particularly, this study proposes a two-dimensional approach (efficiency/effectiveness models) to evaluate the performance of national healthcare systems. Data Envelopment Analysis has been adopted to compute two performance indices, measuring efficiency and effectiveness of these healthcare systems. The results of the study emphasize that the national healthcare systems achieve different efficiency and effectiveness levels. Their performance indices are uncorrelated and behave differently over time, suggesting that there might be no real trade-off between them. The healthcare systems' efficiencies remain generally stable, while the effectiveness values significantly improved from 2011 to 2014. However, comparing the efficiency and effectiveness scores, the authors identified a group of countries with the lowest performing healthcare systems that includes Ukraine, Bulgaria, Switzerland, Lithuania, and Romania. These countries need to implement healthcare reforms aimed at reducing resource intensity and increasing the quality of medical services. The results also showed the benefits of the proposed approach, which can help policy makers to identify shortcomings in national healthcare systems and justify the need for their reform.

JEL Classification: C14, H51, I18, M40

Keywords: efficiency; effectiveness; DEA; healthcare systems; Europe

Introduction

European healthcare systems are facing several challenges since the early 2000s as a consequence of a number of factors (Papanicolas and Smith, 2013): a) increasing costs of healthcare services; b) ageing of population associated to the rise of chronic diseases and thus – the growing demand for healthcare; c) unequal access to healthcare services; d) uneven distribution of healthcare professionals and infrastructure across regions. Moreover, the economic turnaround and budget restrictions in the public sector occurring in the last decade in many European countries have limited the amount of financial resources available to healthcare, thus jeopardizing the sustainability of national healthcare systems, quality of healthcare services and universal access to such services. Henceforth, the need to deliver value-added healthcare services focusing on resource and cost efficiency, increasing healthcare quality at the same time, has become an important goal on the changing landscape of healthcare management in Europe. Indeed, healthcare consumes a large amount of national budgets, but not all countries are able to get an acceptable value for the money spent.

According to the data available from the World Bank database (World Bank, 2017), in 2014 Norway, Switzerland and the United States were the biggest spenders on healthcare in the world, having respectively the total health expenditure per capita of $9,522 (9.7% of GDP), $9,674 (11.7% of GDP), and $9,403 (17.1% of GDP)[1]. However, in the same year the healthcare systems in other countries were achieving similar or even better results while spending far less. For instance, expenditure per capita was $3,258 (9.2% of GDP) in Italy, $2,910 (7.8% of GDP) in Israel, $2,471 (9.7% of GDP) on Malta, and $2,752 (4.9% of GDP) in Singapore. Life expectancy in all these countries is between 82 and 83 years, same as in Norway and Switzerland, higher than that in the United States (79 years).

Notwithstanding some important factors like lifestyles, diet, pollution etc., also affecting life expectancy, the way healthcare services are delivered to population and the healthcare management systems are designed and implemented play a critical part. Both costs and performance of national healthcare systems can be explained in terms of their design, organization, implementation and management. National healthcare systems are different in European countries, because cultural norms, market regulations, policies, and history have shaped each of them. However, although there are differences between the healthcare systems in terms of infrastructure endowment, patient population size, fund allocation, and management settings, they face similar challenges and have common goals. Scholars acknowledge the increasing importance of healthcare system performance for European policy making (Perić *et al.*, 2017). Thus, assessing and comparing the performance of several national healthcare systems provides an opportunity for policy makers to determine how well a particular national healthcare system is performing relative to its international peers, understand how it works in order to identify good and bad practices, and finally find more effective approaches to achieve sustainability and better quality (Nolte *et al.*, 2006). Identifying performance indicators and developing measurement frameworks have become an important concern of both policy makers and scholars (Adam *et al.*, 2011). Both international agencies and academic scholars have proposed various sets of metrics, benchmarking tools, assessment guidelines, and performance evaluation techniques to help healthcare policy makers monitor and evaluate the performance of national healthcare systems, and conduct benchmarking studies both at the national and international levels (World Health Organization, 2010). Unlike the comparison of the performance of a healthcare system in a country with itself over time, comparability of the performance of health systems between countries is viewed as something desirable, but difficult to carry out due to technical and political reasons (Murray and Evans, 2003). Hence, performance evaluation and benchmarking models in the healthcare sector are still far from being developed and capable to provide useful results. Additionally, academic and industry literature reports evidence of diffused inefficiency in healthcare management in Europe that has contributed to health expenditure increase in the last decade (Hollingsworth and Wildman, 2003; OECD, 2014). Furthermore, empirical evidence indicates that high level of efficiency cannot be achieved without reducing quality or effectiveness of healthcare service provision due to potential trade off between them. Thus, developing a performance framework and metrics that focus on the process that transforms resources into healthcare outcomes still remains an important topic on the agenda of researchers.

The *research object* of the current study is the performance measurement of European healthcare systems. The *research aim* of this paper is to conduct a benchmarking analysis for the national healthcare systems in 32 European countries between 2011 and 2014 by implementing a non-parametric frontier method based on Data Envelopment Analysis (DEA). Two indices that measure efficiency and effectiveness of the healthcare systems are obtained.

[1] Total health expenditure includes both private and public sectors' expenditures. Measurements are in current US$.

Using efficiency and effectiveness measurements allows investigating whether there is a possible trade-off between healthcare systems efficiency and quality. Particularly, *research tasks* are aimed at answering the following research questions:

- Which European countries have the most efficient healthcare systems, i.e. systems using less material and human resources to ensure more healthy population?
- Which European countries have the most effective healthcare systems, i.e. systems allowing longer life of their citizens?
- Which healthcare systems need to be improved and reformed?
- How efficiency and effectiveness of European healthcare systems have changed over time?

The rest of the paper is structured as follows. The second section reports shortly a literature review related to efficiency measurement and benchmarking of national healthcare systems. The third section introduces major issues that explain how DEA works as a method to calculate efficiency and conduct benchmarking studies. Focus is on the Slack-Based Measure model. The benchmarking study is illustrated in the fourth section, while its results are presented in the fifth section. Finally, the last section presents the conclusions.

1. Literature review

There is a huge amount of literature focusing on the measurement of efficiency in the healthcare sector. However, there are relatively few studies that evaluated and compared the efficiencies of the healthcare systems at country level (Varabyova and Müller, 2016). Since the seminal study by the World Health Organization on the efficiency of the health systems in 191 countries around the world (World Health Organization, 2000), there has been a growing interest of scholars to develop performance metrics to assess and compare the national healthcare systems, and investigate determinants of either unacceptable or outstanding performance.

A number of studies are based on the utilization of individual performance indicators (DeRosario, 1999; Goncharuk, 2017) or a composite index (Tandon *et al.*, 2000). Such performance indicators are generally derived from publicly available data (World Health Organization, 2017). Sometimes, individual performance indicators are combined together to obtain homogeneous groups of countries whose healthcare systems achieve comparable performance measurements along multiple dimensions (Tchouaket *et al.*, 2012). Some studies rank country healthcare systems and identify determinants of efficiency by implementing various econometric models (Anton and Onofrei, 2012; Berger and Messer, 2002; Evans *et al.*, 2001; World Health Organization, 2000).

Most studies use either parametric and non-parametric analytical techniques such as the stochastic frontier analysis (SFA) model or the Data Envelopment Analysis (DEA), in which the healthcare systems are modeled as production units (Giuffrida and Gravelle, 2001; Hollingsworth, 2003). As this study implements DEA as a method to compute efficiency, literature adopting it is presented with greater detail. Bhat (2005) adopts DEA to assess the influence of specific financial and institutional arrangements on the national healthcare system efficiency in a sample containing 24 OECD countries. Found that countries having public-contract and public-integrated based healthcare systems are more efficient than those having public-reimbursement based systems. Afonso and St Aubyn (2006) perform two-stage DEA estimating a semi-parametric model of the healthcare system in 30 OECD countries in 1995 and 2003. They compute conventional and bootstrapped efficiencies in the first stage and correct these values in the second stage by considering the influence of non discretionary variables such as GDP per head, education level, health behavior using Tobit regression. Results show that a large amount of inefficiency is related to variables that are beyond the

government control. Gonzalez *et al.* (2010) measure the technical and value efficiency of the health systems in 165 countries using data for the year 2004. They use data on healthy life expectancy and disability adjusted life years as health outcomes, and the amount of expenditure on health and education as inputs to the healthcare system. Findings reveal that high income OECD countries have the highest efficiency indexes. Varabyova and Schreyögg (2013) compare the efficiency of the healthcare systems using an unbalanced panel data from OECD countries between 2000 and 2009. In particular, they use different model specifications performing two-step DEA and one-stage SFA and assess internal and external validity of findings by means of the Spearman rank correlations. Their study shows that countries having higher health care expenditure per capita have on average a more efficient healthcare sector, while countries with higher income inequality have a lower efficient healthcare. Hadad *et al.* (2013) compare the healthcare system efficiency of 31 OECD countries utilizing various efficiency conceptualizations (conventional efficiency, super-efficiency, cross-efficiency) and two model specifications, one including inputs that are under management control and another incorporating inputs that are beyond management control. The study provided ambiguous results. Kim and Kang (2014) estimate the efficiency of the healthcare systems in a sample of 170 countries performing bootstrapped DEA. Sample is organized into four groups to obtain homogeneous sub-samples with respect to income. Scholars found that average efficiency in the high-income sub-sample was relatively high, but only a small number of the countries are able to manage their healthcare systems efficiently. de Cos and Moral-Benito (2014) investigate the most important determinants of healthcare efficiency across 29 OECD countries estimating alternative measurements of efficiency performing DEA and SFA from 1997 to 2009. Their study provides empirical evidence that there are significant differences among countries with respect to the level of efficiency in healthcare services provision. Furthermore, there is a positive correlation between the implementation of policies aimed at increasing price regulation and the efficiency of the national healthcare system. Frogner *et al.* (2015) measure healthcare efficiencies of a sample including 25 OECD countries between 1990 and 2010 using publicly available data. Three econometric approaches are adopted, i.e. country fixed effects, country and time fixed effect models, and SFA including a combination of control variables reflecting healthcare resources, behaviors, and economic end environmental contexts. The study shows that rankings are not robust due to different statistical approaches. The study by Kim *et al.* (2016) estimates productivity changes in the healthcare systems of 30 national healthcare systems during 2002-2012. Scholars calculate the bootstrapped Malmquist index to analyze changes in productivity, efficiency and technology. They found that recent policy reforms in OECD have stimulated productivity growth for most countries.

This literature review shows that scholars mostly focused on the measurement of one single index of healthcare system performance, i.e. the efficiency calculated as a ratio of a measure of the quality of life to the amount of health resource used. Neither effectiveness estimates nor joint efficiency-effectiveness indicators are generally used in the analyses. This shortcoming provided one motivation for the present study. Policy formulation in the healthcare sector requires the design of policies that improve both cost efficiency and care provision effectiveness. However, increasing efficiency often challenges the possibility to improve healthcare effectiveness. Studies conducted at the meso-level rather than at the macro-level that either focus on the organizations or organizational units providing healthcare services (i.e., hospitals, acute care hospitals, district hospitals, rural hospitals) are unable to indicate any clear relationship between efficiency and effectiveness in healthcare (lo Storto, 2017). Some scholars suggest that there is a trade-off between increase in efficiency within organizations and effectiveness of care provision (Laine *et al.*, 2005; Martini *et al.*, 2014). Vice versa, other scholars underline that both efficiency and effectiveness can be achieved at

the same time and no trade-off exists (Chang *et al.*, 2011; Nayar and Ozcan, 2008). Investigating the existence of a trade-off between the effectiveness and efficiency of healthcare service provision at the country level is a second important motivation that justifies our research. In this study healthcare efficiency is conceptualized as the ratio of a given healthcare output to the minimum amount of healthcare input (Palmer and Torgerson, 1999), while effectiveness is related to the capability of the healthcare system to achieve the maximum healthcare expected outputs without increasing any unwanted outputs (Sudit, 1996).

2. Method

Efficiency measurement provides information whether healthcare resources are used to get the best value for money (Färe *et al.*, 1997; Goncharuk and Getman, 2014; Palmer and Torgerson, 1999). Since time, Data Envelopment Analysis (DEA) is used to measure efficiency of specific organizational units or national systems in the healthcare context (Bhat, 2001; Borisov *et al.*, 2012; Giuffrida and Gravelle, 2001; Hollingsworth, 2003). An in-depth survey presenting a variety of applications of DEA in the healthcare sector has been conducted by Ozcan (2008). Indeed, DEA has a number of advantages and, particularly, it is very flexible and versatile and requires minimal assumptions relative to the production technology. In addition, DEA does not require price data, and, consequently it can be used to measure efficiency in non-marketed sectors.

DEA is a non-parametric technique that calculates the relative efficiency of several units denominated decision making units (DMUs) by implementing a number of linear programming models, one for every evaluated unit (Charnes *et al.*, 1978). In the DEA technique, efficiency is measured by the distance of a DMU from an envelopment frontier constructed as a set of linear combinations of the input and output measurements of the DMUs belonging to the production possibility set (PPS).

The common radial efficiency analysis generally provides an underestimated measurement of inefficiency because it assumes no substitution or trade-off between outputs (or inputs) and measures the efficiencies adopting a conservative approach. Tone (2001) has introduced a more comprehensive measurement of efficiency that provides a more accurate efficiency measurement than the basic radial model. In the Tone model denominated Slack-Based Measure model (SBM-model), the input and output slack variables s^+ and s^- are utilized to evaluate deviation of a DMU from the envelopment frontier. The national healthcare systems with no slacks achieve better performance than those having large slacks.

Assume that there are n homogeneous DMUs to be evaluated having input and output matrices $X=(x_{ij})\in\Re^{m\times n}$ and $Y=(y_{ij})\in\Re^{s\times n}$ with $X>0$ and $Y>0$. Inputs and outputs of $DMU_k(x_k,y_k)$ can be described as follows

$$\begin{aligned} x_k &= X\lambda + s^- \\ y_k &= Y\lambda - s^+,\ \lambda \geq 0 \end{aligned} \qquad (1)$$

where s^- and s^+ are respectively input and output slack variables, and λ is a nonnegative vector in $\Re^n$. 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 $DMU_k(x_k, y_k)$ can be measured by solving the following fractional program

$$\begin{aligned}
&\rho^* = \min\ \rho = 1-\frac{1}{m}\sum_{i=1}^{m}\frac{s_i^-}{x_{ik}} \\
&s.t.\ \sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = x_{ik} \\
&\quad \sum_{j=1}^{n} y_{rj}\lambda_j - s_r^+ = y_{rk} \\
&\quad \lambda_j \geq 0,\ s_i^- \geq 0,\ s_r^+ \geq 0, \\
&\quad i = 1,2,...,m,\ r = 1,2,...,s, \\
&\quad j = 1,2,...,n
\end{aligned} \qquad (2)$$

Variables s^- and s^+ measure the distance of 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.

3. The study

3.1. Sample, input and output variables

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), Hungary (CO13), Iceland (CO14), Ireland (CO15), Italy (CO16), Latvia (CO17), Lithuania (CO18), Luxemburg (CO19), Malta (CO20), Netherlands (CO21), Norway (CO22), Poland (CO23), Portugal (CO24), Romania (CO25), Slovakia (CO26), Slovenia (CO27), Spain (CO28), Sweden (CO29), Switzerland (CO30), Ukraine (CO31), United Kingdom (CO32).

Data used to measure input and output variables were collected from the EUROSTAT database, covering years 2011 and 2014. *Table 1* reports the list of inputs and outputs.

Table 1. Inputs and outputs

Code	Type	Description	Measuring unit
I1	input	medical doctors (practicing)	no. of units
I2	input	nurses, midwives, healthcare assistants (practicing)	no. of units
I3	input	available beds in hospitals	no. of units
O1	output (bad)	ratio of infant mortality (less than 1 year) to population	percentage
O2	output (good)	healthy life years in absolute value at birth (both males and females)	no. of years
O3	output (good)	life expectancy in absolute value at birth (both males and females)	no. of years
O4	output (good)	population	no. of units

Selected inputs and outputs have been frequently used in studies like this to estimate the efficiency of healthcare at the country level (e.g., Frogner *et al.*, 2015; Hollingsworth and Wildman, 2003; Kim *et al.*, 2016; Rentzlaff-Roberts *et al.*, 2004). Inputs include the following 3 variables: 1) the number of practicing medical doctors (or practicing physicians), 2) the number of practicing nurses, midwives and healthcare assistants, and 3) the number of beds available in hospitals. Medical doctors and nurses, midwives and healthcare assistants

are a proxy measure for the labor resources employed by the national healthcare system to deliver service, while the number of beds provides information on health care system capacities, i.e. capital resources used by the healthcare system. The following 4 variables were included in the analysis as outputs: 1) ratio of infant mortality (between 0 and 1 year of age) to population, 2) healthy life years in absolute value at birth for both males and women, 3) life expectancy at birth in absolute value for both males and women, 4) total country population. While outputs O2, O3, and O4 effectively provide measurements of benefits enjoyed by people, O1 measures an "undesirable" or "bad output" of the health care system. Therefore, the bad output was treated as an input in performing DEA (lo Storto, 2016; Scheel, 2001). Total country population was included in the analysis as a proxy of total demand for national healthcare service.

3.2. Model specification

The benchmarking analysis implemented two DEA models as illustrated in *Table 2*. For both models constant returns to scale have been assumed.

Table 2. DEA models implemented

Model	Index	Inputs	Outputs	Orientation
model 1	efficiency of the healthcare system	I1, I2, I3	O4	input
model 2	effectiveness of the healthcare system	O1	O2, O3	output

Model 1 provides a measurement of the healthcare system efficiency. In this model 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. Model 2 provides an effectiveness measurement for the country healthcare system. Effectiveness is defined as the capability of the healthcare system to provide people with the highest health benefits.

4. Results

Table 3 reports main statistics relative to the four DEA models implemented in the study, respectively in 2011 and 2014. The last two columns of this table include information about the percentage change from 2011 to 2014 for the country health care system efficiency and effectiveness scores. Figures indicate that efficiency and effectiveness have different behaviors. Indeed, efficiency scores tend to remain relatively stable over time, with mean scores varying from 0.643 in 2011 to 0.660 in 2014, while minimum values remain at 0.417 and 0.459. On the contrary, on average the effectiveness score improves from 2011 to 2014.

Table 3. Main statistics relative to DEA models

	2011		2014		Δ%model1	Δ%model2
	Model1	Model2	Model1	Model2		
mean	0.643	0.324	0.660	0.439	3.18%	42.15%
st.dev	0.154	0.160	0.157	0.181	10.41%	39.03%
max	1.000	1.000	1.000	1.000	43.82%	202.94%
min	0.417	0.114	0.459	0.167	-20.92%	-44.04%

Source: own calculation.

However, the effectiveness values are generally significantly lower than the efficiency ones, with mean scores at 0.324 and 0.439 respectively in 2011 and 2014. Similarly, the effectiveness minimum values are proportionally lower than the efficiency minimum values. Finally, the percentage change measurements showed in the last two columns of *Table 3* clearly confirm the different behavior of the health care management system performance indicators. Particularly, while on average efficiency improved slightly from 2011 to 2014, there has been a considerable improvement of the effectiveness measurements over time, even though the country health care systems have been affected differently.

Figure 1 and *Figure 2* display the efficiency (DEA model 1) and effectiveness (DEA model 2) scores for the individual 32 healthcare systems 2011 and 2014. The graphical representations of the performance measurements provide further evidence about their different behaviors over time. The efficiency graph (the blue solid line) shows that efficiency scores remained steady for most countries in the sample. Likewise, in most cases the nearly unchanged shape of the graph between 2011 and 2014 suggests that the relative positions of different countries have not changed noticeably in the comparison. In particular, efficiency largely improved for Sweden increasing from 0.695 to 1.000, while it worsened for Malta and Slovenia, respectively decreasing from 0.694 to 0.549 and from 0.817 to 0.714. Results indicate that the European health care systems generally suffer some stickiness that hinders any efficiency improvement. Vice versa, the analysis of the effectiveness indicator (the red dashed line) reveals a more articulated and dynamic situation. The shape of the graph expands from 2011 to 2014, emphasizing the upward effectiveness trend as emerged from the statistics. Generally, effectiveness changes affected national health care systems differently. For instance, effectiveness largely increased in Cyprus and Slovenia, while decreased in Iceland. Findings suggest that there is a lower inertia in changing health care systems effectiveness.

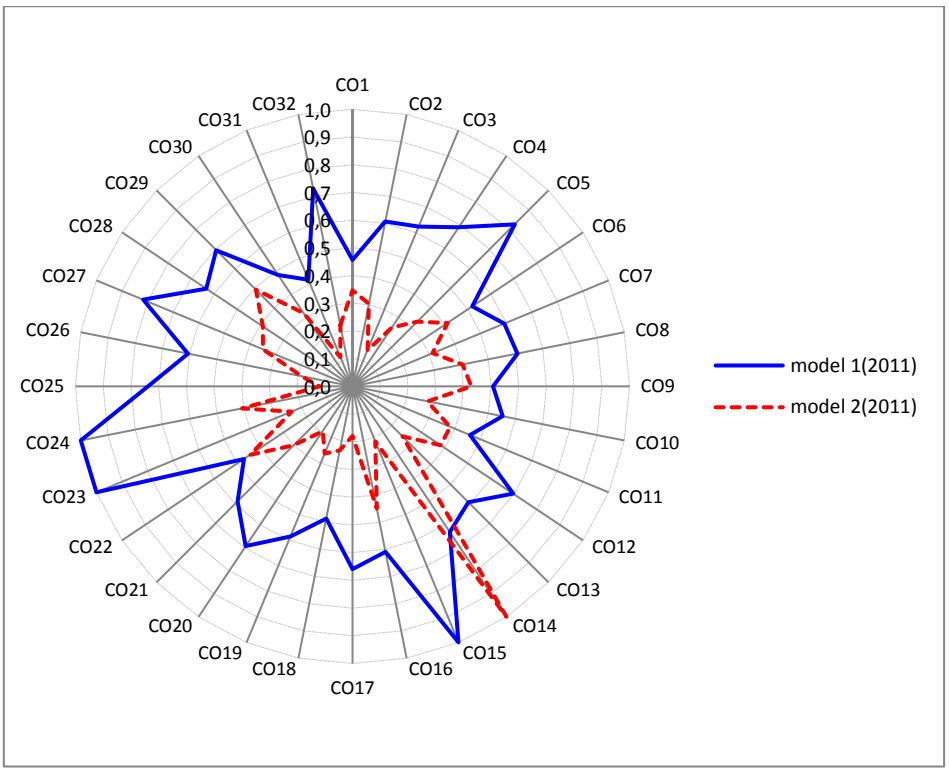

Figure 1. Efficiency and effectiveness scores in 2011
Source: own calculation.

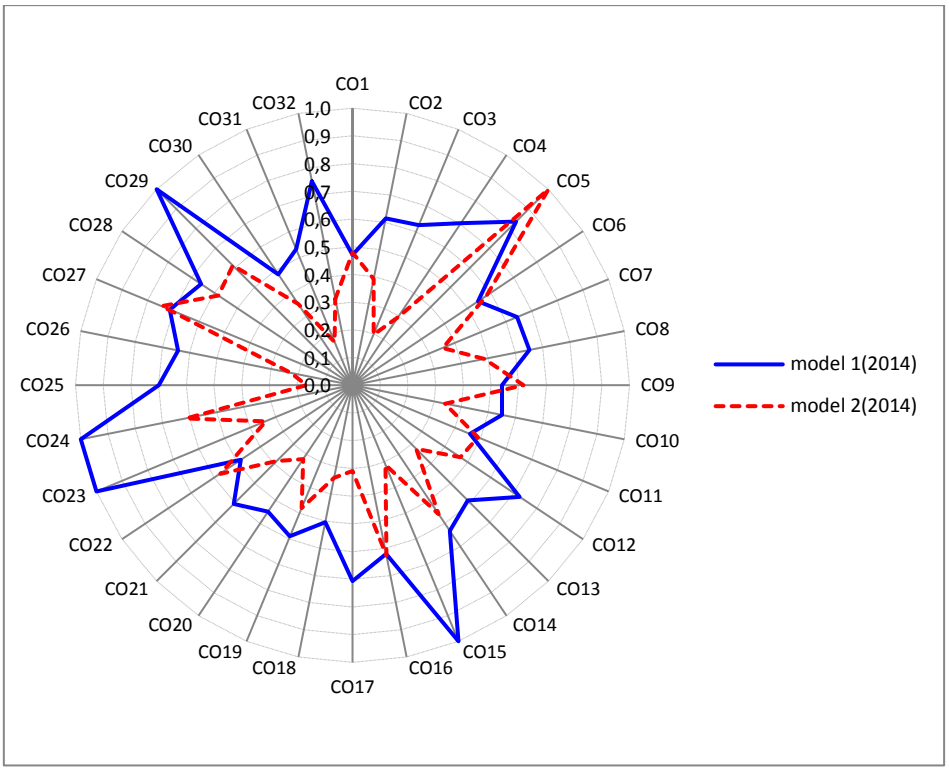

Figure 2. Efficiency and effectiveness scores in 2014
Source: own calculation.

Figure 3 displays percentage changes of both performance indicators – DELTA%model1 and DELTA%model2 – for individual countries. While from 2011 to 2014 efficiency was affected by both improvement and worsening of its score, effectiveness generally improved with the exception of Iceland. Efficiency and effectiveness values are uncorrelated as both plots in *Figure 4* and *Figure 5* display. Henceforth, it seems that in 2011 and 2014 no trade-off between these performance indicators exists.

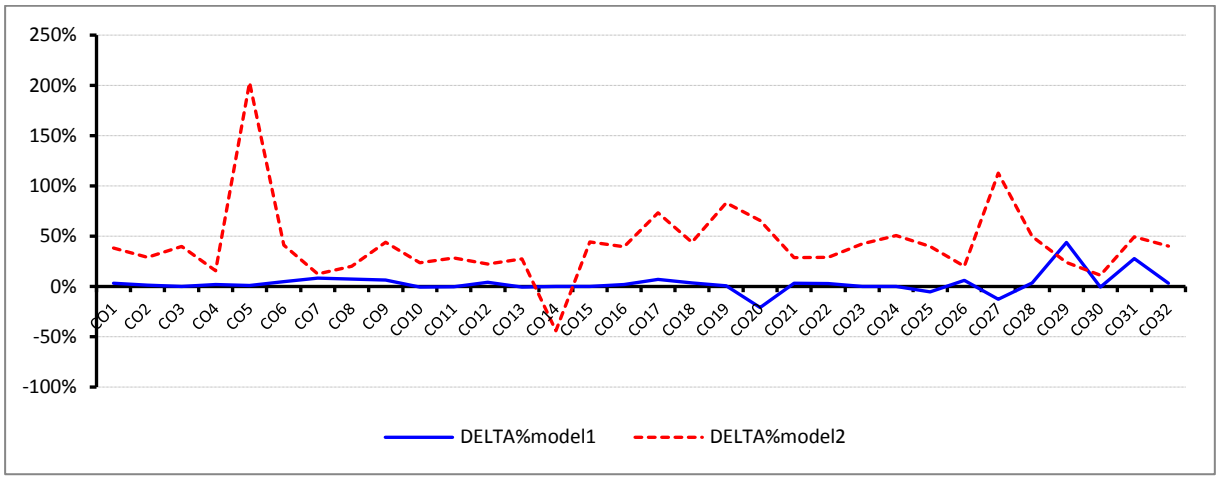

Figure 3. Change of efficiency and effectiveness from 2011 to 2014
Source: own calculation.

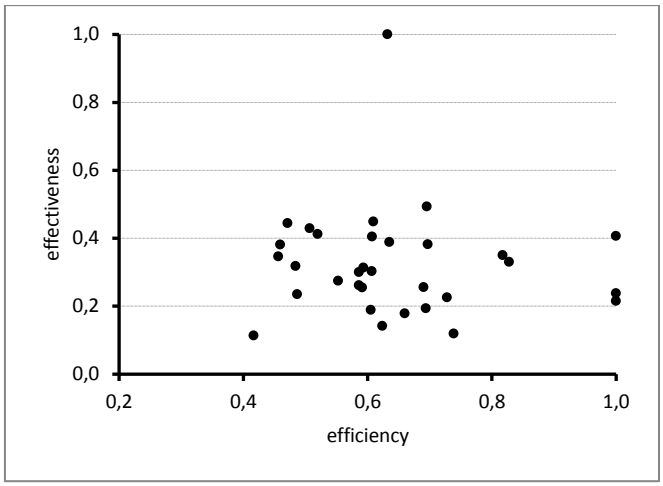

Figure 4. Effectiveness vs efficiency plot in 2011
Source: own calculation.

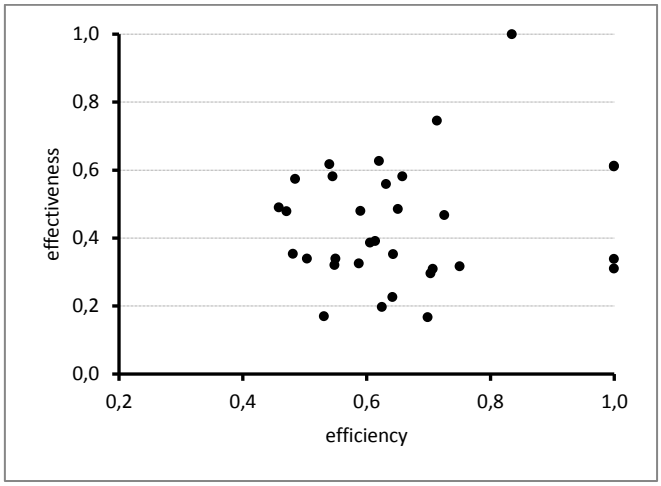

Figure 5. Effectiveness vs efficiency plot in 2014
Source: own calculation.

Conclusion

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 have generally more 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 altogether the efficiency and effectiveness scores in 2014, we identified a group of countries with the least successful healthcare systems.[2] It includes Ukraine, Bulgaria, Switzerland, Lithuania, and Romania. These countries need to implement healthcare reforms aimed at reducing resource intensity and increasing the quality of medical services. The healthcare systems of another group of countries generally performed well both in terms of efficiency and effectiveness indexes. This group is made of Sweden, Portugal and Cyprus. Apparently, these findings do not uncover any positive relationship between healthcare performance and country income emerged in previous studies (see, for instance, Gonzalez *et al.*, 2010).

In addition, the visual joint analysis of the efficiency and effectiveness scores in 2011 and 2014 does not support the idea of the existence of a trade-off between these performance indicators. Data indicate that efficiency and effectiveness in healthcare management at the country level are not necessarily incompatible, and consequently, improving efficiency is not likely to compromise effectiveness in healthcare, or vice versa, achieving higher effectiveness does not require expenditure reduction. Of course, this does not mean that no effort to rationalize the healthcare system may be necessary if there is room for improvement, too.

This study makes a contribution to existing literature on healthcare benchmarking as it suggests the utilization of a two-dimensional approach (efficiency/effectiveness models) to evaluate the performance of healthcare systems in European countries. Results emphasize the benefits of using such an approach, which can help policy makers to identify shortcomings in healthcare systems and justify the need for their reforming. Particularly, 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.

Major limitations of this study relate to the dataset and variables used in the efficiency/effectiveness model specifications. The data span has been limited to two years only within a restricted time window. The effect of government policies aimed at improving performance may have an influence on the healthcare systems with a certain delay. Considering a more extended temporal span would allow dealing with this issue. Literature has also showed that the healthcare system efficiency level may be influenced by a number of context variables (Afonso and St Aubyn, 2006). Consequently, both estimated efficiency and effectiveness measurements may be biased and should be corrected to take into account the weight of non-discretionary context variables. As common in studies like this, research has used data retrieved from a public database (i.e., the EUROSTAT database). As Spinks and Hollingsworth (2009) underline there are still a number of limitations, although the data quality has been improved in the last years. Finally, the efficiency analysis has not included any financial measurements such as government capital and/or current expenditures. Introducing financial metrics in the benchmarking analysis when comparison is performed among several countries having different currencies and macro-economic settings requires that financial measurements are normalized to incorporate exchange rates and PPP effects.[3] While avoiding use these variables simplify the analysis, an important indicator related to public policy efficiency is omitted.

[2] Comparison among country healthcare systems is based on the summation of their efficiency and effectiveness scores.
[3] PPP stands for Purchasing Power Parity.

Further research will be aimed at developing a methodology for diagnosing health systems to identify directions for their improvement and reforming.

Acknowledgement

The authors are thankful to the Department of Industrial Engineering of the University of Naples Federico II for providing funds for covering the costs to publish in open access.

References

Adam, A., Delis, M., Kammas, P. (2011). Public sector efficiency: leveling the playing field between OECD countries. *Public Choice*, *146*(1/2), 163-183.

Afonso, A., St. Aubyn, M. (2006). *Relative Efficiency of Health Provision: a DEA Approach with Non-discretionary Inputs*. ISEG-UTL Economics Working Paper No. 33/2006/DE/UECE (https://papers.ssrn.com/sol3/papers.cfm?abstract_id=952629)

Anton, S. G., Onofrei, M. (2012). Health care performance and health financing systems in countries from Central and Eastern Europe. *Transylvanian Review of Administrative Sciences*, *35* E/2012, 22-32.

Berger, M. C., Messer, J. (2002). Public financing of health expenditures, insurance, and health outcomes. *Applied Economics*, *34*, 2105-2113.

Bhat, R., Verma, B. B., Reuben, E. (2001). Methodology note: Data Envelopment Analysis (DEA). *Journal of Health Management*, *3*(2), 309-328.

Bhat, V. N. (2005). Institutional arrangements and efficiency of health care delivery systems. *European Journal of Health Economics*, *50*, 215-222.

Borisov, D., Cicea C., Turlea, C. (2012). DEA model for assessing efficiency in providing health care. *Management Research and Practice*, *4*(1), 5-18.

Chang, S. J., Hsiao, H. C., Huang, L. H., Chang, H. (2011). Taiwan quality indicator project and hospital productivity growth. *Omega*, *39*(1), 14-22.

Charnes, A., Cooper, W. W., Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, *2*, 429-444.

de Cos, P. H., Moral-Benito, E. (2014). Determinants of health-system efficiency: evidence from OECD countries. *International Journal of Health Care Finance Economics*, *14*, 69-93.

DeRosario, J. M. (1999). Healthcare system performance indicators: a new beginning for a reformed Canadian healthcare system. *Journal of Healthcare Quality*, *21*(1), 37-41.

Evans, D. E., Tandon, A., Murray, C. J. L., Lauer, J. A. (2001). Comparative Efficiency Of National Health Systems: Cross National Econometric Analysis. *BMJ: British Medical Journal*, *323*(7308), 307-310.

Färe, R., Grosskopf, S., Lindgren, B., Poullier, J. (1997). Productivity growth in health-care delivery. *Medical Care*, *35*(4), 354-366.

Frogner, B. K., Frech, H. E., Parente, S. T. (2015). Comparing efficiency of health systems across industrialized countries: a panel analysis. *BMC Health Services Research*, *15*, 415-426.

Goncharuk, A. G. (2017). Socioeconomic Criteria of Healthcare Efficiency: An International Comparison. *Journal of Applied Management and Investments*, *6*(2), 89-95.

Goncharuk, A. G., Getman, M. (2014). Benchmarking to improve a strategy and marketing in pharmaceuticals. *Benchmarking: An International Journal*, *21*(3), 364-385.

González, E., Cárcaba, A., Ventura, J. (2010). Value efficiency analysis of health systems: does public financing play a role? *Journal of Public Health*, *18*(4), 337-350.

Giuffrida, A., Gravelle, H. (2001). Measuring performance in primary care: econometric analysis and DEA. *Applied Economics, 33*, 163-175.

Hadad, S., Hadad, Y., Simon-Tuval, T. (2013). Determinants of healthcare system's efficiency in OECD countries. *European Journal of Health Economics, 14*, 253-265.

Hollingsworth, B. (2003). Non-parametric and parametric applications measuring efficiency in health care. *Health Care Management Science, 6*, 203-218.

Hollingsworth, B., Wildman, J. (2003). The efficiency of health production: re-estimating the WHO panel data using parametric and non-parametric approaches to provide additional information. *Health Economics, 12*, 493-504.

Laine, J., Linna, M., Häkkinen, U., Noro, A. (2005). Measuring the productive efficiency and clinical quality of institutional long-term care for the elderly. *Health Economics, 14*(3), 245-256.

lo Storto, C. (2016). Ecological efficiency based ranking of cities: A combined DEA cross-efficiency and Shannon's entropy method. *Sustainability, 8*, 124.

lo Storto, C. (2017). Performance analysis of healthcare systems in European countries. *Bulgarian Journal of Business Research, 2*, 7-17.

Martini, G. M., Berta, P., Mullahy, J., Vittadini, G. (2014). The effectiveness – efficiency trade-off in health care: The case of hospitals in Lombardy, Italy. *Regional Science and Urban Economics, 49*, 217-231.

Kim, Y., Kang, M. (2014). The Measurement of Health Care System Efficiency: Cross-country Comparison by Geographical Region. *The Korean Journal of Policy Studies, 29*(1), 21-44.

Kim, Y. Oh. D., Kang, M. (2016). Productivity changes in OECD healthcare systems: bias-corrected Malmquist productivity approach. *International Journal of Health Planning Management, 31*, 537-553.

Murray, C. J. L. and Evans, D. (eds.) (2003). *Health systems performance assessment: Debates, Methods and Empiricism*. Geneva: World Health Organization (retrieved online from http://www.who.int/publications/2003/hspa/en/ on September 10, 2017).

Nayar, P., Ozcan, Y. A. (2008). Data envelopment analysis comparison of hospital efficiency and quality. *Journal of Medical Systems, 32*(3), 193-199.

Nolte, E., Wait, S., McKee, M. (2006). *Investing in health: benchmarking health systems*. Technical report published by The Nuffield Trust, London.

OECD (2014). *Geographic Variations in Health Care: What Do We Know and What Can Be Done to Improve Health System Performance?* OECD Health Policy Studies, http://dx.doi.org/10.1787/9789264216594-en

Ozcan, Y. A. (2008). *Health care benchmarking and performance evaluation: an assessment using data envelopment analysis (DEA)*. New York, NY: Springer.

Palmer, S., Torgerson, D. J. (1999). Definitions of efficiency. *BMJ, 318*, 1136.

Papanicolas, I., Smith, P. C. (eds.) (2013). *Health systems performance comparison: an agenda for policy, information and research*. New York, NY: Open University Press.

Perić, N., Hofmarcher-Holzhacker, M. M., Simon, J. (2017). Health system performance assessment landscape at the EU level: a structured synthesis of actors and actions. *Archives of Public Health, 75*(5), 1-10.

Rentzlaff-Roberts, D., Change, C. F., Robin, R. M. (2004). Technical efficiency in the use of health care resources: a comparison of OECD countries. *Health Policy, 69*(1), 55-72.

Scheel, H. (2001). Undesirable outputs in efficiency valuations. *European Journal of Operational Research, 132*, 400-410.

Spinks, J., Hollingsworth, B. (2009). Cross-country comparisons of technical efficiency of health production: a demonstration of pitfalls. *Applied Economics, 41*(4), 417-427.

Sudit, E. F. (1996). *Effectiveness, Quality and Efficiency: a Management Oriented Approach*. The Netherlands, Dordrecht: Kluwer Academic Publishers.

Tandon, A., Murray, C. J., Lauer, J. A., Evans, D. B. (2000). *Measuring overall health system performance for 191 countries*. Geneva: World Health Organization (retrieved online from http://www.who.int/healthinfo/paper30.pdf on September 4, 2017).

Tchouaket, É. N., Lamarche, P. A., Goulet, L., Contandriopoulos, A. P. (2012). Health care system performance of 27 OECD countries. *International Journal of Health Planning Management*, *27*, 104-129.

Tone, K. (2001). A slacks-based measure of efficiency in data envelopment analysis. *European Journal of Operational Research*, *130*, 498-509.

Varabyova, Y., Schreyögg, J. (2013). International comparisons of the technical efficiency of the hospital sector: Panel data analysis of OECD countries using parametric and non-parametric approaches. *Health Policy*, *112*, 70-79.

Varabyova, Y., Müller, J. M. (2016). The efficiency of health care production in OECD countries: A systematic review and meta-analysis of cross-country comparisons. *Health Policy*, *120*, 252-263.

World Health Organization (2000). *Health systems: Improving performance*. The World Health Report.

World Health Organization (2010). *Monitoring the building blocks of health systems: a handbook of indicators and their measurement strategies*. Geneva: WHO Press.

World Bank (2017). *Database: Health Indicators*. http://data.worldbank.org/indicator/ (data retrieved on May 20, 2017).