

The Efficiency of Health Care Systems in OECD Countries. Does it make a difference?

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Abstract: *The main aim of this article is to compare the Efficiency of Health Care Systems in 35 OECD countries during period 2008 – 2015. The efficiency of health care system is discussed topic in many articles and it is very difficult task to find the right methods according to which to measure health care efficiency. In our case for the comparing of the efficiency of health care systems we use nonparametric method, namely Data Envelopment Analysis (DEA). Two different output oriented models are used. The first one is with one output: life expectancy at birth and three inputs: health expenditures, total health and social employment and number of hospitals. The second one is with two outputs: all causes of deaths and infant mortality and three inputs like in the first model. All indicators are obtained from OECD database. Comparing results for these two models, that are very similar, show that both developing and developed countries can be effective.*

Keywords: Health care system, OECD countries, Efficiency, Data envelopment analysis.

JEL codes: I11, C60, C61

1 Introduction

Health state of population and health care belong to the most important questions which the individual countries must solve. Health population means that the people are able to work to earn money. This is the reason why the countries with a good health status of population have a highly developed economy. However, not only health status of population influences state of economy but on the other hand state of economy influences health status of population as well as described in (Jindrová and Kopecká, 2017).

Health care belongs to the most important area of the economy. The main results of health care efforts high life expectancy and low mortality caused by critical illnesses should be. Health care needs lots of financial funds which are used for health expenditure, health employment, hospitals, hospital facilities etc. These health resources should be employed effectively. Many publications deal with issues of efficiency of health care systems, which confirms the importance of this topic, for instance (Asandului et al., 2014; Bem et al., 2014; Evans et al., 2000; Hollingsworth et al., 1999; Kujawska, 2015; Pilyavsky and Staat, 2006).

The most of these papers use Data Envelopment Analysis (DEA) for measuring efficiency not only of health care systems but also another firms. For details see (Charnes et al., 1978; Charnes et al., 1995; Chlebounová, 2017; Dlouhý et al., 2007; Golubchikov, 2006; Pilyavsky et al., 2006; Sherman and Zhu, 2006). This method evaluate efficiency of objects according to values of input and output variables where it can be more of the both kinds of variables. This is very difficult task how to determine input and output variables because inputs should affect outputs but input variables should not be in association each other as well as output variables. Next problem can be observed in case of output variables

of health care systems such as life expectancy and mortality because these outputs are not only influence by health care but they are influence by another factors as well. For instance, gender, life style (alcohol, smoking), age structure of population but also political and economic conditions can be reasons for low life expectancy and high mortality (AMIEHS, 2011; Kossarova et al., 2013; Mackenbach, 2013).

OECD, 2016 compares life expectancy and mortality like outputs for measuring efficiency of health care systems. Final result of this comparison is that mortality is more suitable for measuring this efficiency because it is less affected by non-medial determinants than life expectancy.

2 Methodology and Data

The main objective of this article is to compare the efficiency of health care systems in 35 OECD countries during period 2008-2015 by using nonparametric method, namely DEA. DEA scores are computed based on inputs and outputs which are obtained from OECD database. Following variables are determined as inputs: health expenditure per capita (all financing schemes, US dollars), total health and social employment (per 1 000 population) and hospitals (per 1 000 000 population). Next following variables are stated as outputs: life expectancy at birth, all causes of death (per 100 000 population) and infant mortality (per 1 000 live birth). However, due to strong negative association between live expectancy at birth and all causes of death, two separate models are constructed.

Model Specification

It was Farrell, 1957 who first operationalized a frontier method to estimate the efficiency of a decision-making unit (DMU) by using approach which compared an individual DMU's observed level of inputs and outputs with the best practice production frontier. The frontier was derived by DMUs which could minimize inputs given output (input-oriented model) and maximize output given inputs (output-oriented model) under the usual assumption of production such as homogeneity of degree 0, strong disposability of inputs and outputs and ray homotheticity.

CCR and BCC model (Charnes et al., 1995) belong to the basic DEA models which exist for efficiency estimation of set of economic agents.

In this article output-oriented DEA model for measuring technical efficiency of health care systems is used. The main aim of output-oriented model is to maximize the outputs with the same level of inputs. Formula (1) expresses CCR output-oriented model which calculates technical efficiency proceedings from an assumption of constant return to scale (CRS). For details see (Charnes et al., 1995).

$$\max \phi + \varepsilon \vec{1}s^+ + \varepsilon \vec{1}s^-; s. t. X\lambda + s^- = X_0; Y\lambda - s^+ = \phi Y_0; \lambda \geq 0; s^+ \geq 0; s^- \geq 0 \quad (1)$$

where $X = \{x_{ij}\}$ – matrix of inputs ($i=1,2,\dots,M$) $Y = \{y_{rj}\}$ – matrix of outputs ($r=1,2,\dots,N$), $\varepsilon > 0$ is the so called non-Archimedean element that is determined as a number, which is smaller than any positive real number; s^+ , s^- – vectors of slacks.

Then technical efficiency is according to formula (2):

$$\theta = \phi^{-1}. \quad (2)$$

Next output-oriented efficiency can be estimated proceedings from an assumption of variable return to scale (VRS). This assumption is ensured by the introduction of limitation into formula (1). Formula (3) expresses this limitation.

$$\vec{1}\lambda = 1 \quad (3)$$

VRS means that increase of inputs do not have to be followed by the same increase of outputs.

This model was developed from CCR and it is called BCC output-oriented model as describe in (Charnes et al., 1995). Efficiency, calculated according to BCC model, is called pure technical efficiency (PTE) which excludes scale effect. It means that technical efficiency

calculated according to CCR model can be decompose onto two components, namely pure technical efficiency and scale efficiency (SE).

3 Results and Discussion

As mentioned above, output-oriented models considering CRS and VRS were calculated within estimation of efficiency of health care systems. However, for purposes of this article the results of output-oriented DEA models considering VRS are displayed because both CRS and VRS provide very similar results.

Both models employ the same three input variables, namely health expenditures per capita (US dollar), total health and social employment per 1 000 population and number of hospitals per 1 000 000 population. Health expenditure has increased on average from 3 101 US dollars per capita to 3 471 during period 2008 – 2015. Maximum health expenditures are 7 550 and on the other hand minimum expenditures are 891 in 2008. In the last observed year 2015 maximum value of health expenditures is 8 749 and minimum value is 942. Total health and social employment has increased on average as well from 45 to 49 per 1 000 population during this period. Maximum and minimum values of this indicator are 105 and 8 in 2008 and 109 and 9 in 2015. Finally number of hospitals per 1 000 000 population has decreasing trend. It has decreased from 31 to 29 on average. Maximum is 68 and minimum is 11 in 2008 and 72 and 10 in 2015.

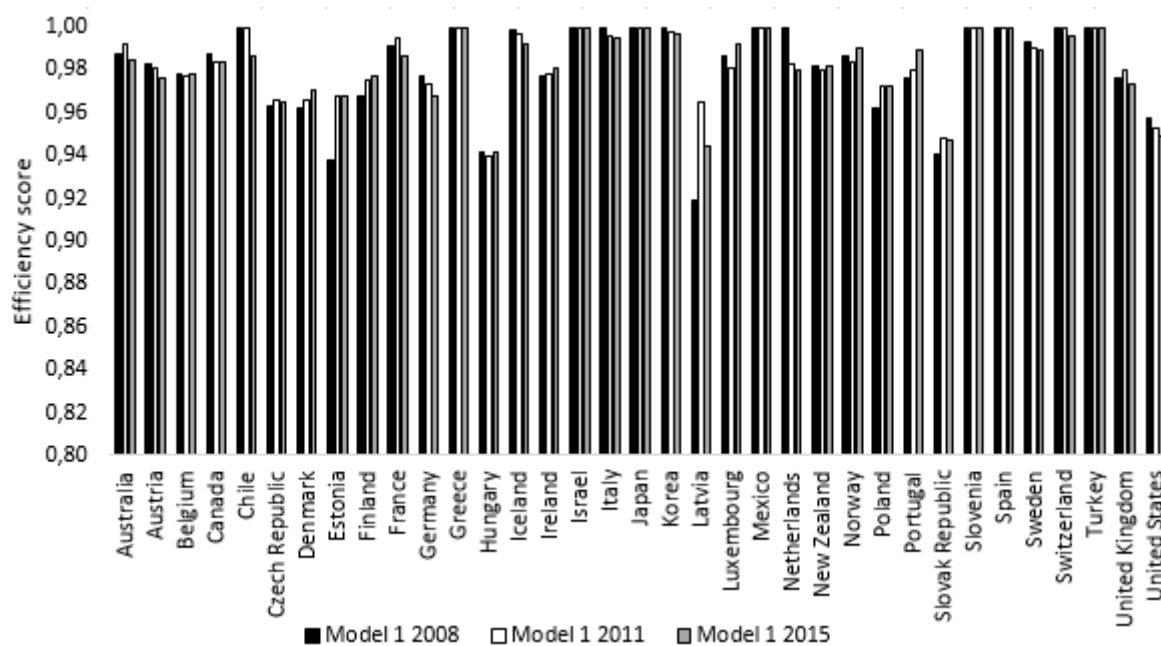
We also constructed two different models for the estimation of the efficiency of health care system (according to the different outputs used), namely Model 1 and Model 2.

Model 1 has one output: life expectancy at birth. This indicator has grown from 79 to 81 years on average during period 2008 - 2015. Maximum and minimum values have increased as well. Maximum value of this indicator has increased from 83 in 2008 to 84 years in 2015 and minimum value has increased from 72 in 2008 to 75 in 2015.

The second model, Model 2 has two outputs: all causes of deaths per 100 000 population and infant mortality per 1 000 live births. All causes of deaths have decreased from 877 in 2008 to 792 in 2015 on average. Maximum value of this indicator has decreased from 1 375 to 1 163 during this period and minimum value has decreased from 634 to 583. The second output variable called infant mortality has decreased from 5 in 2008 to 4 in 2015 on average. Maximum value of this indicator has decreased from 16 to 13 during this period and minimum value has decreased from 1.8 to 1.6. As mentioned above the main aim of output-oriented model is to maximize the outputs with the same level of inputs. Thus, for measuring efficiency of health care systems reciprocal values of mortalities are employed.

Efficiency scores are displayed for 35 OECD countries and for Model 1 in 2008, 2011 and 2015 in figure 1.

Figure 1 Efficiency scores (Model 1)

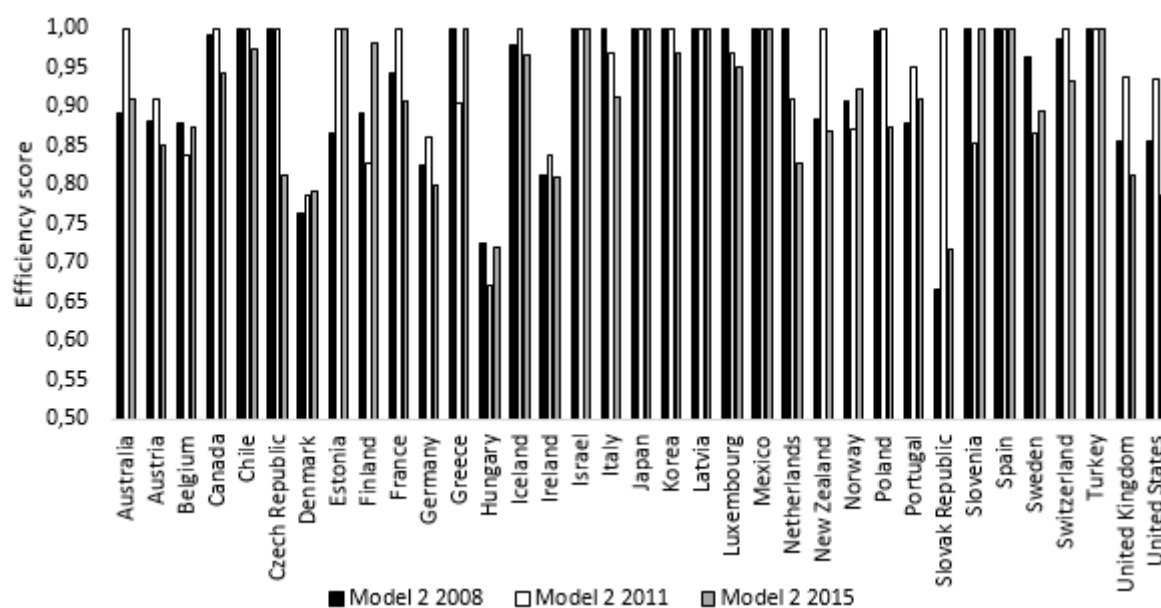


Source: OECD database

Figure 1 shows some countries which have effective health care systems in all three years, namely Greece, Israel, Japan, Mexico, Slovenia, Spain and Turkey. Some of these countries belong to the developing countries and some of them had to adopt austerity measures not only in health care systems but also in other economy sectors during this period, namely Greece and Spain. On the other hand countries such as Czech Republic, Denmark, Estonia, Finland, Hungary, Latvia, Slovak Republic and United States show very low efficiency scores during these years. It means that these inefficient countries should have higher life expectancy at birth with amount of resources which they use in comparing with another effective countries.

Next efficiency scores for Model 2 in the same three years are displayed in Figure 2

Figure 2 Efficiency scores (Model 2)



Source: OECD database

Figure 2 shows the same countries with effective health care systems in all three years but Latvia is next effective country according to Model 2. However, the big growth in efficiency scores is observed in case of many countries from 2008 to 2011 when countries increased their efficiency scores or became effective. But on the other hand this increasing efficiency of health care systems did not last long time. This situation occurred in case of these states, namely Australia, Austria, Canada, France, Germany, Iceland, Ireland, New Zealand, Poland, Portugal, Slovak Republic, Switzerland, United Kingdom and United States. Finally countries such as Austria, Belgium, Denmark, Finland, Germany, Hungary, Ireland, Norway, Portugal, Sweden, United Kingdom and United States show very low efficiency scores in all three years. It means that these inefficient countries should have lower mortalities with amount of resources which they use in comparing with another effective countries.

In table 1 the efficiency scores for 13 selected OECD countries in period 2008 – 2015 are displayed. Countries of Western and Eastern part of Europe and non-European developing and developed countries are selected. Countries which are effective at least according to one of two mentioned models from the beginning of the period or from the next year after the first recording efficiency year are colored black. Next countries which became effective at least according to one of models after the inefficient year are colored dark gray and finally, countries which became inefficient according to both models after the efficient year are colored light grey.

Table 1 Efficiency scores for selected OECD countries in period 2008 - 2015

Model	AUS	CZE	EST	FIN	FRA	DEU	ISR	JPN	MEX	POL	SVK	ESP	UK
Model 1 2008	0.99	0.96	0.94	0.97	0.99	0.98	1.00	1.00	1.00	0.96	0.94	1.00	0.98
Model 2 2008	0.89	1.00	0.87	0.89	0.94	0.83	1.00	1.00	1.00	1.00	0.67	1.00	0.86
Model 1 2009	0.99	0.96	0.95	0.97	0.99	0.97	1.00	1.00	1.00	0.96	0.94	1.00	0.98
Model 2 2009	0.93	1.00	1.00	0.82	0.94	0.82	1.00	1.00	0.91	0.89	0.71	1.00	0.86
Model 1 2010	0.99	0.97	0.97	0.97	0.99	0.97	1.00	1.00	0.99	0.97	0.95	1.00	0.98
Model 2 2010	0.93	1.00	1.00	0.96	0.94	0.82	1.00	1.00	0.81	0.88	0.66	1.00	0.86
Model 1 2011	0.99	0.97	0.97	0.98	1.00	0.97	1.00	1.00	1.00	0.97	0.95	1.00	0.98
Model 2 2011	1.00	1.00	1.00	0.83	1.00	0.86	1.00	1.00	1.00	1.00	1.00	1.00	0.94
Model 1 2012	0.99	0.97	0.97	0.97	0.99	0.97	1.00	1.00	1.00	0.98	0.95	1.00	0.98
Model 2 2012	1.00	0.78	0.90	0.87	0.98	0.91	1.00	1.00	1.00	0.83	1.00	1.00	1.00
Model 1 2013	0.99	0.96	0.97	0.97	0.99	0.97	1.00	1.00	1.00	0.97	0.94	1.00	0.97
Model 2 2013	1.00	1.00	0.81	0.82	1.00	0.82	1.00	1.00	1.00	1.00	0.72	1.00	0.96
Model 1 2014	0.99	0.96	0.96	0.97	0.99	0.97	1.00	1.00	1.00	0.97	0.94	1.00	0.98
Model 2 2014	0.91	0.84	1.00	0.88	0.91	0.80	1.00	1.00	1.00	0.89	0.71	1.00	0.82
Model 1 2015	0.99	0.97	0.97	0.98	0.99	0.97	1.00	1.00	1.00	0.97	0.95	1.00	0.97
Model 2 2015	0.91	0.81	1.00	0.98	0.91	0.80	1.00	1.00	1.00	0.87	0.72	1.00	0.81

Source: OECD database

Countries such as Israel, Japan, Mexico and Spain have effective health care system nearly in each year of this period. Despite the fact that some of these countries keep effective health care systems they belong to the countries which have low health expectancy at birth and high mortality. This is the reason for looking for another causes of these health results. On the other hand most of Western European countries do not maintain effective health care system and use health care resources which should cause higher life expectancy at birth and lower mortality in comparison with effective countries.

4 Conclusions

Based on OECD database our results showed that efficiency of health care systems does not depend on state of health in individual countries because countries with the low life

expectancy and the high mortality can be effective as well as countries with the high life expectancy and the low mortality. Especially developing countries belong to the countries which have effective health care system during all period. On the other hand, the developed European countries such as Finland, Germany and United Kingdom are not effective nearly all period 2008 – 2015. These countries employed too many health care resources and they do not reach adequate life expectancy or mortality in comparison with effective countries. This is the reason for the next research to determine how other factors such as environmental, educational, political etc. influence on the health care system efficiency in studied countries.

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