IDENTIFYING AND EXPLAINING THE EFFICIENCY OF THE PUBLIC HEALTH SYSTEMS IN EUROPEAN COUNTRIES

Laura ASANDULUI*, Cristian POPESCU**, Ionuț Puiu FĂTULESCU***

Abstract

The purpose of this study was to identify the efficient European healthcare systems. The study differs from other similar researches in that it uses different variables in assessing the efficiency of the healthcare systems, and also in that it uses a two-stage approach in the analysis.

In order to identify the efficient healthcare systems, we used a non-parametric method, Data Envelopment Analysis, which allows the evaluation of the countries against an efficiency frontier. Furthermore, we explain the efficiency by analysing several factors which influence the efficiency of the healthcare systems, using the censored regression analysis.

The findings indicate that there are significant efficiency disparities both among the developed states and among the developing ones. Finally, we suggest several directions for the public policy, in order to increase the efficiency of the public healthcare systems in the European countries.

Keywords: efficiency, public health system, determinants, data envelopment analysis

JEL classification: C4, C5, I1

1. INTRODUCTION

The efficiency of the health systems is a key issue of the public policy and creates a clear picture of the welfare level. In order to establish a hierarchy of the European countries in terms of efficiency, we conducted an analysis of the national health systems. This can be useful in establishing the priorities when allocating the funds and in the widely debated restructuring plan of the health systems in Europe. In the second part of the study we highlighted the factors that influence the (in)efficiency of the health systems, using regression analysis to suggest directions for the public policy. The methods we used are the Data Envelopment Analysis (DEA) and the censored regression.

Our approach is placed at the macro level, evaluating the systems as wholes (Delnoij *et al.*, 2003; Berkman, 2011; Brand, 2007; McKee and Ryan, 2003; Lahelma *et al.*, 1996), taking into consideration 30 European countries. DEA has been widely used for highlighting

* "Alexandru Ioan Cuza" University of Iasi, Romania; e-mail: *asand@uaic.ro.*

** "Alexandru Ioan Cuza" University of Iasi, Romania; e-mail: *popescu@uaic.ro.*

*** "Alexandru Ioan Cuza" University of Iasi, Romania; e-mail: *puiufatulescu@yahoo.com.*

the efficiency of health systems from developed and developing countries (Hussey *et al.*, 2009). The efficiency of the Norwegian health care system was analysed (Van den Noord *et al.*, 1998), and also DEA was used to analyse the efficiency of health care systems in 191 countries (Evans *et al.*, 2001). There are other studies that evaluate the efficiency of health systems with the DEA method: Fizel and Nunnikhoven, 1992; Valdmanis, 1992; Kooreman, 1994; Thanassoulis *et al.*, 1996; Parkin and Hollingsworth, 1997; Chirikos and Sear, 2000; Rollins *et al.*, 2001.

Using DEA, we identified an efficiency frontier by calculating efficiency scores. Most of the countries analysed are outside this border. Using the regression analysis, we found that four variables are significant in explaining the efficiency (or, in some cases, we will analyse in terms of inefficiency): the percentage of the population over 65, the level of urbanization, the Literacy Rate, and Euro Health Consumer Index (EHCI). Our research differs from a number of other previous studies, which take into account the level of GDP/capita, the obesity or the smoking habits of the population (Afonso and Aubyn, 2006), the number of treated patients, the mortality rate, the life time span (Palmer and Torgerson, 1999). We believe that the variables selected by us provide a more accurate picture of the positioning of the various European health systems. The correlation between the hierarchy we established through the efficiency analysis and that of the World Health Organization, determined by direct questioning the beneficiaries (patients), is high.

The hypotheses are:

- there is a great heterogeneity in terms of efficiency in the health systems among the European countries;

- the Eastern European countries have inefficient health systems, requiring major adjustments in their organization;

- the most developed countries are closest to the efficiency frontier, with a direct correlation between the level of development and the health state of the population;

- the efficiency of health public spending is influenced by a number of exogenous variables.

The paper contains five sections, as follows: literature review is provided in section two; section three outlines the methodological approach used in the paper; in section four we present and interpret the results of our analysis and section five contains the conclusions.

2. LITERATURE REVIEW

If we look back in history, it is impossible not to notice that spectacular bounces in the evolution took place when population's health status was good and that significant throwbacks occurred when population's health status was bad. Diseases such as plague ("The Black Death" haunted Europe between 1347 and 1351 and killed over 25 million people, pushing the old continent into its darkest period of the Middle Ages; the next pandemic was in the 18th century and considerably delayed the start of the Industrial Revolution), measles, flu, syphilis, tuberculosis, etc., stopped great economic evolutions or even destroyed civilizations (according to the experts, the Maya civilization disappeared because of a pandemic). There are many studies which emphasize the correlation between the health status and economic growth. For example, eradication of the plague in Mediaeval Europe created the premises of a demographic boom, which later became the basis of the industrial revolution (Braudel, 1998). In the USA, the increased attention towards the medical system's reform after the Great Depression generated a substantial increase in

productivity. Sanitary hygiene and food hygiene also account for the increase in productivity. According to Fogel (1994), a sufficient amount of calories collected through correct nutrition and the acknowledgement of its importance achieved by promoting medical information, led, over 200 years, from 1780 to 1980, to an increase by over 56% of the work provided by the British workers. The workers' physical condition visibly improved, thanks to appropriate medical assistance and adequate nutrition. Certain studies (Benefo and Schultz, 1996; Fogel, 1994; Martorell and Habicht, 1986) conclude that there is a direct connection between the weight/height ratio, nutrition and work capacity or between nutrition and productivity. An interesting study is that conducted by Thomas, Schoeni and Strauss (1996) on Brazil's population, in which the authors correlate the data on the individuals' height and their salaries. They conclude that 1% increase in height leads to a 3% increase in the salary in the case of men and 2% in the case of women. In poor countries, this correlation is even stronger, according to Schultz (2003). According to Bloom and Canning (2000) improving health can be as important as an increase in the revenues, if we consider the welfare of the individuals. The relation between different demographic factors and economic growth was assessed by Lleras-Muney (2005) who showed that as the mortality rate falls, the demand for educational investments increases.

Each individual is responsible for his own health status. However, due to the fact that, by its essence, the health status generates many externalities, it also becomes a public policy concern.

For this reason, when talking about the state's intervention in this domain, the comments of the non-interventionists have been conducive to the gradual acceptance of a fruitful cohabitation of the public and private competing systems. Once this compromise is put into effect, the issue of efficiently spending the public money on health services is raised.

Public policies can be evaluated by analyzing whether governments use their resources in an economically efficient manner (Geys and Moesen, 2009). For example, Geys and Moesen use parametric and nonparametric methods to estimate the level of local government technical efficiency in Flanders in 2000. In assessing the efficiency, the choice of inputs and outputs is extremely important and depends on what is important for both the subject(s) and those responsible for the efficiency study (Geys and Moesen, 2009, p. 501).

DEA model was not used convincingly in health systems analysis. At the same time, however, in the literature we find many analyses of public resources allocation efficiency.

The researchers' interest have also been channelled towards the connection between sectorial public spending (especially for education and health) and their outcomes (Rajkumar and Swaroop, 2008). The economic efficiency of the healthcare system means the latter gives to the economy more than it takes from it. The economic effectiveness of the health-care system is frequently higher than the activity directly aimed at the solution of economic problems (Miller and Adam, 1996). Jayasuriya and Wodon (2007) used panel data for provinces from Argentina and Mexico to measure the efficiency of medical and educational services.

Previous research on the efficiency of the public sector that apply non-parametric methods find significant differences in efficiency across countries [Fakin and De Crombrugghe (1997), Gupta and Verhoeven (2001), Aubyn (2003), Afonso et al. (2005, 2006), Afonso and Aubyn (2003, 2006), Baciu and Botezat (2014)]. Most studies apply the Data Envelopment Analysis method, while Afonso and Aubyn undertake a two-step DEA/Tobit analysis in a cross country analysis of secondary education efficiency.

3. DATA AND METHODS

The data were collected from Eurostat and the WHO databases for 30 European countries. In order to calculate the efficiency scores, we used the following input variables: the number of radiotherapy units per 1,000,000 inhabitants, public health expenditures as a percentage of the Gross Domestic Product (GDP), the number of hospital beds for 10,000 inhabitants. The output variables are the incidence of tuberculosis, the number of deaths by ischemic diseases per 100,000 inhabitants, and the health adjusted life expectancy (HALE).

Why have we selected those indicators? The percentage of the GDP spent on the public health sector shows a good correlation in the existing resources, between the development level and the governments' interest in the population's health. The number of beds is one of the most widely used indicators in health; theoretically, it shows the treatment capacity of the health-care systems. However, this indicator has some shortcomings, because there are suspicions that the countries of Central and Eastern Europe artificially keep the beds, for reasons of statistical reporting but also due to the managers' interest. On the other hand, the existence of the beds does not always correlate with the presence of the whole existing infrastructure (equipment, support staff, procedures, etc.). However, the number of beds can provide an insight into the hospital capacity of a health system, as a result of the investments that have been developed over the time. The number of Radiotherapy Units, was selected due to the complexity of the investments and to the relatively strict control over the functioning, which mostly removes the false reports.

In terms of output indicators, Health Adjusted Life Expectancy (HALE) is a reflection of the effectiveness of the health systems, as there is a strong correlation between health expenditure and the population's life expectancy. The number of deaths by ischemic diseases per 100,000 inhabitants has been selected because the ischemic diseases are a leading cause of death in Europe and in the world, and proper but expensive treatments can significantly extend the life expectancy even if the disease has occurred. The Incidence of Tuberculosis is the third output variable used. Tuberculosis appears and spreads as a result of poor nutrition, lack of prevention and of the ineffectiveness of treatments applied in hospital units. From our analysis showed that the incidence of tuberculosis may play the role of an adjustment variable, because of its specificity: it occurs where there is poverty and lack of preventive actions.

The efficiency scores calculated with DEA are used as dependent variables. The explanatory variables considered in the model are: the percent of population over 65, the level of urbanization, the literacy rate, and the Euro Health Consumer Index (EHCI).

The aging population is one of the major problems of the developed countries. According to the 2012 Ageing Report, issued by the European Commission, the ratio of the people over 65 will increase in the EU from 17% to 30% by 2060, while the percentage of active persons will decrease by over 11%.As a result, the ratio between the retired people and the workers will increase from 39% in 2010 to 71% in 2060, which will significantly influence the social systems. An aging population leads to increased expenditures for the health sector and to its decreased efficiency or, in other words, to its inefficiency.

The level of urbanization also influences the efficiency of health system. Increased urban facilities help the improvement of the population's level of health. Easy access to the health infrastructure, rapid interventions and better dissemination of the information are advantages which should support a higher state of health.

The literacy rate is also an explanatory variable of the efficiency in the health system. A high degree of literacy means increased access to information and a better perception of

the preventive medicine. It is well-known that the birth and infant mortality rates are higher among uneducated families. Therefore, the spending for the health recovery of this segment of the population may affect the efficiency of a system.

The Euro Health Consumer Index is one of the most used indicators of the effectiveness of the health systems in Europe. It is an index based on the subjects' self-assessment of their health status and the quality of medical services. This is a good explanatory variable for the inefficient health care systems because, according to self-perceived health status, people may or may not use the services of the health systems. Periodical checks, keeping the patients under control, preventive treatments consistently reduce the occurrence of certain serious illnesses that require substantial amounts to perform treatment and to prolong the life. An exaggerated optimism regarding their health state associated with a negative perception of the health services offered leads to an increased number of serious illnesses such as cancer, heart diseases, etc.

The empirical analysis contains descriptive statistics followed by correlation analysis for the variables used in DEA. Then, the (in) efficiency scores are determined for each country using Data Envelopment Analysis.

Measuring system's efficiency concerns the relationship between the inputs it uses and the outputs it produces. An efficient health system would be one that produces the maximum possible outputs with a given inputs, or one that produces a certain level of output with minimum inputs. The method applied in this research, Data Envelopment Analysis (DEA), is generally accepted as one of the best in assessing the efficiency of a set of decision making units (DMU). DEA is a 'data-oriented' method in that it effects its evaluations directly from observed data (Cooper and Tone, 1997, p. 72).

A DMU is to be rated as fully (100%) efficient on the basis of available evidence if and only if the performances of other DMUs does not show that some of its inputs or outputs can be improved without worsening some of its other inputs or outputs (Cooper *et al.*, 2000, p. 3). In this study, an input oriented DEA model is applied. All deviations from the efficient frontier are classed entirely as inefficiency.

In order to assess the influence of environmental variables on (in)efficiency, the regression analysis was used. The (in)efficiency scores are regressed on factors that may influence inefficiency. These factors are measured by environmental variables. The environmental variables are different from input variables used in DEA.

We have used a limited dependent variable model because of the restriction for the values of the dependent variable. The dependent variable is continuous but it is censored below 1 and above 0 values. The censored regression model arises due to data censoring. We assume that the true inefficiency score depends on the environmental variables. In our analysis, we used both left-censored and right-censored variables with the lower limit 0 and the upper limit 1.

4. RESULTS

4.1. Descriptive Statistics and Correlations

Table 1 summarizes the main descriptive statistics of the six variables. The number of radiotherapy units ranges from 1.2 units for 1,000,000 inhabitants (Romania) to 9.9 units for 1,000,000 inhabitants (Denmark). Moreover, 50% of the countries from the sample have less than 4.45 radiotherapy units per 1,000,000 inhabitants

Table no. 1 – Descriptive Statistics of output and input variables

Statistics	Radiotherapy Units	Public Health Expenditure Percentage	Number of Beds	Incidence of Tuberculosis	Ischaemic Heart Disease	HALE
Min.	1.2	2.457	21	4.4	32.1	52.4
Median	4.45	6.696	56.5	8.75	84.05	62
Max.	9.9	8.98	82	116	305.1	71.7
Mean	4.88	6.527	54.27	18.007	113.59	61.67

Source: Authors' calculations

The percentage of public health expenditures has a minimum of 2.45% (Cyprus) and a maximum of 9% for (Denmark and France). Furthermore, 50% of the states allocate less than 6.7% of the GDP to Health. The number of hospital beds for 10,000 inhabitants ranges from 21 beds per 10,000 inhabitants in Sweden, to 82 beds per 10,000 inhabitants in Germany. 50% of the countries have less than 56.5 beds per 10,000 inhabitants. The incidence of tuberculosis per 100,000 inhabitants ranges from 4.4 new cases per 100,000 inhabitants (Cyprus) to 116 new cases of tuberculosis per 100,000 inhabitants (Romania). The mean is 18 new cases per 100,000 inhabitants and the median is 8.75. These values provide clear evidence that the values of the incidence of tuberculosis are skewed and that mean is biased by Romania's high value. The number of deaths by ischemic deaths per 100,000 inhabitants ranges from a value of 32.1 in France to 305.1 ischemic deaths per 100,000 inhabitants in Lithuania. Also, 50% of the countries have less than 84.05 ischemic deaths per 100,000 inhabitants. HALE ranges from 52.4 years (Slovakia) to 71.7 years (Sweden). 50% of the countries have a population with less than 62 healthy years.

The health expenditures are significantly and strongly correlated with the number of radiotherapy units (0.71). The correlation is explainable by the fact that wealthier economies spend more money on technologies, research and development than growing or poor economies, which spend the health budget on curing and assuring basic services. There is a negative and statistically significant correlation between HALE and the number of death caused by ischemic diseases (-.576). HALE decreases as the number of people suffering from ischemic diseases increases.

4.2. Data Envelopment Analysis

Introducing these variables in the model, we have obtained the results presented in Table 2. The Constant Return to Scales (CRS) input oriented model identifies 8 countries out of the 30 states on the efficiency frontier and 22 countries with inefficient health systems. Thus, Denmark, France, Germany, Italy, Netherland, Portugal, Spain and Sweden were identified as having efficient health systems. Close to the frontier are also Norway and Austria, with a score of 0.95 meaning that, in order to be as efficient as their reference set, the countries should reduce their input utilization level by 5%. The Eastern European block is in the second part of the ranking, with the lowest scores. Thus, starting with the Czech Republic which has a score of 0.68, the scores for the Eastern countries decrease constantly down to 0.38 (Latvia). In other words, Eastern European countries should reduce the level of resources used in health with values ranging from 32% (Czech Republic) to 62% (Latvia), to become as efficient as the Western health systems. The lack of coherence in health system reforms, their insufficiency and poor management of resources can be some of the causes of such poor results.

Table no. 2 – Results for the health system's efficiency, Input oriented, Constant Returns to Scale

Country	Score	Rank	Country	Score	Rank
Denmark	1	1	Iceland	0.867	16
France	1	1	Finland	0.732	17
Germany	1	1	Luxembourg	0.730	18
Italy	1	1	Malta	0.706	19
Netherlands	1	1	Czech Republic	0.681	20
Portugal	1	1	Croatia	0.679	21
Spain	1	1	Slovenia	0.629	22
Sweden	1	1	Slovakia	0.535	23
Norway	0.952	9	Hungary	0.510	24
Austria	0.952	10	Estonia	0.509	25
Greece	0.944	11	Poland	0.508	26
Belgium	0.922	12	Bulgaria	0.489	27
Ireland	0.912	13	Lithuania	0.465	28
United Kingdom	0.906	14	Romania	0.441	29
Cyprus	0.877	15	Latvia	0.377	30

Source: DEA Solver, 2012.

When discussing the weights obtained for the set of variables, it can be seen that for 16 countries the public health expenditures as a percentage of the GDPcontributesto100% when calculating the score of the overall efficiency. This is because the DEA input model takes into account the highest attainable score, given by the combination of inputs. Thus, for the Eastern European countries for example, the gap between the uses of radiotherapy units compared to Western economies was more important and more difficult to absorb than the percentage of health expenditure. The countries from the efficiency frontier obtain their score from a mix of different proportions of the three input variables. Italy, Germany, Netherland and Spain perform best in the public health expenditures as percentage of the GDP; Spain, Portugal and France perform best in the number of beds per 10,000 inhabitants and Denmark performs best in the number of radiotherapy units per 1,000,000 inhabitants. Moreover, Denmark is also the state with the highest value for the number of radiotherapy units per 1,000,000 (9.9).

In terms of slacks, the model identifies Cyprus as the only state which should increase health expenditures percentage of the GDP in order to become efficient. The other states except those on the frontier have to modify the use of radiotherapy units and the number of beds to different extents, in order to achieve efficiency.

In order to reach the efficiency frontier, Romania should increase the number of radiotherapy units to 9.85 per 1,000,000 inhabitants. Moreover, the percentage of the GDP allotted to health should increase to a 226.96% of the current level, reaching 9.74% of the GDP and the number of beds should decrease by 74.09%. Even in these conditions, the model emphasizes that Romania should reduce the incidence of tuberculosis to 8.48 cases per 100,000, this way reducing the considerable gap compared to the other states. In broader terms than those imposed by the model, Romania should focus on the increasing the technological aspects of the health system and on avoiding the tendency to oversize it, at the expense of the quality of the medical service. A smaller number of health units would allow better funding of the existing ones, which would lead to an improvement in the results.

Luxembourg and Finland have a high value of the GDP per capita, high percentages of the GDP allocated to the health system and yet the model reveals a certain degree of efficiency. This can be explained by the output variables chosen. Heart diseases occur more often with older people and their health significantly deteriorates. Therefore, the health system spends considerable amounts to support the elderly. In the case of Finland a further problem occurs, that is a high consumption of alcohol, which is a significant cause of ischemic death.

4.3 Regression Analysis

Because economic and demographic factors play a relevant role in determining heterogeneity across countries regarding health systems and in order to explain efficiency, we have extended our analysis to exogenous factors and have performed the regression analysis.

Therefore, the hypotheses are that the efficiency of the health systems depends on the percentage of the population over 65, the level of urbanization, the Literacy Rate, and EHCI.

The correlations across dependent and independent variables indicate that there is a significant, positive, relatively strong correlation between the DEA score and the EHCI indicator (0.74).The following regression equation is estimated:

$$y_i = \beta_0 + \beta_1 OldPop + \beta_2 UrbLev + \beta_3 Literacy + \beta_4 EHCI + \varepsilon_i$$

Table 3 reports the results of the censored regression analysis.

Table no. 3 – Censored regression' results

Coefficients					
	Estimate	**Std. error**	**t value**	**Pr (> t)**	
(Intercept)	5.7211086	1.8640797	3.069	0.002147	**
OldPop	2.9245393	1.2067272	2.424	0.01537	*
UrbLev	-0.0029739	0.0025834	-1.151	0.249667	
Literacy	-0.0676094	0.0189039	-3.576	0.000348	***
EHCI	0.0022153	0.0003304	6.705	2.02E-11	***
logSigma	-2.0315569	0.1556593	-13.051	< 2e-16	***

Source: Authors' calculations; Note: Significance codes: '***' 0.001 '**' 0.01 '*' 0.05.

β_i estimates the effect of explanatory variables on the latent response variable, y*. The estimated coefficients are the marginal effects of a change in x_i on y*, the latent variable. Change in observable y is found by multiplying the coefficient with Pr (0<y*<1) that is the probability of being uncensored. The logarithm of the residuals' standard deviation is used during the estimation procedure (Table 3).

Our findings from the regression analysis support three out of the four hypotheses on the determinants of efficiency. Therefore, the score is influenced by the percentage of the population over 65, the Literacy Rate, and EHCI. The level of urbanization did not prove to influence significantly the differences among countries regarding the efficiency of the health systems. The variables EHCI and old population have positive effects on the efficiency score, while Literacy has negative effects on the efficiency measure.

An increase in education achievement measured by literacy reduces the inefficiency score by 6.5%, implying that the relevant countries move closer to the production frontier. Therefore, the better the level of education of the population is, the higher is the efficiency.

Aged population affects the inefficiency score, especially in countries with a high GDP and a large proportion of population over 85, such as Luxembourg and Finland. In theory, these two countries should be much closer to the efficiency frontier, having high percentages of the GDP allocated to health care and good infrastructure. However, the costs are also high just because of the large number of medically assisted aged persons.

5. CONCLUSIONS

The evaluation of the health care systems is a very difficult process. The difficulty arises from the specificity of the approach, which cannot be achieved in a purely economic manner, given that an output with deep social implication is taken into account. We refer to an individuals' health status, which is an important determinant of welfare and social stability and not just an economic effect of resources allotment. For this reason, increasing the efficiency of the health system should be a priority for each state which wants to acquire the status of a developed economy. Moreover, speaking from the perspective of human capital theories, an economy cannot positively evolve in the long term unless it invests in a continuous process of improvement in the health status, which is an important determinant of labour.

Starting from these premises, we have tried to identify a possibility to measure the efficiency/inefficiency of the public money allocations for the health services in the European Union, in order to identify the best cases and to classify the states according to their efficiency scores. What is the reason? The new member states, as well as some of those ranked as developed countries, are currently going through certain stages of restructuring the public health system, where they need models and examples. Although imitating is not the best approach to increase efficiency, it remains the cheapest option. The alternative could be experimentation. However, given the specificity of the domain and the immediate implications (e.g. the health of the citizens and the immediate impact on economic growth), situations of uncertainty should be avoided. The social experiment, as Popper emphasized, is inappropriate. A possible failure would be measured in loss of human lives and there is neither morale nor political justification for those policy-makers who would assume the process.

Our results show that there are situations, like Denmark's, where a certain efficiency state can be attained by correctly allocating available resources, even if these are low. There are many examples of countries in which, although they spend large amounts of money on health (UK, Belgium, Austria with over 3400 $ per capita), the efficiency of their allocation is substantially lower than in countries like Portugal, Spain (which allocates under 3000$ per capita).

Therefore, the hypothesis according to which the most developed states are closest to the efficiency frontier is only partially verified. The reality shows that there are developed countries with very inefficient health systems (Finland, Luxembourg). Instead, the paper proves the hypothesis that the developing states, especially the former communist countries sample, are located furthest from the border, still need in reforms and major investments focused on resources allocation and their correlation with the economies' potential. Increasing the efficiency of the health system should be a priority for each state which wants to acquire the status of a developed economy.

Overall, it can be seen that there are huge differences within the analysed sample. There are significant efficiency disparities both between the developed states and between the developing ones. The last hypothesis, that of exogenous influences, is mostly confirmed, as three of the four variables proposed by us get positive scores. Therefore, making health

systems efficient is not related just to the volume of investments, but also to global reforms, aimed to raise the living standard, the level of education, the social security and the positive social perception.

Our analysis has some limitations, induced by the adopted analysis model, which limited the number of possible variables that could be taken into account. Although we have tried to choose the most representative ones, changing them could reorder a countries' position in the efficiency table. However, the changes are not significant, the assumptions being validated in the same way and in other possible combinations. In the future, we intend to check the efficiency using another model that allows the introduction of a greater number of variables.

References

Afonso, A., and Aubyn, M. S., 2003. Non-parametric approaches to education and health expenditure efficiency in the OECD countries. *Working Papers*.

Afonso, A., and Aubyn, M. S., 2006. Relative Efficiency of Health Provision: a DEA Approach with Non-discretionary Inputs. *Working Papers, 33*.

Afonso, A., Schuknecht, L., and Tanzi, V., 2005. Public sector efficiency: An international comparison. *Public Choice, 123*(3), 321-347. DOI: http://dx.doi.org/10.1007/s11127-005-7165-2

Afonso, A., Schuknecht, L., and Tanzi, V., 2006. Public sector efficiency: evidence for new EU member states and emerging markets. *European Central Bank, Working Paper*(581).

Aubyn, S. M., 2003. Evaluating efficiency in the Portuguese health and education sectors. *Economia, 26*.

Baciu, L., and Botezat, A., 2014. A Comparative Analysis of the Public Spending Efficiency of the New EU Member States: A DEA Approach. *Emerging Markets Finance and Trade, 50*(Supplement 4), 31-46.

Benefo, K., and Schultz, T. P., 1996. Fertility and child mortality in Cote d'Ivoire and Ghana. *The World Bank Economic Review, 10*(1), 123-158. DOI: http://dx.doi.org/10.1093/wber/10.1.123

Berkman, L. F., 2011. Unintended consequences of social and economic policies for population health: Toward a more intentional approach. *European Journal of Public Health, 21*(5), 547-548. DOI: http://dx.doi.org/10.1093/eurpub/ckr124

Bloom, D. E., and Canning, D., 2000. The health and wealth of nations. *Science, 287*(5456), 1207-1209. DOI: http://dx.doi.org/10.1126/science.287.5456.1207

Brand, H., 2007. Good governance for the public's health. *European Journal of Public Health, 17*(6), 541. DOI: http://dx.doi.org/10.1093/eurpub/ckm104

Braudel, F., 1998. *Les Mémoires de la Méditerranée*. Paris: De Fallois.

Chirikos, T. N., and Sear, A. M., 2000. Measuring hospital efficiency: A comparison of two approaches. *Health Services Research, 34*(6), 1389-1408.

Cooper, W. W., Seiford, L. M., and Tone, K., 2000. *Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software*. Boston: Kluwer Academic Publishers.

Cooper, W. W., and Tone, K., 1997. Measures of inefficiency in data envelopment analysis and stochastic frontier estimation. *European Journal of Operational Research, 99*(1), 72-88. DOI: http://dx.doi.org/10.1016/S0377-2217(96)00384-0

Delnoij, D. M. J., Klazinga, N. S., and Van der Velden, K., 2003. Building integrated health systems in Central and Eastern Europe: An analysis of WHO and World Bank views and their relevance to health systems in transition. *European Journal of Public Health, 13*(3), 240-245. DOI: http://dx.doi.org/10.1093/eurpub/13.3.240

Evans, D., Mays, N., and Wyke, S., 2001. Evaluating complex policies: What have we learned from total purchasing? *, 7*(4), 405-426. DOI: http://dx.doi.org/10.1177/135638900100700402

Fakin, B., and De Crombrugghe, A., 1997. Fiscal adjustments in transition economies transfers and the efficiency of public spending: A comparison with OECD countries *World Bank Policy Research Working Paper*.

Fizel, J. L., and Nunnikhoven, T. S., 1992. Technical efficiency of for-profit and non-profit nursing homes. *Managerial and Decision Economics, 13*(5), 429-439. DOI: http://dx.doi.org/10.1002/mde.4090130507

Fogel, R. W., 1994. Economic growth, population theory, and physiology: the bearing of long-term processes on the making of economic policy *Working Papers*. Cambridge: National Bureau of Economic Research.

Geys, B., and Moesen, W., 2009. Measuring Local Government Technical (In)Efficiency. An Application and Comparison of FDH, DEA, and Econometric Approaches. *Public Performance & Management Review, 32*(4), 499-513. DOI: http://dx.doi.org/10.2753/PMR1530-9576320401

Gupta, S., and Verhoeven, M., 2001. The efficiency of government expenditure - experiences from Africa. *Journal of Policy Modeling, 23*(4), 433-467. DOI: http://dx.doi.org/10.1016/S0161-8938(00)00036-3

Hussey, P., De Vries, H., Romley, J., Wang, M. C., Chen, S. S., Shekelle, P. G., and McGlynn, E. A., 2009. A systematic Review of Health care Efficiency Measures. *Health Services Research, 44*(3), 784-805. DOI: http://dx.doi.org/10.1111/j.1475-6773.2008.00942.x

Jayasuriya, R., and Wodon, Q., 2007. Efficiency in improving health and education outcomes: provincial and state-level estimates for Argentina and Mexico. *Estudios Económicos., 22*(2), 57-97.

Kooreman, P., 1994. Nursing home care in The Netherlands: A nonparametric efficiency analysis. *Journal of Health Economics, 13*(3), 301-316.

Lahelma, E., Karisto, A., and Rahkonen, O., 1996. Analysing inequalities: The tradition of socioeconomic public health research in Finland. *European Journal of Public Health, 6*(2), 87-93. DOI: http:dx.doi.org/10.1093/eurpub/6.2.87

Lleras-Muney, A., 2005. The relationship between education and adult mortality in the United States. *The Review of Economic Studies, 72*(1), 189-221. DOI: http://dx.doi.org/10.1111/0034-6527.00329

Martorell, R., and Habicht, J. P., 1986. Growth in early childhood in developing countries. *Human growth: a comprehensive treatise. Volume 3: Methodology and ecological, genetic, and nutritional effects on growth, 2nd ed* (pp. 241-262). New York: Plenum Press.

McKee, M., and Ryan, J., 2003. Monitoring health in Europe: opportunities, challenges and progress. *European Journal of Public Health, 13*(3), 1-4. DOI: http://dx.doi.org/10.1093/eurpub/13.suppl_3.1

Miller, J. L., and Adam, E. E., 1996. Slack and performance in health care delivery. *International Journal of Quality & Reliability Management, 13*(8), 63-74. DOI: http://dx.doi.org/10.1108/02656719610128501

Palmer, S., and Torgerson, D. J., 1999. Definitions of efficiency. *British Medical Journal, 318*(7191), 1136. DOI: http://dx.doi.org/10.1136/bmj.318.7191.1136

Parkin, D., and Hollingsworth, B., 1997. Measuring production efficiency of acute hospitals in Scotland, 1991-94: Validity issues in data envelopment analysis. *Applied Economics, 29*(11), 1425-1433. DOI: http://dx.doi.org/10.1080/000368497326255

Rajkumar, A. S., and Swaroop, V., 2008. Public spending and outcomes: Does governance matter? *Journal of Development Economics, 86*(1), 96-111. DOI: http://dx.doi.org/10.1016/j.jdeveco.2007.08.003

Rollins, J., Lee, K., Xu, Y., and Ozcan, Y. A., 2001. Longitudinal study of health maintenance organisation efficiency. *Health Services Management Research, 14*(4), 249-262. DOI: http:dx.doi.org/10.1258/0951484011912753

Schultz, T. P., 2003. Human capital, schooling and health returns. *Yale University Economic Growth Center Discussion Paper*(853).

Thanassoulis, E., Boussofiane, A., and Dyson, R. G., 1996. A comparison of data envelopment analysis and ratio analysis as tools for performance assessment. *OMEGA-International Journal of Management Science, 24*(3), 229-244.

Thomas, D., Schoeni, R. F., and Strauss, J., 1996. Parental investments in schooling: The roles of gender and resources in urban Brazil. . *Working Paper*(96-02).

Valdmanis, V., 1992. Sensitivity analysis for DEA models: An empirical example using public vs. NFP hospitals. *Journal of Public Economics, 48*(2), 185-205.

Van den Noord, P., Hagen, T., and Iversen, T., 1998. The Norwegian Health Care System. *OECD - Economics Department Working Papers*(198). DOI: http://dx.doi.org/10.1787/571585217086