

UNIVERSITY “ALEXANDRU IOAN CUZA” FROM IAȘI  
THE FACULTY OF ECONOMY AND BUSINESS ADMINISTRATION  
THE DOCTORAL SCHOOL OF ECONOMY

A statistical assessment the public health  
system’s efficiency of Romania compared to  
other countries from the European Union

SUMMARY OF THE DOCTORAL THESIS

Scientific coordinator,

Prof. Univ. Dr. **Anca Laura Asandului**

PhD Candidate,

Fătulescu D. Puiu-Ionuț

## Table of Contents

Introduction	4
Chapter 1. Health Systems in Europe	10
1.1. The organization of health systems	12
1.2. Methods of financing the health systems	22
1.3. Resources and results	29
Chapter 2. Health systems' efficiency	41
2.1. Introductory notions	41
2.2. Types of efficiency	46
2.3. Health systems' efficiency	49
Chapter 3. Statistical methods for measuring health systems' efficiency	69
3.1. Measuring efficiency	69
3.2. Statistical methods for measuring health systems' efficiency	75
3.2.1. Data Envelopment Analysis	78
3.2.2. Bootstrapping method for Data Envelopment Analysis scores	90
3.2.3. Malmquist Index	94
3.2.4. Stochastic Frontier Analysis	99
3.3. Variables selection in efficiency frontier models	110
3.3.1. Variables selection criteria in Data Envelopment Analysis	112
3.3.2. Variables selection criteria in Stochastic Frontier Analysis	116
3.3.3. Variables selection in efficiency frontier models for assessing health systems 'efficiency	117
3.4. The comparison of the statistical methods for assessing health systems' efficiency	119
3.5. Efficiency and inefficiency in frontier estimation models	126
Chapter 4. Case study. European Union health systems' efficiency	129
4.1. Data included in the analysis	130
4.2. Analyzed models	132
4.3. Input oriented, constant returns to scale Data Envelopment Analysis results	137
4.4. Output oriented, constant returns to scale Data Envelopment Analysis results	144
4.5. Input oriented, variable returns to scale Data Envelopment Analysis results	151
4.6. Output oriented, variable returns to scale Data Envelopment Analysis results	158
4.7. Bootstrapping results	163
4.8. Malmquist index results	182
4.9. Stochastic Frontier Analysis results	194
4.10. Comparison between results	205
4.10.1. Comparison between different Data Envelopment Analysis results	205
4.10.2. Comparison between different Stochastic Frontier Analysis results	208
4.10.3. Comparison between Data Envelopment Analysis and Stochastic Frontier Analysis	210
Conclusions	212
Bibliography	220
ANEXES	234

The society of the 21st century, the century of speed, is under the sign of continuous changes on all levels, proving to be more dynamic than ever, thus giving the advantage of time to those who have the complete and accurate pieces of information. Facing a continuous technological, economic and social development, the contemporary society has adjusted to this dynamic rhythm, acting on its turn with a boomerang-like effect, requiring continuous progress, accuracy, transparency and efficiency. And although these requirements are essential for a continuous and sustainable economic growth, the cumulated individual actions must also be efficient in order to ensure the optimal results. In consequence, efficiency acts as a synergetic leverage that maximizes the yields of the socio-economic activities.

In this doctoral study, it is considered that efficiency produces and is produced at the same time by information. Nonetheless, in a society where the number of technological breakthroughs increases exponentially, information ensures a considerable advantage to the owner, whether one discusses about decision makers, institutions or citizens. These things apply furthermore within the health sector since it has always been a highly important sector for any state, which was submitted to perpetual changes and adjustments due to the evolution of medical knowledge, technological development, social and economic changes, etc. Therefore, within the socio-economic context of the European Union, even though each country has the full discretion of choosing its own public health policies according to national realities and traditions, the European Union as a whole shares common values with the final goal of providing efficient services for all the members of the community.

However, in order to ensure the quality standards in an optimal manner, filling in the scientific gaps is of primary necessity, as the theoretical fundamentals are a feature required by any type of evolution. As underlined in this thesis, each country's health system presents specific elements, non-transferable to other systems due to socio-politic, economic, geographic and other types of factors. This matters delay communication and the applicability of best practices, as well as a national level coordination between policies. Therefore, a standardized methodology within the area is required. Classifications of terms, clarifications of equivocal, the adjustments of measuring methods, are only a few steps required to increase the efficiency of the health systems and, in the end, the quality of the services provided.

The proposed research theme is part of a domain enclosed in that of Economic Sciences, namely "Cybernetics and Economical Statistics". The reason for choosing the statistical area is not random, as this domain is capable of offering, through its methods, the maximization pure, abstract social information, otherwise subjective. In other words, by

using statistical methods, certain elements of the society can be reduced to intrinsic characteristics, by eliminating the personal, the human factor, or generally anything that could affect the representativeness of the studies.

Things seem to be more sensitive when assessing the efficiency of the health systems, as the efficiency of the overall Romanian health system and not at indicator's level of is the subject of endless debates, where the ground seems to be instable due to the lack of firm standards and fixed, universally agreed notions.

The title of the thesis – “A statistical assessment the public health system's efficiency of Romania compared to other countries from the European Union “ was chosen to aim, concentrate and emphasize the goal of the research. This subject was chosen as in the context of Romania's membership in the European Union, it is highly important to know and understand where we stand compared with the other member states under the aspect of public health system's efficiency.

The doctoral thesis and all the steps towards its completion have as scope the statistical evaluation of the public health system's efficiency in Romania compared to other the efficiency of the health systems from the European Union<sup>1</sup>. The benefits of such a study are multilateral, as the results could either be easily applied to analyse other national health systems, or be adjusted in order to identify the directions of policies within this sector.

The scope of the research is established based on the hypothesis that depending on the values obtained by the health systems for certain indicators, the health systems may be compared. For achieving the scope, the consecrated econometric models (i.e. "Data Envelopment Analysis", "Stochastic Frontier Analysis", the Malmquist index), validated by the literature of speciality, will be applied on the data of EU's health systems. More precise, the above mentioned econometric models will be applied on the statistical data available for 2010 for the member countries of EU, published by Eurostat, in order to assess the efficiency of the health systems.

Complementary to the scope, the research will also have some objectives that will help the achievement of the scope on one hand and that will function as a verification and validation elements throughout the research on the other hand. The objectives have been defined and structured in such a manner that will make them compliant with the “SMART” fundamentals<sup>2</sup>.

---

<sup>1</sup> EU-27, prior Croatia's adherence on 1<sup>st</sup> of July 2013.

<sup>2</sup>Simple, Measurable, Achievable, Realistic, Time.

Thus, the first objective follows to emphasize how the main systems from the European Union are structured and are functioning. This objective will be accomplished along the first chapter and will be achieved by using the information from the international literature in the field of public health as well as the available statistical data. The importance of this objective for the scope of the research is given by the necessity of a more accurate knowledge in respect to the functioning coordinates of the Romania's public health system, as well as some of the health systems of the European Union.

The second objective of this research is set to define the conceptual frame specific to the notion of health systems' efficiency. Therefore, with the definition of the efficiency as starting point, a classification of the types of efficiency will be presented, underlying the implications that the notion has when assessing health systems. The theoretical frame is essential for any undertaken activity, and moreover in a research paper with the span of a doctoral thesis, being capable of ensuring credibility and relevance to the expressed notions and by acting as a foundation upon the entire future structure of the thesis will be based. Nevertheless, the delimitation between the notions that will be used throughout this paper is highly important in order to avoid equivocal.

The third objective is set to develop the methodological frame used for assessing the efficiency of the Romanian health system. This objective will be achieved once with the presentation of the non-parametrical method "Data Envelopment Analysis", of the complementary method "Bootstrap" for the "Data Envelopment Analysis" scores of efficiency, of the parametrical method "Stochastic Frontier Analysis" and of the productivity index Malmquist. This objective is important for the thesis because defining the methodological frame will also emphasize the advantages and limitations of each method used, highlighting in this way the context these methods may be used in when assessing the health systems efficiency.

The hypotheses on which the research is based are the following:

- Romania has an inefficient health system, both from the point of view of the national indicators of the health system and when comparing public health system from Romania with other national health systems from the European Union. By extending it, the Eastern European block is described by a low efficiency compared to the systems from the Western European countries.
- From the point of view of health systems' efficiency, the European Union is heterogeneous – there are major discrepancies between the member states.

- The way the variables from the health sector are chosen is significantly influencing the results of the analysis regarding the health system efficiency.
- The results obtained by applying the parametric methods are comparable with those obtained by the non-parametric ones.

The study is structured in such a manner that the reader, regardless of his knowledge in the economic and econometric fields, is introduced to the notions and concepts discussed and developed throughout the research.

Thus, subsequent the introductory part, in chapter 1 the health systems of France, Great Britain, Germany, Sweden and Romania will be presented according to their structure, their funding, the results and the future directions that policy makers should consider. Within this chapter, elements specific to each system, best practices, reforms from this area will be emphasized and empirical evidence based on the main indicators that describe the systems and their components will be brought.

In chapter 2, the idea of efficiency and its derived terms that represent the key notions this research is based on (i.e. the efficiency of the public sector and the efficiency of the health systems especially) are developed. Thus, in the subchapter 2.1., general notions in connection with the concept of efficiency will be presented and in the subchapter 2.2. a classification of the types of efficiency based on the international studies and researches will be suggested. Subsequently, in the subchapter 2.3 the notion of health systems efficiency will be presented.

Chapter 3 analyses efficiency from a quantitative perspective. Within this chapter some of the most common statistic methods of efficiency measurements, starting from the most elementary ones (subchapter 3.1) to statistic parametric and non-parametric methods, and extensions of methods (subchapter 3.2) will be presented. Ulterior, in subchapter 3.3, there a series of steps and certain criteria for selecting the health variables in order to measure the efficiency will be suggested, and in the subchapter 3.4 the presented statistic methods will be compared, marking both the advantages and limitations for each of them. The chapter ends with the subchapter 3.5, where the modality of interpreting the efficiency scores resulted after applying the statistic methods developed over the chapter will be discussed.

Chapter 4 represents a case study where the statistical methods presented in chapter 3 are applied, in order to assess the efficiency of Europe's health systems. The statistical methods were applied by using 10 models composed from variables specific to the health systems, for all of the 27 member states (prior to the adherence of Croatia). In the opening of this chapter the variables chosen for the analysis will be presented, together with the

reasoning for building those models. Starting the subchapter 4.3., a comparative analysis of the results of the models will be accomplished, analysing the effect that the insertion or the replacement of one variable with another has on the result.

The personal contributions brought within the Economic field may be synthesized as following:

Chapter 1 presents the key elements of organizing and functioning of 5 health systems from Europe. The importance of this contribution is given by the fact that, as the health systems are quite a dynamic component of the public sector, the evolution and the dynamics of health systems from other states are quite difficult to synthesize, especially since the Romanian literature in this field is limited as volume. Furthermore, presenting the 5 systems that are different under the aspect of functioning modality will bring to the readers a first picture of the health systems from the European Union. Adding to this that France, Sweden and Germany are considered amongst the most efficient countries with respect to the health systems, the contribution is even more important as Chapter 1 may serve as a best practices guide for Romania's policy makers.

Not the least, describing how the Romanian health system is functioning in 2013, after 24 years since the transition to the market economy, emphasize once more the chronically need for a reform that in the system, by adopting policies directed towards the citizens and the employees of the system in the same time.

In chapter 2, the contribution of the research resides mainly in presenting the national and international literature from the field of economic efficiency and the health systems' efficiency. A very important aspect is, based on the articles within the field and bringing them as support, the problems that institutions are facing in terms of notions and utilised definitions. Also, it is highlighted that the disparity at international level between the policies should be controlled and limited, by providing standard alignments. Not the least, drawing a continuous line from the notion of efficiency to the way this is applied to the health systems, accompanied by the main determinants of efficiency is value added to the research paper.

The contribution of chapter 3 is brought by the presentation in Romanian of the statistical methods of efficiency assessment "Data Envelopment Analysis", "Stochastic Frontier Analysis", and the Malmquist index. Although wide known and appreciated in the international literature, these methods are relatively new entered in the Romanian literature. Therefore, the contribution towards this direction consists of presenting the existing materials in the Romanian language, as their authors have had in their consecrated papers, connecting them to each other and offering an overview of the way these methods are applied. Not least,

within this chapter, there a taxonomy for the variables specific to the above mentioned methods is suggested, as well a series of criteria based on which the variables from the health systems could be chosen in order to attain consistency when assessing health systems' efficiency. At the end of the chapter, a comparison between the methods presented in the current paperwork and the wide known analysis of regression is given in a tabular form, offering the readers a rapid identification of both advantages and disadvantages for each method.

Chapter 4 represents without any doubt the most important contribution that this thesis brings to the Economic field. Except for the introductive subchapter introducing the variables enclosed in the analysis and the methods of selecting the data, an analysis of health systems in the European Union, following mainly the evolution of efficiency in Romania is performed. The novelty of the models adds value to the analysis. Thus, although studies in the field have already used with different occasions some of the variables from this analysis, the author has not found yet a study that encloses the same model structure as the ones in this paper. Moreover, the description of the health system efficiency in Romania has often been made taking into account individual indicators that were compared with the average of the European Union or other member states. The current study, however, evaluates the impact of more variables over the life expectancy of the citizens as well as the evolution of the efficiency scores as consequence of changing the models structure. Not the least, calculating the Malmquist index gives extra information regarding the evolution of health systems and their efficiency.

Assessing health systems' efficiency represents a difficult process that is often affected by methodological problems. In addition, interpreting the results in a purely economic manner represents an almost utopian thing, given the social implications that health systems' efficiency has. Starting with the citizens' state of health, that has implications over the productivity, over the wealth level or the social-economic stability, raising the level of efficiency for the medical services provided for the population represents a perpetual objective. Furthermore, increasing efficiency is becoming a priority and an imperative need for the countries with a high or medium index of development. Complementary, the countries with higher index of development have to maintain a high level for the sanitary services that are provided to the population and to raise the quality level where possible.

Starting with these premises, the scope of this doctoral thesis has been to measure the efficiency of Romania's public health system, by applying a series of statistical methods upon the statistical data of the member states of the European Union for the year of 2010. This



subject was chosen as health systems represent an essential component within the public sectors. If to the above mentioned we add the reforms that Romania's public health system has known for the years passed years, while making the transition towards the market economy, the need for assessing the state of facts becomes an obvious.

Another point of view from which it became necessary a research as the present one is the context of Romania's adherence to the European Union. The need for commensurable capacities that national health system should have to provide quality services for the citizens is impressive, but observing the evolution of its results is also a highly important action. The new EU member states must be capable of ensuring the fulfilment of the commitments undertaken through the community and international treaties. The health sector is not an exception, as the leverages that act in this area, based on the periodical systems' assessments, are political. For the inefficient countries or for those with a lower index of human development, taking the best practices in this sector may represent the cheapest solution for increasing the efficiency, especially since the alternative in the health sector – empirical experiments – may turn into life losses, which is a much too high risk to be taken.

The scope of the research has been achieved, as in the thesis the efficiency of the Romania's health system has been assessed. The (in)efficiency scores have been analysed, interpreted, compared and commented, bringing a justification for the reasons that led to them, as well as future implications on policies within the field.

Moreover, in chapter 1, the first objective is achieved, as the functioning modalities of health systems from France, Germany, Sweden and Great Britain are presented, as they are recognized as examples of best practices that offer high standards of quality and efficient services to their citizens. Still in chapter 1, the functioning modality of the Romanian health system is presented, pointing out the major deficiencies that it presents compared to others in the EU and underlining the need for reform and continuity of the policies in the field in order to increase efficiency.

The second objective of this doctoral thesis is achieved in chapter 2, where the main notions in connection with efficiency and with the health systems' efficiency are presented. Thereby, in chapter 2 the delimitation between the theoretical frame and the main notions that have served as foundation for the doctoral thesis was made.

The third objective - of distinguishing between the different methodological frames used for the assessment of the health systems' efficiency – has been achieved in chapter 3, by presenting the main statistical methods of efficiency assessment. Thereby, by presenting the non-parametrical method Data Envelopment Analysis, the complementary Bootstrap one for

the scores of efficiency, the Malmquist index and the parametric method of Stochastic Frontier Analysis we present the reader with both the advantages and the disadvantages for each one of them, as well as the conditions and prerequisites to use each.

Regarding the hypotheses of the study, by analysing the results we may emphasize the following:

The first hypothesis of the study is partially confirmed, as after analysing the data, it can be ascertained that the health system from Romania is inefficient when compared to the systems from the Western Europe when taking into account certain variables or applying certain types of models. However, when the values of the inputs are taken into account, Romania may also be identified as a country with high efficiency on the grounds that, in economic terms, it is using a low amount of resources for achieving quite good results. Moreover, the appendix of this hypothesis – the eastern European block is described by low efficiency when compared to the systems from the Western European countries - is confirmed, with the demonstration that, for most cases, the Eastern European block is situated in the second part of the ranking of inefficiency scores.

The second hypothesis of the study is confirmed, by presenting relevant and consistent results referred to the literature within the field. Moreover, through gradually changing the models and composition, the evolution of the systems efficiency could be ascertained. After the analysis, the results do not change significantly and where major differences occur, they are caused by indicators values added, replaced or removed. An illustrating example of this is the value resulted when interpreting the SFA results that change as expected depending on the model, and do not have values of the scores that change in a radical manner.

The third hypothesis is confirmed since the considerable differences between the scores of efficiency prove that the health systems from the European Union present major differences when it comes to the results of the medical services that are provided to the citizens.

Moreover, hypothesis 4 is confirmed, the results of the analysis indicating that, depending on the variables used within the composition of models, the results may be different and there are cases when, in terms of certain variables, a health systems as that of Romania may be considered efficient.

Hypothesis 5 is rejected; the results retrieved within DEA are not entirely comparable with the results of SFA – however, there is still imposed the comment that the number of countries in the sample is relatively small. Therefore, on what concerns the DEA, the

“Bootstrap” method and the Malmquist index, the results are fluent and comparable, showing consistency. When applying the parametric method instead, the scores of efficiency change from those retrieved through DEA, as ascertained within the subchapter 4.10.2. The author considers that a bigger sample of countries would have led to results that are more consistent.

Amongst the limitations of this research, probably the most important one is represented by the relatively small number of evaluated countries, thing that leads to a series of inconveniences, especially when applying the parametric method. As from certain points of view, this is a similar method with that of regression analysis and the values of the variables for the health system indicators are heterogeneous, the scores of efficiency that resulted may somehow be different from the real ones. In other words, although the thumb rule of the applied methods (the number of evaluated methods should be at least 3 time bigger than the number of variable within the analysis), the author considers that, at least when applying the SFA, a more reliable result would be obtained based on a higher number of countries.

Another limitation of this work, from the author’s perspective, is caused by the lack of health systems indicators. The information presenting the health system results is often displayed as raw indicators, not taking into account the influence of other indicators or factors. To support this affirmation, the percentage from the GDP that assigned to health in may serve as example. In the case of Great Britain, 7.8% is lower than the 9% of Denmark’s, but when making an overall comparison it may be noticed that Great Britain is assigning more money to the health system.

Not the least, the lack of data applied on the public health system makes the comparison between the results achieved in this research and others from the field impossible. This is also caused by the fact that the applied statistical methods have passed through an impressive metamorphosis in the last 30 years, with new models capable of a better enclosing of the specific that the assessed units being developed. Hereby, the probability of using the same type of model over identical or similar variables is quite reduced.

From a theoretical approach, as shown in chapter 2, an important limitation shown by the health systems is caused by the lack of homogeneous definitions at international level. Moreover, for some cases data mining is very difficult, therefore conceiving some viable and useful know-how and instruments would be required, especially since the current technology ensures the necessary premises for an exponential development of the data mining and management systems. In addition, the dynamics of populations is higher than ever and the

impact of the diseases and the risks of maladies have undoubtedly reached their historical peak. One of the safest methods of preventing the spread of these phenomena is the increase of efficiency of medical services, preventing and treating, this way, any threat brought to the citizens.

From the author's perspective, the future research directions are multiple and can be directed towards extending and completing the current research or towards comparing this one with other researches within this field. One first future direction of research may be represented by applying the same statistical methods on a database comprising variables that belong to more health systems. This approach would lead to more consistent results for the non-parametric method and the results themselves more interesting through the variety of comparisons that such an analysis would allow. Alternatively, based on the same data that this paperwork contains, other statistical methods used for describing and assessing the efficiency of the health system from Romania could be applied.

From a methodological approach, a future approach could consist of developing some DEA models that would take note of certain factors that should not be changed at the moment when the level of extra – utilised resources or the low outputs are being calculated.

Although the health systems specific to each state are in continuous improvement process and they adopt policies and reforms aimed to raise the level of efficiency, their impact is unknown or difficult to ascertain. First of all, the difficulty of measurement and the influence of various exogenous factors over the efficiency can hardly be tempered and limited throughout the evaluation of policies. More than this, in many cases, the reforms and programs within the field are adopted based on some political and short term ideological considerations.

Based on the selected data set, there has been shown that the countries belonging to the Eastern European block are deficient and have to recover a significant gap compared with the western countries under what concerns ensuring the optimal levels of medical services. In addition, the achieved results could be used as references when adopting the field policies or assessing the eventual reforms. Thus it has been demonstrated that, for the year of 2010 for HALE, certain countries (Sweden, Malt, Great Britain) have the level of life expectancy too low, or that for the level of the life expectancy within the same year, the level of such variables as the Child Mortality Rate or Mother Mortality Rate should be dramatically reduced for Romania and Bulgaria.

The current study has attended the notion of efficiency for public health systems. If to the emphasised need of assessing the health systems' efficiency it is added the importance of

the subject – given the fact this is a wide domain but with overwhelming social implications – one can allege without the fear of mistaking that it is essential to decide what aspect of the health systems is being evaluated as different approaches could lead to different results.

### Selected References:

- 1 Afonso, A., Schuknecht, L., Tanzi, V., 2006. Public sector efficiency: evidence for the new EU member states and emerging markets. Working paper no. 581, European Central Bank, Frankfurt, Germany.
- 2 Ahs, A., Westerling, R.,(2005). Self-rated health in relation to employment status during periods of high and of low levels of unemployment. *European Journal of Public Health, 2005, Vol. 16, No. 3, 294–304*
- 3 Aigner, D. J., C. A. K. Lovell, and P. Schmidt (1977). Formulation and Estimation of Stochastic Frontier Function Models. *Journal of Econometrics* 6, 21–37.
- 4 Alemayehu B, Warner KE. (2004). The lifetime distribution of health care costs. *Health Serv Res* 2004; 39(3):627-42.
- 5 Ali, A.I. and Seiford, L.M. (1993). The Mathematical Programming Approach to Efficiency Analysis, in *The Measurement of Productive Efficiency: Techniques and Applications*, Harold O. Fried, Lovell, C.A.K. and Schmidt, S.S. (Eds.), Oxford: Oxford University Press: 121–159. Gilbert, R. A., P. Wilson. W (1998). Effects of Deregulation on the Productivity of Korean Banks. *Journal of Economics and Business* 50(2) (March/April), 133–155.
- 6 Allonier C et al. (2008). Enquête santé protection sociale 2006, un panel pour l'analyse des politiques de santé, la santé publique et la recherche en économie de la santé. *Paris, Institut de recherche et documentation en économie de la santé (IRDES rapport 1701)*
- 7 Andrews, G.J. and Evans, J. (2008) Understanding the reproduction of health care: towards geographies in health care work. *Progress in Human Geography* 32, 759–8.
- 8 AQA. “Principles of `Efficiency` Measures”. April 2006. The AQA.
- 9 Asandului L., Popescu C., Fatulescu P. (2012). The Assessment of the Health Systems in EU Member States using a two stage approach.
- 10 Asandului L., Popescu, C., Fatulescu P. The Assessment of the health systems in EU member states using Data Envelopment Analysis. *The Proceedings of the 6<sup>th</sup>*

*International Conference on Globalization and Higher Education in Economics and Business Administration*, 2012. ISBN 978-973-703-766-4.

11 Asandului, L., Ceobanu, C. (2011). Use of Information and Communication Technologies in the instructors' activities of teaching and assessment of students – a Case Study. *Recent Researches in Educational Technologies*. ISBN: 978-1-61804-010-7

12 Asandului, L., Fatulescu P. (2012). Measuring the Efficiency of EU Health Systems using Data Envelopment Analysis. *Reproduction of the Human Capital Conference Proceedings*, ISBN 978-80-86175-82-9.

13 Balan, C., Jaba, E. (2012). Life expectancy and its determinant factors at regional level in Europe. *Economy & Business*, Volume 6, Part 1. ISSN 1313-2555, Published at <http://www.scientific-publications.net>

14 Balk, B. (1993). Malmquist Productivity Indexes and Fisher Ideal Indexes, Comment, *Economic Journal*, 103, 680-682.

15 Bambra C, Pope D, Swami V, Stanistreet D, Roskam A, Kunst A, ScottSamuel A. (2009). Gender, health inequalities and welfare state regimes: a crossnational study of 13 European countries. *Journal of Epidemiology and Community Health*, 63:38-44.

16 Battese G.E., and Coelli T.J., (1995), 'A Model for Technical Efficiency Effects in a Stochastic Frontier Production Function for Panel Data', *Empirical Economics*, 20, pp. 325-32.

17 Beraldo, S., Montolio, D., Turati, G. (2009). Healthy, educated and wealthy: A primer on the impact of public and private welfare expenditures on economic growth. *The Journal of Socio-Economics* 38 (2009) 946–956.

18 Bhalotra S. (2007). Spending to save? State health expenditure and infant mortality in India. *Health Economics* 16: 911–28.

19 Blidu, D. (2006). Asigurările sociale pentru sănătate în România. *Posibilități de îmbunătățire*, ASE, București

20 Bogetoft, P., Otto., L. (2013). Benchmarking R Package, available at: <http://cran.r-project.org/web/packages/Benchmarking/Benchmarking.pdf>

21 Bokhari FAS, Gai Y, Gottret P. (2007). Government health expenditures and health outcomes. *Health Economics* 16: 257–73.

22 Boyle, S. (2011). United Kingdom (England). Health System Review. *Health Systems in Transition*. Vol 13. No1.

- 23 Brendkamp, C., Mendola, M., Gragnolati, M. (2010). Catastrophic and impoverishing effects of health expenditure: new evidence from the Western Balkans. *Health Policy and Planning* 2010;1–8
- 24 Cesaro, L., Marongiu, S., Arfini, F., Donati, M., Capelli, M., G. (2009). Methodology of Analysing competitiveness, efficiency and economy of scale. *Farm Accountancy Cost Estimation and Policy Analysis of European Agriculture*.
- 25 Charnes, A. and W.W. Cooper, 1962, Programming with linear fractional functionals, *Naval Research Logistics Quarterly* 9, 181-185.
- 26 Charnes, A., W.W. Cooper, and E. Rhodes. (1978). “Measuring the Efficiency of Decision Making Units.” *European Journal of Operational Research*, 1, 429–444.
- 27 Chevreur, K., Durand-Zaleski, I., Bahrami, S., Hernandez-Quevedo, C., Mladovsky, P. (2011). France. Health system review. *Health Systems in Transition*, Vol, 12 No, 6, 2010.
- 28 Cicea, C., Busu, C., Armeanu, E. (2011). The SWOT Analysis of the Romanian Health Care system and the key elements fro Resources Allocation. *Management Research and Practice*. Vol 3. Issue 3, pp 32-41
- 29 Coelli, T. J., Rao, D. S. P., O'Donnell, J. C., Battese G. E. (2005). An Introduction to Efficiency and Productivity Analysis. *Springer* ISBN 10: 038724266X / ISBN 13: 9780387242668
- 30 Coelli, T., Henningsen, A. (2012). Frontier R Package, available at <http://frontier.r-forge.r-project.org/>
- 31 Cooper W., W., Seiford, L., M., Tone, K. (2002). Data Envelopment Analysis. A comprehensive text with Models, Applications, References and DEA-Solver Software.
- 32 Cooper, W. W., Seiford, L.; Tone, K. (2007) Data Envelopment Analysis: A Comprehensive Text with Models, Applications, References and DEA-Solver Software. 2nd edition. Springer; New York.
- 33 Cooper, W., W., Seiford, L., M., Zhu, J. (2011). Handbook on Data Envelopment Analysis ISBN: 978-1-4419-6150-1 (Print) 978-1-4419-6151-8 (Online), Springer.
- 34 D. Perkins. 1998. Economics for Health Care Management. London: FT Prentice Hall.
- 35 De Gooijer W. (2007). Trends in EU health care systems. *New York: Springer-Verlag*.

- 36 Dooren, Wouter van, Miekatrien Sterck and Geert Bouckaert (2007), “Institutional Drivers of Efficiency”, internal literature review, Public Governance and Territorial Development Directorate, OECD, Paris.
- 37 Drummond, M.F.; Sculpher, M.J.; Torrance, G.W.; O'Brien, B.J. and Stoddart, G.L. (2005): *Methods for the Economic Evaluation of Health Care Programmes*. 3rd Edition, Oxford University Press.
- 38 Durie, R. and Wyatt, K. (2007). New communities, new relations: the impact of community organization on health outcomes. *Social Science and Medicine* 65, 1928–41.
- 39 Efron B. (1979). Bootstrap methods: Another look at the Jackknife, *Annals of Statistics* 7, 1-26.
- 40 Färe, R., Grosskopf, S. (1996). Malmquist Productivity Indexes and Fisher Ideal Indexes, *The Economic Journal*, 102:4, 158-160.
- 41 Farrell M., J. The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society. Series A (General)*, Vol. 120, No. 3, (1957), pp. 253-290
- 42 Fătulescu, P. (2011) Romanian Health System: Lessons Still to Learn. *Acta Universitatis Danubius. Œconomica*, Vol 7, no 3 **Print ISSN: 2065-0175 Online ISSN: 2067 – 340X**
- 43 Fătulescu, P. (2012). Measuring Efficiency of e-technologies implementation using data envelopment analysis. “E” Era & Higher education. *Proceedings of the 7<sup>th</sup> International Conference Quality Management in Higher education*, Iasi 16-17 November 2012. ISBN 978-3-85403-291-5.
- 44 Fătulescu P. (2013) (a). Changes in Efficiency Scores by Adding Variables in Stochastic Frontier Analysis. *Czech Demographic Society Conference Proceedings*. ISBN 978-80-245-1934-0.
- 45 Fătulescu P. (2013) (b). A DEA- SFA Comparison on the Impact of ICT’s Utilization. *Annual International Interdisciplinary Conference*.
- 46 Forsund, F., 2001. Categorical variables in DEA. International Centre for Economic Research (ICER), Turin, January – March 2001
- 47 Gardener, M.(2012). *Beginning R – The Statistical Programming Language*. John Wiley & Sons. ISBN: 978-1-118-16430-3
- 48 Graham, H., Kelly, M. P. (2004). Health inequalities: concepts, frameworks and policy. *Health Development Agency Briefing Paper*.



- 49 Greene, W. (1997). Frontier Production Functions. In Handbook of Applied Econometrics. Volume II: Microeconomics, M.H. Pesaran and Schmidt, P. (Eds.), Oxford: Blackwell.
- 50 Greene, W., (2007). "Fixed and Random Effects Models for Count Data," Working Papers 07-15, New York University, Leonard N. Stern School of Business, Department of Economics.
- 51 Hjalmarsson, L., Kumbhakar, S. C., Heshmati, A. 1996. DEA, DFA and SFA: A comparison. Journal of Productivity Analysis, Vol. 7, Issue 2-3, pp 303-327
- 52 Hollingsworth B. The measurement of efficiency and productivity of health care delivery. Health Economics 2008; 17(10):1107–1128. [PubMed: 18702091]
- 53 Horrace, W. C., Schmidt, P., Witte, A. D. (1995). Sampling Errors and Confidence Intervals for Order Statistics: Implementing the Family Supporting Act. NBER Working Papers Series Industry, Journal of Development Economics, 9, pp. 43-64.
- 54 Ingram, D., Kalra, D., Austin, T., Darlison, M., Modell, B., Patterson, D.(2006). Towards an interoperable healthcare information infrastructure — working from the bottom up *BT Technology Journal • Vol 24 No 3 • July 2006*.
- 55 Jaba, E., Balan, C., Palașcă, S. (2011)."Statistical Evaluation Of The Influence Of Determining Factors Of Life Expectancy," *Analele Stiintifice ale Universitatii "Alexandru Ioan Cuza" din Iasi - Stiinte Economice*, Alexandru Ioan Cuza University, Faculty of Economics and Business Administration, vol. 2011, pages 215-223, july.
- 56 Jabubowski, E., *Health Care Systems in the EU: A Comparative Study*, E. P. Working Paper, SACO 101/rev. EN, European Parliament, 1998.
- 57 Jackson, T. P., Mills, A.(2007).A review of health resource tracking in developing countries. *Health Policy and Planning 2007;22:353–362*
- 58 Jondrow, J, Lovell, C.A.K., Materov, I.S. and Schmidt, P. (1982). On the Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model. *Journal of Econometrics*, 23: 269–274.
- 59 Kneip, A., Simar, L., Wilson, P. (2007). Asymptotics and Consistent Bootstraps for DEA Estimators in Non-parametric Frontier Models. *Econometric Theory*.
- 60 Koopmans TC. Efficient allocation of resources. *Econometrica* 1951;19(4):455-65.
- 61 Kumbhakar, S., C., Lovell, K. (2003). *Stochastic Frontier Analysis*. Cambridge University Press.

- 62 Lee, L.F. and Tyler, W.G. (1978), "A Stochastic Frontier Production Function and Average Efficiency: An Empirical Analysis", *Journal of Econometrics*, 7, 385-390.
- 63 Löthgren, M., (1998). How to Bootstrap DEA Estimators: A Monte Carlo Comparison, *Working Paper Series in Economics and Finance*, No. 223.
- 64 Lubotsky, D., Mazumder B. (2010). New perspectives on health and health care policy. The Federal Reserve Bank Julz of Chicago, 2010.
- 65 Malmquist, S. (1953) Index numbers and indifference curves. *Trabajos de Estadística* 4(1):209–242
- 66 Mandl U., Dierx A., Ilzkovitz, F., (2008). The Effectiveness and Efficiency of Public Spending. *Economic Papers* 301. ISBN 978-92-79-08226-9 doi: 10.2765/22776
- 67 McCarthy M.,(2007). European public health research literatures - measuring progress. *European Journal of Public Health*, Vol. 17, Supplement 1, 2007.
- 68 Meeusen, W. and J. Van den Broek (1977). Efficiency Estimation from Cobb-Douglas Production Functions with Composite Errors. *International Economic Review* 18, 435–44.
- 69 Mihăescu-Pinția, C., Pamfilie, R., Ștefănescu A., Copca, N., Constantinescu, M., V. (2012). Romanian Healthcare System Capacity of Responding to Population Needs as Perceived by Key Persons. *African Journal of Business Management* Vol 6(7) pp 2666-2677
- 70 Morita, H., Haba, Y. (2005) Variable selection in data envelopment analysis based on external information. *Proceedings of the eighth Czech-Japan Seminar 2005 on Data Analysis and Decision Making under Uncertainty*, 181–187.
- 71 OECD (2012), *Health at a Glance: Europe 2012*, OECD Publishing. <http://dx.doi.org/10.1787/9789264183896-en>
- 72 Popescu C., Asandului L., Fătulescu P. (2013). A Data Envelopment Analysis for Evaluating Romania's Health System. *World Conference of Business, Economics and Management*.
- 73 Potrafke, N. (2010). The growth of public health expenditures in OECD countries: Do government ideology and electoral motives matter? *J. Health Econ.* (2010),doi:10.1016/j.jhealeco.2010.07.008.
- 74 Rivera, B. (2010). The effects of public health spending on self-assessed health status: an ordered probit model. *Applied Economics*, 33: 10, 1313 — 1319.
- 75 Roman, M.M., Suci, C.-M. Analiza eficienței activității de cercetare dezvoltare inovare prin metoda DEA. *Studii și Cercetări de Calcul Economic și Cibernetică Economică*. Numărul 1-2/2012. ISSN print: 0585-751. ISSN on-line:1843-0112

- 76 Roman, M.& Suci, C., 2012. "Analiza eficienței activității de cercetare dezvoltare inovare prin metoda DEA[The Efficiency Analysis Of R&D Activities By Using Dea]," MPRA Paper 44000, University Library of Munich, Germany.
- 77 Scherer P, Devaux M. (2010). The challenge of financing health care in the current crisis: an analysis based on the OECD data. *OECD Health Working Papers, No. 49, OECD Publishing.*
- 78 Schoenberg, N. E., Kim, H., Edwards, W., Fleming, S. T.(2007) Burden of Common Multiple Morbidity Constellations on Out-of-Pocket Medical Expenditures Among Older Adults. *The Gerontologist, Vol. 47, No. 4, 423–437*
- 79 Seiford LM and Zhu J (1999). Infeasibility of super-efficiency Data Envelopment Analysis models. *INFOR 37: 174–187.*
- 80 Silva Portela, M., E. Thanassoulis, and G. Simpson (2004): Negative Data in DEA: A Directional Distance Approach Applied to Bank Branches, *Journal of the Operational Research Society, 55(10), 1111-1121.*
- 81 Simar, L., Wilson, P. (1996). Estimating and Bootstrapping Malmquist Indices, CORE, Discussion Paper 9660, Center for Operations Research and Econometrics, Université Catholique de Louvain.
- 82 Simar, L., Wilson, P. L. (1997). Sensitivity Analysis of Efficiency Scores: How to Bootstrap in Nonparametric Frontier Models, *Management Science.*
- 83 Simar, L., Wilson. W. (1998). Productivity Growth in Industrialized Countries. *Working Paper, Department of Economics, University of Texas, Austin, TX 78712, USA.*
- 84 Smith, P. (1997). Model Misspecification in Data Envelopment Analysis. *Annals of Operations Research 73(0): 233-252.*
- 85 Stevenson, R. (1980). Likelihood Functions for Generalized Stochastic Frontier Estimation. *Journal of Econometrics, 13(1): 58–66.*
- 86 Straub, A. (2013). Stochastic Frontier Analysis R Package, available at: <http://cran.r-project.org/web/packages/sfa/sfa.pdf>
- 87 Tambor, M., Pavlova, M., Woch, P., Groot, W.(2010). Diversity and dynamics of patient cost-sharing for physicians' and hospital services in the 27 European Union countries. *The European Journal of Public Health Advance Access published September 30, 2010*
- 88 TEMPO (bază de date), Institutul Național de Statistică al României, 2009. Disponibil on line la <http://statistici.insse.ro/shop/>

- 89 Thomson S, Mossialos E. (2009). Private health insurance in the European Union. Brussels: European Commission, Directorate General for Employment, Social Affairs and Equal Opportunities.
- 90 Timmer, C. Peter, (1971). Using a probabilistic frontier production function to measure technical efficiency, *Journal of Political Economy* 79, 776-794.
- 91 Tudorel, A., Mitrut, C., Constantin, D., Oancea, L.(2009). "The Impact of Decentralization on Public Health System's Results. The Case of Romania," *Theoretical and Applied Economics*, Asociația Generală a Economistilor din România - AGER, vol. 10(10(539)), pages 17-22, October.
- 92 Tziogkidis, P. (2012). *Bootstrap DEA and Hypothesis Testing*. Cardiff Business School.
- 93 Venables, W., Smith, D. (2008). *An Introduction to R*. ISBN 3-900051-12-7.
- 94 Vladescu C, Scintee G, Olsavszky V, ed. Allin S, Mladovsky P (2008). Romania: Health system review. WHO, *European Observatory on Health Systems and Policies. Health Systems in Transition* 10(3): 1-172
- 95 Voicu, B., (2005). *Penuria Pseudo-Modernă a Postcomunismului Românesc. Volumul II: Resursele, Editura Expert Projects, Iași*.
- 96 Wilson, P. (2010). FEAR R Package available at: <http://www.clemson.edu/economics/faculty/wilson/Software/FEAR/FEAR-1.13/FEAR-manual.pdf>
- 97 Woolridge, M. J., (2002). *Econometric analysis of cross section and panel data*. London: The MIT press.
- 98 WHO. (2006). *Approaching health financing policy in the WHO European Region*. Copenhagen: WHO-Europe, 2006.
- 99 Xue M and Harker PT (2002). Note: Ranking DMUs with infeasible super efficiency in DEA models. *Mngt Sci* 48: 705–710.
- 100 Zhu, J. 2002, *Quantitative Models for Performance Evaluation and Benchmarking: Data Envelopmen Analysis with Spreadsheets and DEA Excel Solver*, Kluwer Academic Publishers, Boston.