Ranking Romanian Universities: How much the Choice of Nonparametric Variables Matters?

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Choosing the best university has never been an easy decision and it has now become a thorough process with the rapidly increase in the education market. This paper examines the efficiency of Romanian universities by applying various multiple input – multiple output models. The estimators obtained were used in order to build the efficiency frontier and to rank the universities. The choice of input and output variables has proved to be crucial in the analysis and a reason for an in depth interpretation of the method used. I examined the effect of variables choice on the performance of universities and also the effect of trade-off between research and teaching. This is the first nonparametric efficiency analysis conducted on Romanian universities and its results can be used by prospective students, university teachers, as well as the public and media.
Keywords: *Data Envelopment Analysis, Universities, Efficiency*

1 Introduction

Many analyses have been conducted to study university efficiency using both parametric and nonparametric methods but, to my knowledge, only one has assessed the ranking sensitivity to variables specification.

This paper fills a gap in the literature regarding sensitivity analysis of higher education efficiency estimates in terms of resource utilization and output obtained, as well as classifications built to rank Romanian universities. More than that, the data has recently been published and I am not aware of any other analysis that has used it. Unlike the few previous rankings of Romanian universities built on only one criterion, this paper uses data envelopment analysis to explore the efficiency measured by considering multiple input - multiple output models of various complexity.

Detailed sensitivity analysis to the variables chosen and efficiency scores obtained is provided. The study has a basic outline model consisting in input variables classified in three categories of resources (human, financial and physical) and two output components (research and teaching). All models are a variation of this basic framework, taking into account different measures for the same economic aspect.

The government is particularly interested in ranking universities because the budget funds allocation represents an increasing pressure on universities to use resources more efficiently. Prospective student's enrolment is influenced by the perspective of public / media over the universities and they will choose the institution according to general perception, personal beliefs, media recognition. The tops built in this paper are meant to offer an academic overview of universities capacity and ability to transform the inputs used in terms of human capital, physical capital and financial resources into research and teaching output. An image of the current situation of higher education is provided in terms of efficiency. The analysis does not take into account the quality of teaching as no available data was found in order to cover this issue.

Romanian university system has changed significantly after 1989, and the effect of a new type of government can be seen in the number of graduated students, as well as in budget funds. The effect the revolution had on the higher education institutions can be seen in the increasing number of professors that left the system and went to teach in western European countries or U.S. [1]. Even though the number of teachers decreased, the students enrolled relative to 10.000 inhabitants increased four times in the period

1991/1992 - 2005/2006. The number of universities in Romania increased significantly from 56 in 1990 to 117 in 2006 and 90 in 2012.

In order to construct the rankings I employ basic DEA (data envelopment analysis) models using previous specification of variables, adjusted according to the available data for Romanian universities and such that I could test different hypothesis. The mainly focus of this paper was to study the teaching output when different types of input categories were employed (financial, human or material). Another analysis conducted refers to the effect of trade-offs between research and teaching, also discussed in [2].

The rapid development of data envelopment analysis technique is shortly presented in Section *Literature review*, along with major contributions and studies conducted to assess universities efficiency. Section *Methodology* offers a brief overview of the methodology used in this analysis. Basic DEA models VRS are employed, with output orientation.

The description of the variables used and the models in the analysis are explained in Section The s*ystem of variables and the DEA models*. The models were built taking into account the correlation between variables. This is one of the reasons why only some indicators were used and others excluded.

Section *Data Description* presents the database used in the analysis, with a detailed interpretation of the variables. Because most of the measures used can be found in other studies, the data has several recognized limitations. Some preliminary rankings of universities are presented according to several efficiency criteria derived from the original data. These rankings can be used for various purposes and provide an image of the resource utilization (funds), work load, graduating rate or research efficiency.

The following section describes the results of applying different specifications of variables, as well as comparative analysis and interpretations. Although the models use well known variables specifications in the literature, there are many inputs that can be replaced and still have the same economic meaning. Another contribution is regarding testing previous studies findings on a new set of data. I used two methods of aggregation: simple sum and weighted number of publications and teachers, three types of inputs and the generally accepted outputs in the literature. Sensitivity analysis revealed some facts regarding the modifications rankings suffered when variables were changed in the models. *Conclusions* can be found in the last part of the paper.

2 Literature Review

Over the last sixty years, university efficiency has been estimated using several techniques, among the nonparametric methods we encounter: DEA, FDH (free disposal hull), one-stage or two-stage techniques, partial frontiers, conditional measures to account for environmental variables, conditional directional distance function or hyperbolic estimators.

DEA has become a popular and practical method of estimating efficiency for cross-sectional data. Interest in DEA and its easy use lead to an exponential increase in the number of articles written from its development in 1978 with the paper of [3] and lead to approximately 468.000 entries in a Google search in 2014.

Despite the relative recent development of this analysis technique, its roots can be found in the paper "Activity Analysis of Production and Resource Allocation" [4] written in 1951. In this paper, Koopmans defines efficiency as the situation where any increase in the net quantity of output can be obtained only by diminishing the net quantity obtained from another output. Because of its obvious similarity with the Pareto definition of optimum, this is called the Pareto-Koopmans definition of technical efficiency.

According to Tzeremes and Halkos [5], DEA measures the efficiency relative to a set of DMUs (decision making units) and objectivity is one of the most important advantages provided by this method. Also, DEA makes no assumptions relative to the functional relationship between inputs and outputs and the choice of variables is at the analyst's freedom. Tzeremes and Halkos [5] also make a short overview of the methods used in order to estimate efficiency, as well as a literature review relative to the DEA studies conducted in the education system.

One controversial problem when applying DEA on universities is regarding the choice of variables. McMillan and Datta [6] use nine different models in order to study the sensitivity of scores regarding the choice of variables. Also, they use a simulation in order to prove that cutting down from the provincial grants leads to an increase in efficiency. The same techniques are applied in the paper by Flegg et al. [7], where the authors find that giving universities a greater financial independence and flexibility leads to an increase in efficiency. They use both input and output oriented approaches, studying TE (technical efficiency) as decomposed into PTE (pure technical efficiency), CE (congestion efficiency) and SE (scale efficiency). A detailed analysis regarding choice of variables can be found in Stoica [8].

Coelli et al. [9] provide a comprehensive study on efficiency and productivity analysis including a thorough presentation of basic DEA models, extensions, practical implementations using DEAP (Data Envelopment Analysis Program), as well as productivity measurement using the Malmquist TFP (total factor productivity) index. The paper contains an empirical application of DEA using the software DEAP for a sample of 36 Australian Universities with data from 1994.

Another problem in the university efficiency literature is the consideration of number of students sometimes as an input variable, and in other studies as an output. Flegg et al. [7] sustain that the number of students should be included as an input, being an indicator for labor and university size. In the same respect, Tzeremes and Halkos [5] consider the number of student as an input variable. The analysis made in this paper will consider both approaches and include student enrolments as an input and student degrees obtained as an output measure.

3 Methodology

This paper uses data envelopment analysis technique in order to estimate university efficiency. The method has been widely applied to study public institutions efficiency in many countries. It was originally developed in order to assess the efficiency of firms that convert inputs into outputs [10] and later was transformed into a linear programming problem [3]. DEA is a relative method [11] and the concept of efficiency is not absolute [7].

The firms are usually referred to as Decision Making Units (DMU) for a more general perspective. DEA is used when dealing with multiple inputs and multiple outputs that cannot be aggregated in a meaningful way with predetermined and generally accepted weights.

Unlike parametric methods of estimating production functions, DEA method estimates the function taking into account all observations, and not their average points.

In case of universities, inputs and outputs generally do not have prices associated (if we do not consider salaries as prices and of course material resources which usually have acquisition prices); therefore the models applied deal with technical efficiency measures and not economic indicators. The presentation below follows the notation as in [9].

Technical efficiency is defined as the fraction of weighted sum of outputs to the weighted sum of inputs. For university *i* technical efficiency can be expressed as:

$$TE_i = \frac{\sum_p u_{pi} q_{pi}}{\sum_s v_{si} x_{si}} \quad (1)$$

where for the *i*th university the inputs and outputs are represented by the column vectors x_i and respectively q_i and their corresponding weights v' and respectively, u'.

The model assumes the existence of N inputs and M outputs. In this paper I use the variable returns to scale model, both input and output oriented, as it is presented in the book by Coelli et al. [9]. The constant returns to scale assumption is appropriate when dealing with universities that operate at an optimum level. However, universities do not use their resources at maximum capacity. Therefore I

assume the variable returns to scale as being in scope for the analysis.
Using mathematical programming, DEA finds a set of weights that are most favorable for each university leading to efficiency estimates in the range (0, 1) [6]. The optimal weights are computed using the VRS model as presented in [9]:

$$\min_{\theta,\lambda} \theta$$
$$s.t. \quad -q_i + Q\boldsymbol{\lambda} \geq \mathbf{0},$$
$$\theta x_i - X\boldsymbol{\lambda} \geq \mathbf{0},$$
$$I1'\boldsymbol{\lambda}=1$$
$$\boldsymbol{\lambda} \geq 0. \qquad (2)$$

where θ is a scalar and **λ** is a scalar vector of order I*1. The value obtained for θ represents the efficiency estimate for the i^{th} university and it will satisfy $\theta \leq 1$, with a value of 1 indicating an efficient university. This model is called the envelopment form or the Farrel model. It represents the dual problem for the multiplier form of the CRS model where an additional convex constraint is added ($I1'\boldsymbol{\lambda}=1$).
The model presented above is an input oriented model in which technical inefficiency is identified as a proportional reduction in input usage holding the output quantity fixed [9]. In case of universities, inputs are considered to be human capital, financial resources and physical conditions, as Bonaccorsi, Daraio and Simar [2] use in their study. Therefore, lowering the input quantities as much as possible is not a plausible solution at least on the short term perspective. The government will ask for a more efficient utilization of budget funds and not a reduction of the amount provided. The number of teachers need not be decreased in an efficient university, but more explored from the academic perspective. I am interested in obtaining as much output as I can from the input quantities available, because I assume they are fixed.
The input and output oriented approaches lead to the same efficiency measures under CRS, but different when VRS are assumed [9]. The output oriented model is similar to the input oriented one and for VRS is it given below:

$$\min_{\emptyset,\lambda} \emptyset$$
$$s.t. \quad -\emptyset q_i + Q\boldsymbol{\lambda} \geq \mathbf{0},$$
$$x_i - X\boldsymbol{\lambda} \geq \mathbf{0},$$
$$I1'\boldsymbol{\lambda}=1$$
$$\boldsymbol{\lambda} \geq 0. \qquad (3)$$

where $1 \leq \emptyset \leq \infty$, and $1/\emptyset$ is the proportional increase in outputs that can be achieved by university *i*, in case of fixed input quantities. The value of $1/\emptyset$ is the TE score reported in DEAP and lies between 0 and 1. The two different orientations lead to the same set of universities as being efficient. It is only the TE scores that may differ between them when assuming VRS.
Another DEA feature is that it provides appropriate benchmarking for DMUs in order to compare inefficient units with efficient ones (peers) and a way of targeting by associating weights.
The calculations associated with DEA can be made in excel or software program SAS, but also using a number of specialized packages that were built for DEA computations like ONFront, iDEAs, Warwick DEA, FEAR or DEAP. In this analysis I will use DEAP 2.1 build by Tim Coelli.

4 The System of Variables and the DEA Models

The analysis of universities conducted in this paper is made considering the following process of education:

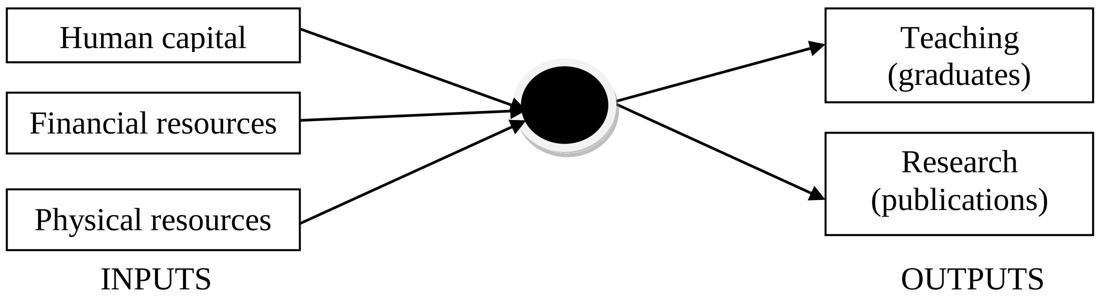

Fig. 1. Education process

The choice of both input and output variables is a debatable subject in the literature, but to my knowledge, most papers that use DEA assume that the education process has two outputs: teaching and research. However, the variables used to measure these two are various and often they do not account for qualitative aspects. The lack of information may conduct to misleading pictures of the university system efficiency. In order to overcome the problem of variable choice I use different model specifications.

The variables used in the analysis are summarized in the table below:

Table 1. Variable description

INPUT	Description
CDID	Full professors, assistant researchers, researchers and assistant professors (simple sum).
CDIDW	Full professors, assistant researchers, researchers and assistant professors (weighted sum).
NPROG	Number of faculty programs
SPEC	Number of curricula (specialisations)
FONDR	Amount of national grants (RON)
FONDS	Amount of foreign grants (RON)
FOND	Total amount of grants (national + foreign)
CARTI	Number of books in the school library
DOT	Classroom equipment for teaching and research
CAMIN	Number of places in the student houses
TOTINM	Total number of enrolled student (bachelor, master, doctoral, post-doctoral)
OUTPUT	**Description**
PUB	Cumulated sum of publications of type ISI (international Statistics Institute) and IDB (International databases)
PUBW	Weighted sum of publications (1 for ISI and 0.75 for IDB).
PUBISI	Number of publications in the ISI journals with impact factor computed
PUBCAR	Number of books with unique author or coordinated
PUBBDI	Number of publications in IDB journals

TOTABS	Total sum of graduated students
Efficiency measures	**Description**
RFIN	Percentage of graduation (total sum of graduated/ total number of enrolled) or teaching activity efficiency
RPUB	Total number of publications per 100 scholars or research activity efficiency
Ranking criteria	**Description**
SPECp100CDID	Number of specializations per 100 scholars
FONDp100TOTINM	Total grants per enrolled student
FONDp100CDID	Total grants per scholar

Using the number of academic staff as input is a common choice in the literature: [6], [7], [11], [2], [5]. In order to obtain one indicator for number of teachers and publications I used two methods of aggregation: the first one is simple summing up, like in [2] and the other one uses weighted values, like in [5] who base their weighted approach on the paper by Kao and Hung [12]. Weights are assigned on the assumption made by Tzeremes and Halkos [5] that a professor is expected to produce more research than an assistant or lecturer.

The amount of funds is considered in some studies as an input [6], [13], [14], [15] and in others as an output [6], [16]. I considered for this analysis as an input variable and obtained it by summing up the amount of national and foreign grants received for research purposes and not only.

The number of specialization, faculty curricula and the variables to account for physical resources were also used in the study [2].

Academic research is a controversial output in the way it can be measured [5]. I chose for this analysis the number of publications because it is a direct measurement of academic research and has also been used before by [2] and [5]. The weights associated are 1 for ISI journal publications and 0.75 for IDB articles.

The second output used is the total sum of graduated to account for the teaching activity. One disadvantage of this approach is that the variable does not refer to the quality of teaching, but only to the amount. In lack of other data available, I will stick to this indicator, also used in previous studies: [7], [2] and [5].

The last part of the table above describes some primary data efficiency measures considered in order to provide primary rankings of universities (Annex 2) and the abbreviation for the universities names can be found in Annex 1.

The first column shows the rank of university according to the rate of publications per 100 scholars for academic years, 2008-2009 and 2009-2010, being a measure of research efficiency (the more publications, the better).

The second column presents the partial rankings according to the success rate of study completion (being also a measure of university attractiveness among potential students over time).

The third variable measures the work load of a professor as accounted by the number of different specializations that correspond to a scholar (1 the worst, 60 the best).

The fourth and the fifth indicators are an expression of the funding rate for each student or professor in the university. The top universities are the ones that have a greater amount of grants reported for each individual.

In order to study the effect of variable modifications to the efficiency scores I run a series of models, summarized in the table below. The analysis uses an outline model, consisting in three types of input resources (human, physical and financial) and two types of output (research and teaching). All models are built around this basic model, including different measures to account for these categories.

Table 2. Efficiency models

Model / Variable	1	2	3	4	5	6
INPUT						
CDID	*	*	*	*	*	
NPROG	*					
FOND						*
CARTI	*	*	*			
DOT	*					
CAMIN		*				
OUTPUT						
PUB		*	*	*		
TOTABS	*	*	*		*	
RFIN						*
RPUB						*

5 Data description

The data used was collected from a survey of assessing universities in Romania realized by the Ministry of Education, Research, Youth and Sports in order to apply art. 193 from the Law of national education no. 1/2011 and Government decision no. 789/2011. This study was made in order to rank the learning programs of the universities that were accredited from the national system of education in Romania.

Although the original database consisted of 61 universities, I found an outlier in the data by plotting CDID against TOTABS and decided to eliminate it. Some descriptive statistics are presented in the table below. The range and variance are quite high for variables FOND with its components and CARTI. The Skewness and Kurtosis coefficients indicate that the distributions are asymmetric to the left (all Skewness are positive) and steep in case of variables like: SPEC, FONDR, FOND, CARTI, PUBCAR, or flat for variables like: CDID, TOTINM, TOTABS.

Table 3. Descriptive statistics

Descriptive Statistics

	N	Range	Minimum	Maximum	Sum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
CDID	60	1232	15	1247	17463	291,05	281,174	1,487	,309	2,009	,608
CDIDW	60	850	9	859	10737	178,95	179,919	1,593	,309	2,719	,608
NPROG	60	447	4	451	4760	79,33	96,134	2,238	,309	5,681	,608
SPEC	60	4443	4	4447	8183	136,38	569,953	7,580	,309	58,237	,608
FONDR	60	2,E8	0	2,E8	7,E8	1,15E7	2,349E7	4,326	,309	22,518	,608
FONDS	60	5636240	0	5636240	4,E7	6,66E5	1166274,305	2,305	,309	5,632	,608
FOND	60	2,E8	0	2,E8	7,E8	1,22E7	2,399E7	4,273	,309	22,002	,608
CARTI	60	2036772	175	2036947	8374660	1,40E5	297255,821	4,917	,309	28,784	,608
DOT	60	4799	18	4817	49742	829,03	948,155	2,063	,309	5,203	,608
CAMIN	60	13050	0	13050	106097	1768,28	2416,010	2,371	,309	7,309	,608
TOTINM	60	40840	53	40893	564336	9405,60	8865,516	1,394	,309	1,812	,608
PUB	60	1336	2	1338	14118	235,30	280,253	1,794	,309	3,628	,608
PUBW	60	1098	2	1100	11393	189,88	230,809	1,851	,309	3,855	,608
PUBISI	60	457,00	,00	457,00	3178,00	52,9667	101,03112	2,632	,309	6,440	,608
PUBCAR	60	52	0	52	223	3,72	8,355	4,264	,309	21,133	,608
PUBBDI	60	951	2	953	10940	182,33	209,048	1,749	,309	3,366	,608
TOTABS	60	12102	56	12158	174537	2908,95	2835,319	1,381	,309	1,556	,608
Valid N (listwise)	60										

6 How Much the Choice of Variables Influences the Tops?

Among the analyses, I studied the effect that large universities, with a high number of professors are more efficient when it comes to resource concentration. As a result, professors are considered to be more efficient if they are able to teach to more students at a time or to publish more papers. This is one of the reasons why increasing returns to scale are assumed in the education system [2]. Results show that 11 universities are efficient, and among those, two are classified as being universities of advanced research by the Ministry of Education: Bucharest Academy of Economic Studies and Babes-Bolyai University of Cluj-Napoca. Many large size universities are less efficient in resource concentration than small ones in this model so the assumption that large universities are more efficient is not true in general, but only for some particular cases. In terms of input slacks, the third variable of input (number of books contained in the library), results show that the amount could be lowered considerably in case of most universities without modifications to the output. This can be considered an effect of the increase in online sources of information and research for the young generation rather than traditional paper based ones.

The second model described in Table 2 estimates the global university efficiency considering both research and teaching output. Human resources and material conditions contribute to the results. Sixteen universities have an efficiency score of 1; among these, four are classified as high research universities. In order to study efficiency score sensitivity to the variables chosen, I have eliminated from the model above variable CAMIN, which refers to student living conditions. This small modification in input variables has not influenced significantly the top obtained, only some universities changing their position. In the new ranking, 23% of the universities are efficient.

According to [2], there exists a trade-off between research and teaching because Professors are free to allocate different amount of time to these activities. I also wanted to test this assumption on my data using two efficiency models (4 and 5) and not environmental factors, like in the mentioned study. I found that most of the universities that were efficient in one model were also efficient in the second model, with few exceptions. It seems that, in particular, medical profile universities tend to allocate more time to publications than to teaching and some generalist universities (containing a vast range of programs and specializations) tend to be more efficient in teaching activities. Although much controversy is related to not taking into account the quality of teaching [8], the available data could not make it possible to include this in the analysis.

Model 6 aims to express the financial efficiency and it has a very different specification of variables. It does not take into account as input the number of scholars, but only financial resources. Instead of direct measures of output, it uses indirect indicators with the same economic meaning expressed as fractions. As it was expected, the results are very different. The efficient use of financial resources is not the primary purpose of high, prestigious universities, but of the small universities. No high research university is efficient in this model. This can be a good start in reallocation of budget funds from government to more efficient universities rather than to large institutions, as well as an alarm signal of excessive inefficient allocation of funds. This classification also reflects results - cost perspective that could be the basis for future strategies in planning research funds.

In order to have a comprehensive model that would account for most of the input and output variables used in the models above, I built an *aggregated model*. This model was constructed using the technique of reducing dimensionality from [17]. The aggregated input variable was build using the highly correlated indicators CDIDW, NPROG, FOND, CARTI, DOT, CAMIN and TOTINM. In case of output, the correlated variables PUBW and TOTABS were used.

The one input - one output model obtained is consistent in terms of efficient institutions with the other models only in case of two universities: Bucharest Academy of Economic Studies and University Babes-Bolyai of Cluj-Napoca. These two proved to be efficient in all models, except for model 6, where I used fractions as output variables. The conclusion is that, given the available data, those two universities are efficient, regardless of the criteria used.

In order to visualize the data, I constructed an efficiency frontier using the package benchmarking from R. The frontier for the aggregated model looks like this:

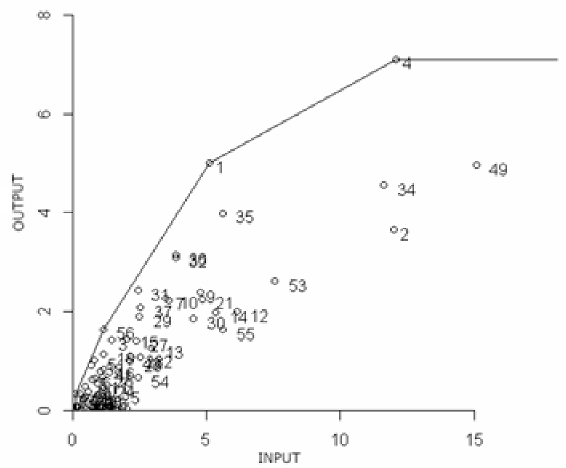

Fig. 2. Efficiency Frontier for the aggregated model

Plotting the output values against the input values, the five efficient firms can be easily observed. Universities number 1 and 4 (ASE and BBC) are on the top of the efficient frontier. The remaining three efficient universities can be found lower on the curve. All other universities lie below this curve, suggesting that they can improve their efficiency by changing their strategy to those of the DMU's found on the frontier. The DEA output shows the peers for every university, as well as the target values for every input and output. A classification of the universities according to the efficiency range in brackets is provided below.

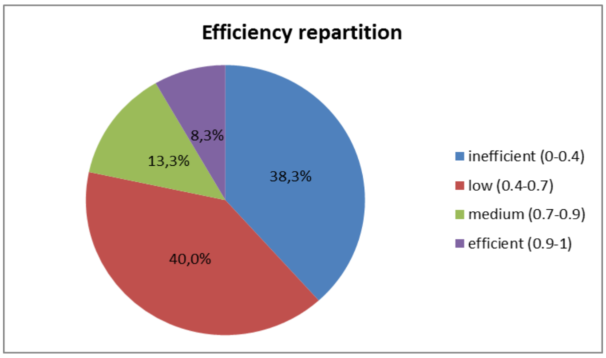

Fig. 3. University repartition according to efficiency scores

The majority of universities are inefficient or with a low efficiency (78.3%) and only 8.3% of the universities analyzed are found to be efficient.

7 Conclusion

This paper analyses the efficiency of universities through various models. The rankings built reveal the models sensitivity to the change of variables and can be used by the government in planning their budget funds strategy or their research grants, by prospective students who want to know more about their future university or by public / media.

I found that a small change of the input variables, in which the replacement variables have similar economic meaning, does not have a significant influence on the rankings. However, when all variables are changed, whether input side or output side, with others that account for different or additional economic purposes or differ in a high degree from the original variables, the tops obtained are not consistent anymore and show different aspects of university efficiency. This modification has a greater impact in case of output side changes.

Two universities have proved to be efficient in all models including primary data variables: Bucharest Academy of Economic Studies and University Babes-Bolyai of Cluj-Napoca. Given the available data and due to the fact that different measures were used, these universities have the necessary managerial abilities and government support to effectively use all resources in order to provide quality research papers and teaching output.

The analysis conducted in this paper reveals some characteristics regarding universities. I found that the most efficient universities regarding publishing are University of Agricultural Sciences and Veterinary medicine Ion Ionescu of Iasi, University of Agricultural Sciences and Veterinary medicine from Cluj-Napoca and Bucharest Academy of Economic Studies. Also, I found that technical universities are less efficient when it comes to input minimization. These universities focus more on publishing than on teaching and especially on high rated journal publications. Medical profile universities prove to have the same focus in their strategy, probably because the research activity is given more credit in this type of universities. On the other hand, generalist universities, containing a wide range of programs, are more efficient in teaching than specialized ones, having a higher number of graduated students.

Another finding of this paper is that the statement that large universities are more efficient in resource utilization is not always true. Results also show that universities could lower their library collection without loss of efficiency, proving that the use of internet is now more popular than traditional book reading.

Future research could be done to include the “quality” measure for teaching activity and also to increase the number of units available for analysis. Different advanced nonparametric methods could also be applied in order to overcome the “curse of dimensionality” of nonparametric techniques.

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Annex 1

	University	**University abbreviation**
1	Bucharest Academy of Economic Studies	ASE
2	University Alexandru Ioan Cuza of Iasi	AIC
3	University Aurel Vlaicu of Arad	AVA
4	University Babes-Bolyai of Cluj-Napoca	BBC
5	University Constantin Brancoveanu of Pitesti	CBP
6	University Constantin Brancusi of Targu Jiu	CBT
7	University Danube of Galati	DJG
8	University Eftimie Murgu of Resita	EMR
9	University Lucian Blaga of Sibiu	LBS
10	University Ovidius of Constanta	OVC
11	University Petru Maior of Targu Mures	PMM
12	University Politehnica of Timisoara	UPT
13	University Stefan Cel Mare of Suceava	SMS
14	University Transilvania of Brasov	UTB
15	University Valahia of Targoviste	UVT
16	University Vasile Alecsandri of Bacau	VAB
17	University Andrei Saguna of Constanta	ASC
18	University Crestina Dimitrie Cantemir of Bucharest	DCB
19	University of Architecture and Urbanism Ion Mincu of Bucharest	AUI
20	University of Arts George Enescu of Iasi	GEI
21	University of Medicine and Pharmacy Carol Davila of Bucharest	DAV
22	University of Medicine and Pharmacy Gr. T. Popa of Iasi	POP
23	University of Medicine and Pharmacy Victor Babes of Timisoara	VBT
24	University of Medicine and Pharmacy of Craiova	MFC
25	University of Medicine and Pharmacy of Targu Mures	MFM
26	University of North of Baia Mare	UNB
27	University of Agricultural Sciences and Veterinary Medicine Ion Ionescu of Iasi	IIB
28	University of Agricultural Sciences and Veterinary Medicine of Timisoara	MVB
29	University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca	MVC
30	University of Agronomic Sciences and Veterinary Medicine of Bucharest	AMV
31	University of West Vest Vasile Goldis of Arad	VGA
32	University of West of Timisoara	UVT
33	University Dimitrie Cantemir of Tirgu Mures	DCT
34	University of Bucharest	UNI
35	University of Craiova	UCR
36	University of Oradea	UOR
37	University of Pitesti	UPI
38	Ecological University of Bucharest	UEB
39	University Emanuel of Oradea	UEO
40	University George Baritiu of Brasov	GBB
41	University Hyperion of Bucharest	HYP
42	Maritime University of Constanta	MAR

43	National University of Defence Carol I of Bucharest	UNA
44	National University of Theater and Film I. L. Caragiale of Bucharest	ART
45	National University of Art of Bucharest	ARB
46	National University of Physical education and Sports of Bucharest	FIZ
47	National University of Music of Bucharest	MUZ
48	University Petrol-Gas of Ploiesti	PGB
49	Polytechnic University of Bucharest	UPB
50	Romanian University of Science and Art Gheorghe Cristea	SAG
51	Romanian-American University of Bucharest	ROM
52	Romanian-German University of Sibiu	ROG
53	Technical University Gheorghe Asachi of Iasi	GHA
54	Technical University of Construction of Bucharest	TCB
55	Technical University of Cluj-Napoca	UTC
56	University Titu Maiorescu	UTM
57	University Athenaeum of Bucharest	UAB
58	University Mihail Kogalniceanu of Iasi	UMK
59	University George Bacovia of Bacau	UGB
60	University Tibiscus of Timisoara	UTT

Annex 2

	RPUB		**RFIN**		**SPECp100CDID**		**FONDp100CDID**		**FONDp100TOTINM**	
University	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10	2008/09	2009/10
ASE	3	4	13	6	40	42	28	23	22	15
AIC	14	23	39	32	7	14	21	28	12	21
AVA	24	33	9	13	33	36	45	38	44	32
BBC	6	8	30	36	44	46	16	19	10	12
CBP	31	24	27	11	35	33	50	53	48	52
CBT	27	3	17	20	4	3	49	43	49	45
DJG	16	21	24	31	31	39	26	25	25	26
EMR	40	45	10	15	19	24	37	34	33	33
LBS	26	27	22	18	17	15	20	10	18	8
OVC	12	31	48	43	10	21	33	33	31	35
PMM	35	32	16	33	5	13	39	9	38	3
UPT	32	40	31	44	18	20	18	6	16	7
SMS	36	16	19	29	15	12	11	41	3	40
UTB	39	38	45	48	16	17	19	18	21	17
UVT	11	5	20	40	21	28	22	16	17	11
VAB	8	17	33	46	27	11	31	32	30	30
ASC	46	54	54	58	52	38	53	52	51	50
DCB	33	41	35	34	55	48	44	45	41	44
AUI	56	58	60	60	56	58	5	12	7	18
GEI	57	57	50	42	13	16	38	48	43	51
DAV	15	18	57	55	60	60	9	2	15	6
POP	30	22	51	56	53	55	27	24	36	27
VBT	18	26	56	50	59	59	6	14	11	24

MFC	42	47	49	49	58	56	10	13	13	20
MFM	43	50	59	59	57	57	14	26	20	28
UNB	25	39	38	45	6	4	40	39	39	39
IIB	**1**	**1**	21	52	42	32	2	8	1	9
MVB	28	20	5	21	41	45	13	4	14	13
MVC	2	2	34	47	2	2	4	7	6	10
AMV	13	15	8	23	49	49	8	15	5	16
VGA	37	44	3	3	36	41	43	44	37	43
UVT	10	7	41	25	12	6	42	37	40	38
DCT	22	14	52	30	39	23	47	**1**	46	**1**
UNI	23	29	29	28	23	22	7	5	4	4
UCR	19	25	11	19	26	25	30	31	28	31
UOR	17	12	44	41	25	29	41	35	42	41
UPI	21	30	26	26	28	26	32	27	29	23
UEB	45	48	12	5	30	40	46	42	45	37
UEO	47	34	58	39	3	5	25	29	34	36
GBB	58	56	2	2	54	51	56	55	56	55
HYP	53	51	6	9	47	43	29	49	24	47
MAR	54	10	23	35	29	44	34	11	27	2
UNA	29	42	1	1	32	7	1	56	23	56
ART	59	60	28	16	24	37	35	51	47	54
ARB	41	46	46	22	11	8	24	30	32	34
FIZ	48	11	42	24	37	35	57	56	57	56
MUZ	60	59	43	38	50	52	48	47	53	49
PGB	44	43	15	12	8	18	36	40	35	42
UPB	20	28	36	51	34	31	3	3	2	5
SAG	55	55	32	14	48	54	57	56	57	56
ROM	9	13	18	7	46	34	54	54	54	53
ROG	52	19	53	37	1	9	51	46	50	46
GHA	34	37	25	53	38	27	15	17	19	19
TCB	51	52	55	54	45	47	23	20	26	25
UTC	38	35	47	57	14	19	12	21	9	22
UTM	5	9	4	4	51	53	17	22	8	14
UAB	50	36	40	8	20	1	57	56	57	56
UMK	49	49	14	27	43	50	57	56	57	56
UGB	7	53	7	10	9	10	55	36	55	29
UTT	4	6	37	17	22	30	52	50	52	48

Madalina STOICA has graduated the Faculty of Economic Cybernetics, Statistics and Informatics in 2010. She is a PhD Student at the Cybernetics and Statistics program at the Bucharest Academy of Economic Studies since 2013 and part of the research program “Excellence academic routes in doctoral and postdoctoral research - READ” in affiliation with the Romanian Academy. Currently she also works as a Research Scientist for SAP. The main research focus is on efficiency and nonparametric techniques in the operations research area, with application on education.