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EFFICIENCY OF TEACHING AND RESEARCH ACTIVITIES IN ROMANIAN UNIVERSITIES: AN ORDER – ALPHA PARTIAL FRONTIERS APPROACH

Abstract. *Romanian universities are characterized by increasing teaching activities that are sometimes detrimental to the professors' research activities due also to the lack of funding. The importance of evaluating universities efficiency rose in recent years to become one of the primary aims of universities management. This paper examines the universities managerial efficiency using nonparametric partial frontiers on empirical data regarding Romanian education system. We employ FDH and robust order α efficiency estimators in order to get a better insight in the data set outliers. Results are reported for two separate categories of universities according to their size analyzing research, teaching and overall efficiency estimates. Interesting insights regarding the trade-offs between teaching and research activities shows as an increased effort in the Romanian universities to increase their ranking by investing in the research area even with the reduce funding.*

Keywords*: FDH, nonparametric efficiency estimators, partial frontiers.*

JEL Classification: C14, C38, I20, I23

Introduction

Universities efficiency has been the subject of many papers in recent years given the complexity of the process and the competition on budget funds and the restrictive allocation. The institutions' management needs to optimally use the available resources in order to get an output measured both in terms of research and teaching activities. Prospective students are interested in the university rankings, especially when, for a potential employer, the reputation and education provided by an academic institution are recognized in the recruitment process.

Some universities developed a special department for business intelligence with the aim of monitoring the activity in terms of use of resources and outputs. The tools vary according to the scope of the evaluation, but the aim is the same: increase in efficiency and a better understanding of how things are managed inside the

institution. Those universities that learn and optimize their use of the available resources have a lot to gain in the long run.
The authorities also invested time and effort to create a system that evaluates, in a standardized manner, the activities and the management of institutions.This is also the case of the Romanian higher education system which was under evaluation in 2011 in order to create a European framework that classifies universities and ranks different programs. Professors' workload represented by both the large number of students and the weekly number of hours they teach together with the limited research funding are among the subjects highly debated in the media and identified as the sources of different problems that connect to the 2011 classification. This is also one of the explanations of the fact that, even though, the teaching activities are considered to be very good and provide a high level of information, fact that is also highlighted by the great international absorption of our Romanian students on the EU and US PhDs markets, none of our universities is present in the Top 500 universities. Only one university, the Babes-Bolyai University of Cluj-Napoca is situated in the Top 600 universities as of 2015.
In this multivariate context of the education process, the need to use nonparametric efficiency techniques which allow multiple input-multiple output evaluation are a nice way to approach the issues at hand.
The rankings which are usually found in the media are only related to simple indicators like fractions of primary data indicators. This is why, this paper aims to clarify the rankings provided and offer a perspective over the Romanian universities, separately on teaching and research activities.
The paper unfolds as follows: it starts with an Introduction followed by a short presentation of the Methodology followed by an Overview of the data. The Efficiency analysis using both full and partial frontiers is largely presented on both identified clusters ant the Conclusions give a final perspective into the Romanian higher education system.

Section 1: Methodology

The technical efficiency methodology applied in this paper is based on a probabilistic approach of the production set of all feasible combinations of inputs and outputs:

$$\psi \equiv \{(x,y), where\ x\ can\ produce\ y\} \in R_{+}^{N+M}\} \quad (1)$$

where$x \in R_{+}^{N}$ is the inputs vector and $y \in R_{+}^{M}$ is the outputs vector.

The production frontier is given by the upper boundary of P:

$$\Psi^{\partial} = \{(x,y) \in \Psi | (\theta x, y) \notin \Psi, \forall\ 0 < \theta < 1, (x, \lambda y) \notin \Psi, \forall 0 < \lambda < 1\} \quad (2)$$

Points inside the frontier are technically inefficient while the units that operate at points situated along the frontier are technically efficient.
The Ferrel-Debreu measure of efficiency in an output orientation, for any unit situated inside the production set is given by:

$$\lambda(x,y) = \sup\{\lambda | (x, \lambda y) \in \Psi\} \quad (3)$$

First proposed by Deprins et al. (1984), the free disposal hull (FDH) is a traditional nonparametric estimator for the efficiency frontier, where the only assumption required is the free disposability for the inputs and outputs, also referred to as weak dominance:

$$\hat{\psi}_{FDH} = \{(x, y) \in R_{+}^{N+M} \mid y \leq y_i; x \geq x_i; (x_i, y_i) \in \chi_n\} =$$

$$= \cup_{(x_i, y_i) \in \chi_n} \{(x, y) \in R_{+}^{p+q} \mid y \leq y_i; x \geq x_i\} \quad (4)$$

andx_i, y_i are the classic notations in the literature for input and output vectors of sizes *p* and respectively q, while x_n is the available sample.

A nonparametric estimator for the output efficiency of any given point (x,y) can be obtained if we replace the true production set Ψ with the estimator $\hat{\psi}_{FDH}$ and we find the FDH estimator of $\lambda(x, y)$:

$$\hat{\lambda}(x, y) = \sup\{\lambda \mid (x, \lambda y) \in \hat{\Psi}_{FDH}\} \quad (5)$$

Successively developed in the papers of Cazals, Florens and Simar (2002), Simar (2003), Daouia and Simar (2005, 2007), Wheelock and Wilson (2008, 2009) and Simar and Wilson (2013), the idea behind partial frontiers is to construct an estimate of the full frontier which does not envelop all the data in the sample, but only a fraction of it. The influence of outliers is diminished and the efficiency estimates will be more robust.

Two types of partial frontiers are commonly used: the order *m partial* frontiers proposed by Cazals, Florens and Simar (2002) and the order α partial frontiers introduced for the single variable case by Aragon, Daouia and Thomas-Agnan (2005) and for the multivariate case by Daouia and Simar (2007). The first one uses a trimming parameter to exclude some of the units under analysis and has a discrete formulation. The latter one expresses the percentage of decision making units (DMUs) found below the curve by the value of the parameter α and has a continuous nature. The advantages of using the order α frontier is that one can construct a partial efficient frontier for any DMU under analysis since we can build a curve that passes exactly through the unit and the α can be computed accordingly. This type of estimators do not suffer from the curse of dimensionality as in the case of the FDH estimator and the rate of convergence is much better approaching the one of the parametric methods.

For the order α partial frontier, one first needs to set up a value for the parameter in order to define the percentage of sample points which are left outside the partial frontier. The α efficiency estimate expresses the relative efficiency of a unit compared to a percentage of the points in the sample and according to Simar and Wilson (2015) it is computed by:

$$\lambda_{\alpha}(x, y) = \sup\{\lambda \mid S_{Y|X}(\lambda_y \mid x) > 1 - \alpha\} \quad (6)$$

where$\lim_{\alpha \to 1} \uparrow \lambda_\alpha(x,y) = \lambda(x,y)$, and↑ denotes the monotonic convergence from below.

The plug-in principle can be used to get a nonparametric estimator of $\lambda_\alpha(x,y)$by replacing $F_{X|Y}(x|\lambda y)$with the empiric distribution function $\hat{F}_{X|Y}(x|\lambda y)$as in Daouia and Simar (2007). The nonparametric estimator will be:

$$\hat{\lambda}_{\alpha,n}(x,y) = \sup\{\lambda \big| \hat{S}_{Y|X,n}(\lambda y|x) > 1-\alpha\} \quad (7)$$

In order to get the partial frontier, we used the output oriented estimator and the efficiency estimate,$\lambda_\alpha(x,y)$,gives the unit efficiency at α*100% level with a probability of (1-α)*100% of being dominated by any other unit randomly chosen from the sample. If the efficiency estimate $\lambda_\alpha(x,y)$ is smaller or larger than 1, then the respective unit can proportionately reduce or increase the level of output produced in order to become output efficient at α*100% level.
The order-alpha efficiency estimator $\hat{\lambda}_{\alpha,n}(x,y)$ gives us a robust estimator of the full frontier, with a root-n convergence and asymptotic normality:

$$\sqrt{n}(\hat{\lambda}_{\alpha,n}(x,y) - \lambda_\alpha(x,y)) \xrightarrow{d} N\left(0, \sigma^2_{out}(x,y)\right) \; as \; n \to \infty, \quad (8)$$

where this estimator converges to the FDH estimator:

$$\lim_{\alpha \to 1} \uparrow \hat{\lambda}_{\alpha,n}(x,y) = \hat{\lambda}_{FDH}(x,y), \text{ as } \alpha \to 1. \quad (9)$$

Robust frontiers are used to estimate universities efficiency due to the fact that they are less sensitive to extreme values than FDH or DEA estimators. We computed the efficiency estimates for the two groups of universities and constructed the corresponding partial efficiency frontiers where the value for the α parameter is chosen such that only 5% of the dominant universities will be left outside this frontier.

Section 2: Overview of the Romanian universities - data description

Using a study made by the Ministry of Education and Research in Romania in August 2011[1] in order to provide a standardized way to classify universities and rank the faculty programs, we gathered information regarding89 universities in 2008-2009. The data were gathered from 89 pdfs provided by the website. A preview of the 17 variables that define the universities performances are provided in Table 1. Previous use of the data was possible in Stoica (2015).

[1]http://chestionar.uefiscdi.ro/public5/index.php?page=punivlist

Table 1.Universities indicators

Inputs and Outputs	Description (as in the above mentioned 2011 study)
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 (specializations)
FONDR	Amount of national grants (RON)
FONDS	Amount of foreign grants (RON)
FOND	Total amount of grants (national + foreign)
BOOKS	Number of books in the school library
DOT	Classroom equipment for teaching and research
HOUSES	Number of places in the student houses
TOTINM	Total number of enrolled student (bachelor, master, doctoral, post-doctoral)
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

Several preliminary analyses were conducted on the initial data set. Annex 1 gives summary statistics. The data ranges are large in several cases such as the number of enrolled students or the academic staff. A detailed analysis of the data set is required to make sure heterogeneity will not influence the efficiency frontier.

A graphical representation of the number of programs against the sum of academic staff gives the *workload related to specialization* (Figure 1). The majority of universities are bundled in a cluster in the left lower part of the graph, while some others are spread far away from this group, with large values for both the academic personal and the number of programs. If we consider the number of programs or the academic staff as an indicator of the university size, we can relate to the second group as one constructed of large universities. As we move to the right side of the graph we encounter universities with high reputation, also known as the best in their field of study in Romania, for example University Babes-Bolyai(BBC) or Polytechnic University of Bucharest (UPB).

In order to assess *the publication rate*, the number of weighted publications per weighted academic staff is presented in the second graph, where an increased data spread can be detected compared to previous graph. One can notice that large universities, such as University of Economic Studies (ASE) or the University Babes-Bolyai (BBC) are located far away from the main cluster.
The *financial resources* for each university in relation to its size given by the number of academic stuff are presented in the third graph where we can see that UPB, the largest university of technical studies in Romania, seems to attract the highest amount of funds. Other similar examples include University of Bucharest (UNI) and University Babes-Bolyai (BBC).
16 universities attract the lowest amount of research funds.

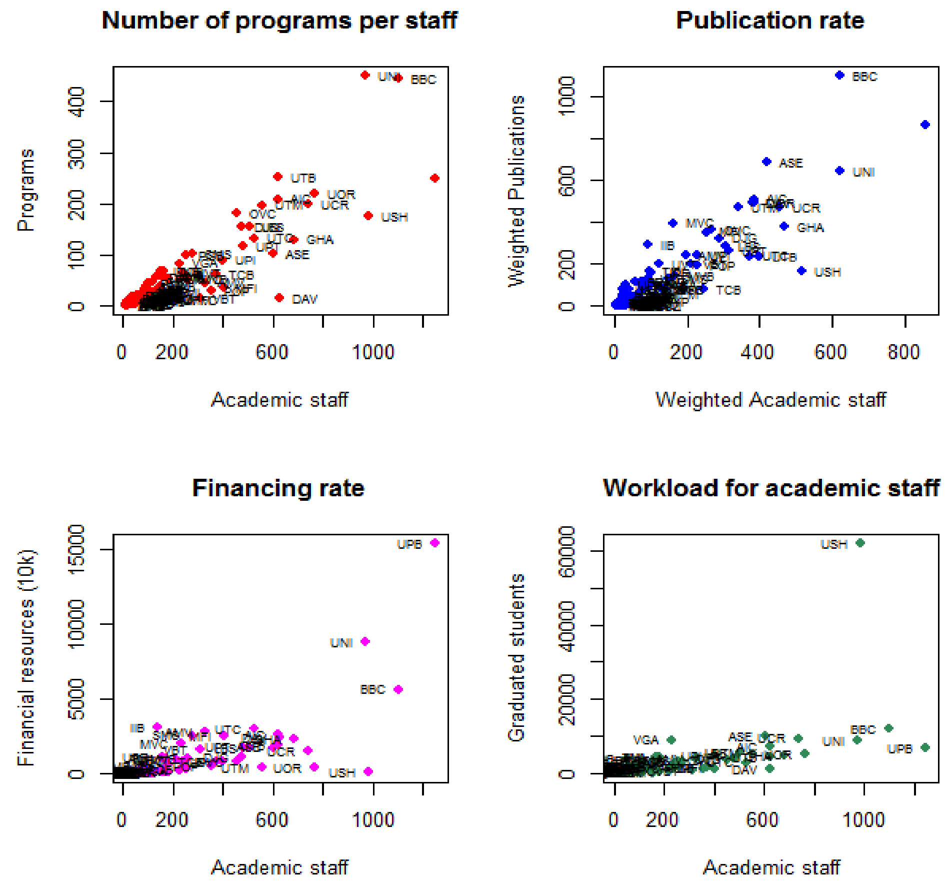


Figure 1.Preliminary analysis 2008-2009

In the local media, there is a general perception that more students per professor mean higher workload and decrease in teaching quality. Given the lack of a quality indicator for this data set, we analyze the workload for each university to observe the ones which have the highest number of graduated students per academic staff. From the fourth graph, we can notice that one university stands out and this is University SpiruHaret in Bucharest (USH), with the highest number of graduated students and relatively the same number of academic staff as other large universities (UNI, BBC).Given the discrepancy with the rest of the data set, we chose to exclude this university from the sample.

Section 3: Efficiency analysis of the Romanian higher education system

Before starting any efficiency analysis, we make use of data analysis in order to identify the outliers and have an insight of the information provided by the 17 variables divided by their standard deviation.We employ a principal component analysis using R 3.3.0 and we find that almost 85% of the original information can be represented in 3 dimensions (compared to our initial 17) which is a real gain in dimensionality.

A scatterplot of the universities according to the first three principal components gives us two large groups, one clustering in a small portion of the cube and the other spread inside the area.In the main grouping area small and medium size universities are found, whereas all large size universities have a high degree of spread inside the cube.

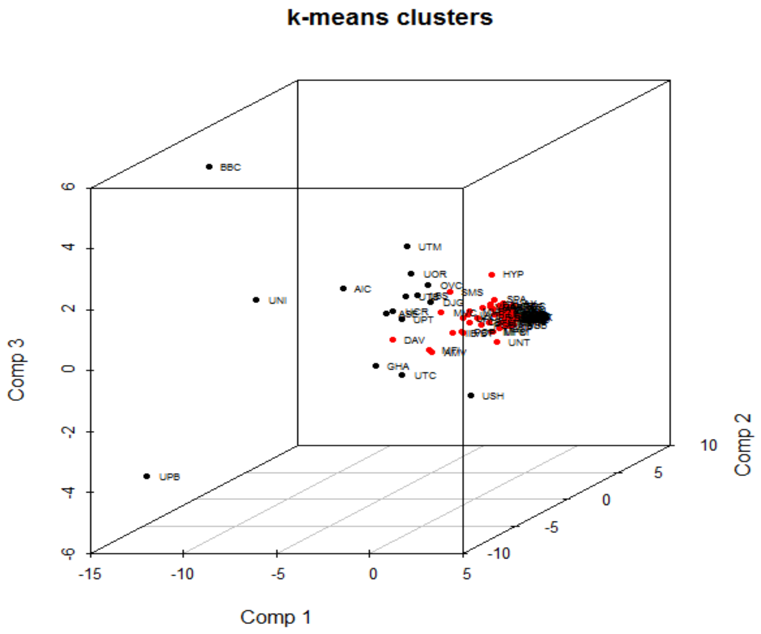


Figure 2. 3D scatterplot of universities

Since heterogeneity in the data set can influence the universities performance, we target to obtain a homogeneous set of data. In order to properly identify the groups of institutions which are similar we performed k-means clustering on the standardized initial 17 variables. The uses of the k-means function in R 3.3.0 leads to identification of two groups with 72 and 17 universities. The cluster with 72 universities is composed of small and medium size universities, and the other one includes large, well-known universities in Romania, along with the extreme value identified in the previous section. An analysis of the first cluster based on the descriptive statistics (Annex 2) indicates a much homogeneous group than the initial data set of institutions. Variables ranges have decreased significantly, for example the range for the number of academic staff has reduced from 1239 to 393 and the number of graduates varies between 61875 and 9033.

Efficiency models for the education process

Following the available data set and the models construction as in Daraio and Simar (2006), we chose 8 variables combined as in Table 2 in order to evaluate the education process. The first 5 variables are inputs and the last 3 are outputs.

Table 2.Combination of inputs and outputs

Models	CDID	cdidw	nrprog	FOND	Books	PUBW	pubisi	TOT ABS
Research		*					*	
Teaching	*				*			*
Overview	*		*	*		*		*

The first model, named *Research model*, evaluates the university efficiency given by the research activity of the academic staff. It includes one input as the academic staff weighted according to their academic position and one output to account for the high quality ISI publications and IDB papers as a weighted sum of publications (1 for ISI and 0.75 for IDB) as in Bonaccorsi et al. (2006).

The second model, also called the *Teaching model*, takes into account two input variables, one for academic personal and one for the number of books in the university library and one output, the number of graduate students.

The third model aims to provide an *overview* of the universities' efficiency taking into account the human resources, the indicator for the university size and the financial resources as inputs and the number of weighted publications and the total number of graduated students, as outputs that include both aspects of an academic life, teaching and research.

When we analyze universities, the output orientation is a reasonable assumption since higher education institutions target to obtain as much teaching and research output as possible rather than trying to use a smaller amount of resources.

Reducing dimensionality for each cluster of universities

Because of the 72 available observations for the first group of universities and the large number of dimensions needed for all 3 efficiency models, we found ourselves in the situation where we need to reduce space dimensionality in order to avoid the well-known problem of the small data sets, the curse of dimensionality. In order to do this we employ Daraio and Simar (2007)dimensionality reduction procedure, based on Mouchart and Simar (2002), which involves an aggregation of the input/output variables. The technique is based on the construction of an aggregated input and output as a linear combination of the standardized input variables:

$$I = \sum_{i=1}^{p} v_i \, I_i{}' \qquad O = \sum_{i=1}^{q} v_i \, O_i{}' \tag{10}$$

I_i' an d$O_i{}'$are the original standardized variable obtained by dividing primary data by the standard deviation. The weights v_i used to obtain the aggregated input above are given by the values of the eigenvector for $X'X$ correspondant to the highest eigenvalue, where X is the matrix of scaled input variables. The same aggregation technique is used for the output variables to obtain an aggregated output. These aggregated inputs and outputs allow us to have a graphical representation of the efficiency frontiers in two dimensions.

For the *Teaching model*, we need to aggregate two input variables CDID and CARTI (Books), which have a correlation coefficient of 0.56, indicating that a reduction in size will not significantly affect the amount of original information we choose to keep in the model. The eigenvector corresponding to the highest eigenvalue 269.05 is (0.75; 0.65) which will give the weights used to obtain aggregated input for model 2.

For the *Overview model*, we include three input variables (CDID, NPROG, FOND) and we find that the highest eigenvalue for the matrix is 353.93 and the corresponding eigenvector is (0.66; 0.62; 0.4). A similar analysis is used for the outputs.

The same procedure has been used to reduce dimensionality for the heterogeneous group of universities.

High correlations between the aggregated input and the initial inputs and, respectively, between the aggregated output and the initial outputs are also found which means that we do not face a loss of information by the dimensions reduction.

Estimating efficiency of the heterogeneous group compared to the homogenous group

For the first model also named the research model, we construct the efficient frontier using the FDH estimator and the order α partial frontier. Results for both small/medium size universities named homogeneous group and the previous universities together with the large ones, named heterogeneous group are available on their respective efficiency frontiers.

By analyzing the changes in the efficiency frontier when moving to the larger group of universities, our aim is to see whether the split into two clusters had any effect on the frontier and if the size of the university is an important factor in the universities' efficiency.

As far as the first model, the *Research model* goes we report 11 efficient universities, four of them being considered large universities: University Babes-Bolyai in Cluj Napoca (BBC), Bucharest University of Economic Studies (ASE), Alexandru Ioan Cuza University from Iasi (AIC) and Carol Davila Medical University of Bucharest (DAV). These universities are also among the advanced research and learning Top 10 universities in Romania published in a 2011 study[2]. An explanation to why only 4 of the 10 universities included in the Top 10 are on our efficiency frontier is given by the choice of input and output, our model being defined only by the high level research results such as papers published in ISI and IDB journal, without taking into consideration all other types of publications. The other 7 efficient universities are exactly the same as the ones found to be efficient in the homogeneous group. This may imply that the inclusion of the large universities in the cluster did not lead to a change in the efficiency frontier for the homogenous group and only 4 of them are actually on the frontier. A simple comparison among the average samples efficiency shows a 7% increase in efficiency from the smaller to the larger sample, that has a 49% mean.

We also provide the order α partial frontier that allows us to have a better understanding of the universities that display high efficiency estimates. If we take a closer look at the universities between the full and the partial frontier, we find several universities that are not on the full efficiency frontier but they are above the 95% partial frontiers: Iulia HaţeganuUniversity of ClujNapoca (MFI), University of Bucharest (UNI) or the Polytechnic University of Bucharest (UPB) that belong to the Top 10 research and teaching universities together with several others such as: The West University of Timişoara (UVT) or The Agronomic Science and Veterinary Medicine of Bucharest (AMV).

[2] http://www.edu.ro/index.php/pressrel/16071

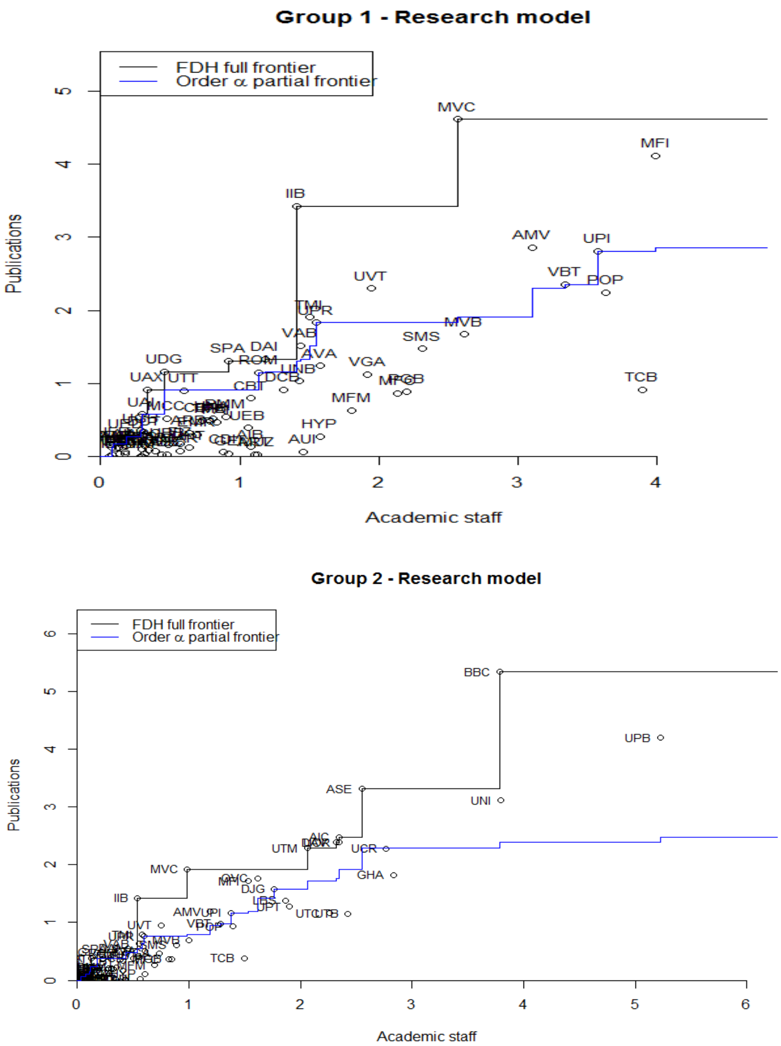
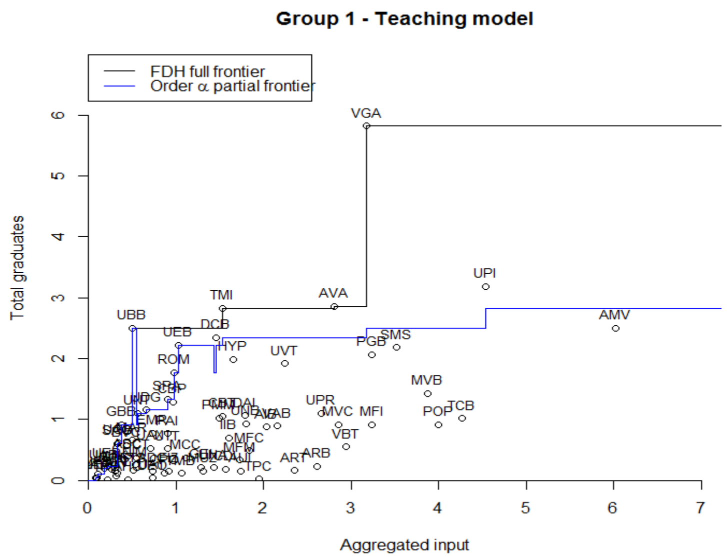


Figure 3. Full and partial frontier for homogenous group (above) and heterogeneous group (below) – model 1

A similar analysis is performed for the teaching model, where we repot 12 efficient universities found on the efficient frontier, among which two are large universities Bucharest University of Economic Studies (ASE) and, again, University Babes-Bolyai in Cluj Napoca (BBC). The other 10 efficient universities belong to the smaller group. We found an almost similar efficiency average for both groups, around 45%. Efficiency frontiers are presented in Figure 3.

A comparison between the two models in both groups shows that university that are found to be efficient according to the Research model are no longer efficient after the teaching model was performed. The switch between efficient and very inefficient performance for those institutions shows that there might be a trade-off between allocating more time to do research work instead of teaching students, as previously investigated at the European level by Bonaccorsi, Daraio and Simar (2006). The trade-off is a side effect of the fact that a professor needs to choose between allocating more time to one activity or the other.

The FDH efficiency estimates showed only three universities efficient in the case of the publishing model but inefficient according to the teaching model. This can reveal interesting insights regarding the main goal of the institutions management. On the other hand, we noticed some universities such as: University George Baritiu in Brasov, Romanian American University in Bucharest, TituMaiorescu University that focus on teaching rather than publishing. In the heterogeneous group, the trade-off effect can be noticed for National University of Defense Carol I in Bucharest and Mihai Eminescu University in Timisoara which focus their activity on research. On the other hand, the European university Dragan in Lugoj was found inefficient in the research model, but efficient in the teaching model. Six universities were efficient in both models.



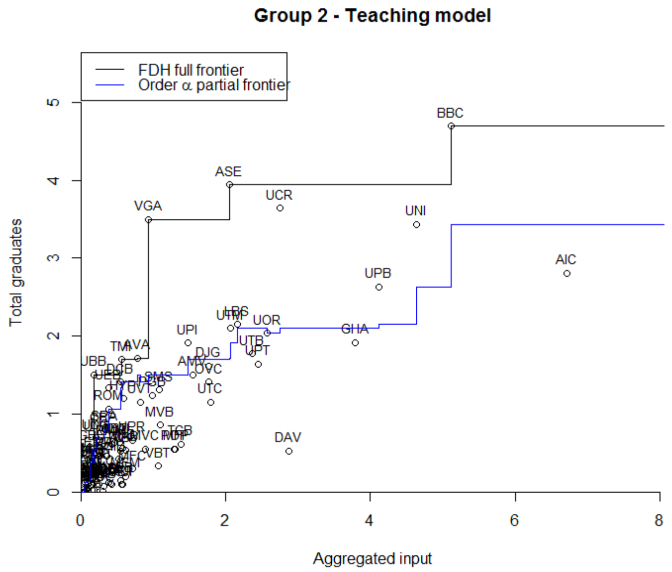


Figure 4.Full and partial frontier for homogenous group (above) and heterogeneous group (below) – model 2

As for the third model, this estimates the overall managerial efficiency of the institutions. Results for the small to medium size universities show nine universities to be efficient in this case, six of them were also found to be efficient in the teaching model. Such cases are represented by Titu Maiorescu University (TMI) or Vasile Goldis West University of Arad. All these universities are among the ones listed as universities that have education as main objective. Although universities have a focus on generating both number of graduates and research publications, these institutions have a higher focus on teaching.

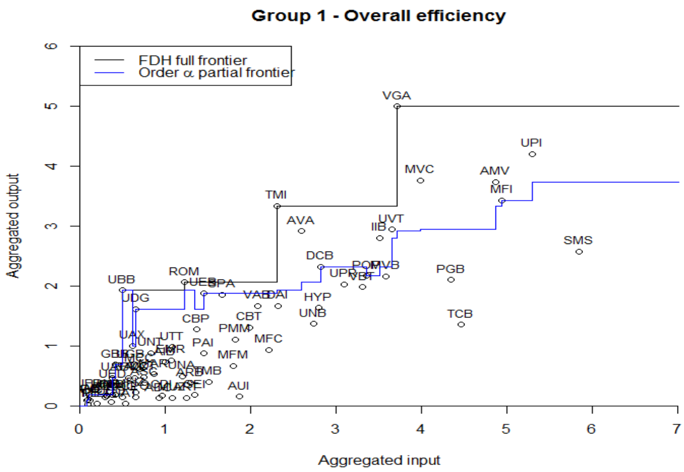


Figure 5. FDH efficiency frontier for the homogeneous group – model 3

In the heterogeneous group we report 12 universities situated on the frontier, two of which are large universities: Bucharest University of Economic Studies (ASE) and University Babes-Bolyai in ClujNapoca (BBC), as in the previous model and eight of them belong to the homogeneous efficient universities.

One can notice the presence of two large universities, UNI and UPB that are situated between the full and the 95% efficiency frontiers for the heterogeneous group, exactly as in the previous two models which suggest a very good approach to both university management as well as targets in research and teaching.

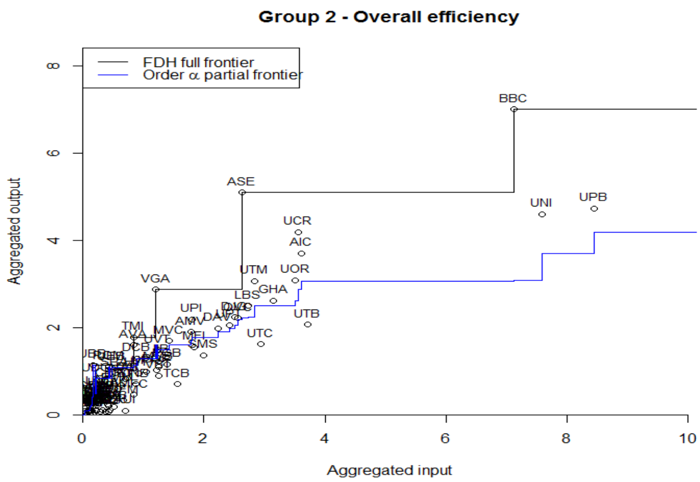


Figure 6.Full and partial frontier for the heterogeneous group – model 3

All average efficiency estimates for all three models increased in the case of the heterogeneous group compared to the homogeneous one. This proves the overall efficiency estimates of the large size universities are higher, and they add efficiency to the sample. However, the addition of two large universities to the small ones did not modify the frontier.

This research allows us to make some remarks regarding homogeneity in the data sample. Although we have found differences regarding size for universities, it seems that most of the efficient universities that belong to the homogeneous group remain efficient in the larger group. As it was investigated in the literature, the economies of scale have a small impact in case of Romanian universities, since size is not a guaranty for efficiency, but rather an advantage in the way to achieve it.

Conclusions

We employ traditional nonparametric technique FDH and advanced order α frontier to estimate the efficiency of the teaching and research activities in Romanian universities. Thorough preliminary analysis on the data set revealed two groups of decision making units with high variability between the clusters. This indicated we need to conduct two separate analyses in order to be able to investigate the efficiency estimates. The homogeneous or the small group analysis was made using both FDH and order αefficiency estimators based on three efficiency models regarding research, teaching and an overall efficiency.

The models were constructed such that we were able to investigate the trade-offs between teaching and research activity, given the fact that a professor has limited time to allocate to any of these activities and it may be that sometimes the balance leans more to one of those. Some examples have been found in the analysis.

We find that the universities included in the 2011 advanced research and education category are efficient in one or two efficiency models but not in all three of them. For instance, The Bucharest University of Economic Studies (ASE) has a unitary efficiency estimates in both research and overall efficiency models, but a low efficiency estimate in the teaching model. An analogous situation is found in the case on the Babeş-Boyali University (BBC) with the BBC having a larger efficiency estimates as far as the teaching activities model goes, 0.64 compared to 0.44 for ASE. Another university from this category is the Bucharest University that has a large efficiency estimate for the research model (0.87) and appears to be efficient in the teaching model. The MFI University of Cluj-Napoca also appears to be efficient according to the teaching model. As for the overall efficiency model, one can notice that high efficiency estimates for the universities from this category are also found (in decreasing order) for AIC-Alexandru Ioan Cuza University of Iasi, UPT-Politehnica University of Timisoara, DAV-Carol Davila University of Bucharest, UPB-Bucharest Politehnica University and UNI-Bucharest University.

From this advanced research and education category, the lowest efficiency estimates for the overall model belong to the POP-Gr T PopaUniversity of Iasi and

UTC-Technical University of Cluj-Napoca. Several aspects concerning their object of activity that separates them from the others might be one of the explanations for these efficiency estimates.

Partial frontier analysis revealed that 8 universities are efficient on the 95% partial frontier. Those universities have a publication rate above average, with more than one article per academic staff and relatively high workload per professor, with at least 10 graduates per teacher.

Because of lack of other data, we only focused on research and teaching efficiency, with no direct measure to account for teaching quality. Further analysis would need to account for success rate after graduation and also for teaching quality as reported in student's experience.

Overall managerial efficiency was found for universities with focus on both sides (research and teaching) and the most inefficient universities were found to be the ones in the artistic field. Also, results revealed that universities dimension is not a guarantee for an increase in efficiency and most small/medium size universities remain efficient when bigger universities were introduced in the sample. Further analysis can include the quality of teaching in the models. Because data was difficult to obtain to include the quality of teaching into the research, further analysis can be conducted to provide a better picture of the higher education efficiency.

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Annexes

Annex 1 Summary statistics for original data set

Variable	Min	1st Qu	Median	Mean	3rd Qu	Max
NPROG	1	12	26	60.24	64	451
TOTINM	53	1201	4549	7724	9462	64331
CDID	8	49	115	228.1	311	1247
CDIDW	4	25	68	138.5	196	859
SPEC	0	10	20	48.17	52	250

TOTABS	21	318	1389	2900	3451	61896
PUBISI	0	0	6	39.52	32	457
PUBCAR	0	0	0	2.876	3	52

Annex 2 Summary statistics for small group of universities

Variable	**Min**	**1st Qu**	**Median**	**Mean**	**3rd Qu**	**Max**
NPROG	1	11	18.5	27.29	38.25	104
TOTINM	53	954	3220	3991	5332	16533
CDID	8	40.25	84	115.99	159.5	401
CDIDW	4	20	50.5	68.43	92.75	252
SPEC	0	6.75	14	22.31	30.25	88
TOTABS	21	246.8	918.5	1378.6	1710.5	9054
PUBISI	0	0	2	10.56	16	155
PUBCAR	0	0	0	0.875	1.25	6