IMPACT OF ROMANIAN HIGHER EDUCATION FUNDING POLICY ON UNIVERSITY EFFICIENCY

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Abstract: *The issues of higher education funding policy and university operating efficiency are hot points on the actual public agenda worldwide as the pressures exercised upon the public resources increased, especially in the aftermath of the last economic crisis. Concerned with the improvement of the funding mechanism through which government allocates the public funds in order to meet the national core objectives within the area of higher education, the policy makers adjusted the funding policy by diversifying the criteria used in distributing the funds to public universities. Thus, the aim of this research is to underline both the impact and the consequences the public funding patterns of higher education have on the relative efficiency of public funded higher education institutions, across time. Moreover, the research conducted aims to determine whether the changes occurred within the Romanian public funding methodology of higher education institutions improved the relative efficiency scores of public funded universities, before and after the economic crisis of 2008. Thus, on one hand we have underlined the changes brought to the Romanian public funding mechanism of higher education during the years of 2007, 2009 and 2010 compared to the year of 2006, using the content analysis, and on the other hand we assessed and compared the relative efficiency scores of each selected public funded university using a multiple input - multiple output linear programming model, by employing the Data Envelopment Analysis technique. The findings of the research undertaken emphasized that a more performance oriented funding mechanism improves the efficiency scores of public universities. The results of the research undertaken could be used either by the policy makers within the area of higher education or by the administrative management of public universities in order to correlate the funding with the results obtained and/or the objectives assumed by both the government and the higher education institution as well as to optimize the public funding policy designed according to the degree of efficiency each university accomplishes in using the allocated funds.*

Keywords: public funding policy; efficiency; higher education; performance funding; input-output model; Data Envelopment Analysis.
JEL classification: C67; I23; I22; I28; J18.

1. Introduction

Given the international and European changes that occurred in the last decades within the area of higher education, the issues of financial autonomy and public responsibility universities enjoy were also incorporated into the national regulations regarding the Romanian higher education system (National Law for education, 1995 and 2011). As a consequence, significant system-level and also institutional-level changes, concerning the funding mechanisms through which the public funds allocated to the higher education system are granted to public universities, emerged.

Thus, the national funding mechanism was improved almost annually. More exactly, starting with the year of 2002, the core funding of universities, covering staff and material expenses, was allocated using a funding formula considering, along with the number of equivalent students and the cost indexes for each higher education major field of study, also the aggregate qualitative indicators determined for each public university (Ministry of

Education and Research, 2002).
The diversification registered, after 2003, within both the number as well as the type of qualitative indicators, used for the allocation process of public resources to universities, emphasizes the interest policy makers have in tying the public funding to first quality in higher education and secondly to institutional performance. As Barnetson and Cutright (2000, p.281) underline, using performance indicators might lead to the appearance of financial rewards and punishments, through which the institutional behaviour of educational institutions could be manipulated. Another view upon the reasons for introducing performance indicator within the field of higher education refers to identifying the most efficient way to allocate scarce resource in this field, to manipulating/controlling the higher education institutions or to determine the universities to improve their operational efficiency (Taylor and Taylor, 2003, p.71).
Also, the issues of funding higher education based on input and/or output measures and that of assessing the impact different reforms had on higher education systems and/or universities raised the interest of numerous researchers (Rabovsky, 2011; Frølich et al., 2010), there is still room for a detailed research on the impact and consequences of a particular national funding pattern on the efficiency of higher education institutions.
Moreover, given the increasing pressure on public resources, especially in the aftermath of the economic crisis of 2008, the public decision makers within the area of higher education oriented the funding mechanism to the institutional performance of higher education institutions.
Though different issues regarding Romanian public funding of higher education captured the attention of several researchers (Miroiu and Vlasceanu, 2012; Vasilache et al., 2012), the scrutinized research papers on this topic do not directly address the impact the public funding policy within the higher education industry had on the operational efficiency of public universities.
But, from a theoretically point of view, after recognising both the positive changes as well as the unintended side effects of using performance-based funding methods for higher education institutions, Liefner (2003, p.469) emphasizes that the way the public resources are distributed to universities influences the behaviour of academics and managers, especially in terms of level of activity performed, types of activities envolved into and type of risks assumed.
Based on these circumstances, throughout this paper we conducted a two stage analysis of the national funding pattern of higher education institutions trying to answer the main research questions, i.e. whether and to what extent the changes occurred within the Romanian public funding methodology of higher education institutions improved the relative efficiency scores of public funded universities, before and after the economic crisis of 2008.
Thus, on one hand we underlined the changes brought to the Romanian public funding mechanism of higher education during the years of 2007, 2009 and 2010 compared to the year of 2006, using the content analysis, and on the other hand, we assessed and compared the relative efficiency scores of each selected public funded university using a multiple input - multiple output linear programming model, by employing the Data Envelopment Analysis technique.
The rest of the paper is organized as follows. In section 2 we present the research methodology and data used. Section 3 presents the results of the empirical research, while section 4 deals with a short discussion upon the results obtained and concludes.

2. Data and Methods

The aim of this research is twofold. Thus, the empirical research conducted within this paper uses both qualitative and quantitative data.

As in the first study we underline the changes brought to the Romanian public funding mechanism of higher education during the years of 2007, 2009 and 2010 compared to the year of 2006, the research was based on qualitative data retrieved from legislation and other policy documents within the area of higher education.
The quantitative part of the research aims at assessing the relative efficiency of some Romanian public universities during the selected universities and consists of a Data Envelopment Analysis (DEA). The DEA study was conducted based on publicly available data, reported by the Romanian Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI).

2.1. Stage one – Is the Public Funding Mechanism More Performance Oriented?
In order to answer this research question we have consulted a variety of resources, among which the national Law of education, the annual funding methodologies for public universities and other public reports drawn by The National Council for Higher Education Funding (CNFIS).
The content analysis of all the consulted documents was conducted for the years of 2006, 2007, 2009 and 2010, without excluding the years bringing important reforms within the field of funding universities, focusing on the usage of different qualitative criteria/performance indicators in the core funding of Romanian public universities and on the importance input and /or output indicators play within the national funding formula.
2.2. Stage two – Does the Public Funding Mechanism Influence University Efficiency?
After evaluating the changes occurred within the funding methodology of Romanian public universities, an individual study was conducted for each of the years of 2006, 2007, 2009 and 2010 to empirically determine the efficiency frontier and to assess the efficiency of each of the selected Romanian universities, employing the non-parametric technique of Data Envelopment Analysis, first developed by Charnes et al. (1978).
The mathematical linear programming model used for determining the efficiency scores registered by the universities is an input-oriented one (using variable returns to scale), as we want to find out the proportion in which the input measures could be reduced, in efficiency terms, while obtaining the same results.
Based on the notation and exposition of DEA provided by Din and Cretan (2010), the input-oriented VRS model presented below identifies the VRS frontier, the increasing returns to scale, the constant returns to scale, the decreasing returns to scale, the inefficient units as well as their efficiency target (achieved by reducing inputs).

$$\begin{cases} \min\left(\theta - \varepsilon\left(S^- + S^+\right)\right) \\ \begin{cases} \lambda^t \cdot A_I + S^- = \theta \cdot X_{j_0} \\ \lambda^t \cdot A_O - S^+ = Y_{j_0} \end{cases} \\ 1_n^t \cdot \lambda = 1; \lambda \geq 0, S^- \geq 0, S^+ \geq 0 \end{cases}$$

where:
θ measures the distance between a DMU and the efficiency frontier defined as a linear combination of the best practices observations;
λ is a n-dimensional column of constants measuring the weights used to determine the location of an inefficient DMU, if it were to become efficient;
1_n is a n-dimensional column vector; the constraint $1_n \cdot \lambda = 1$ imposes the convexity of the frontier in the VRS model;
$A_I = \left(x_j^{(i)}\right)_{\substack{j=1,n \\ i=1,m}}$ is the matrix with m columns $X^{(i)}$, input *i* used by all $DMU_j, j = \overline{1,n}$;

$A_o = \left(y_j^{(r)}\right)_{\substack{j=1,n \\ r=1,s}}$ is the matrix with s columns $Y^{(r)}$, output *i* obtained by all $DMU_j, j = \overline{1,n}$;

This image cannot currently be displa... is the matrix of input/output column for the n DMUs;

T h is the line from A matrix containing inputs and outputs corresponding to the DMU under evaluation, i.e. This image...;

S^- is a (m x 1) vector of input slacks

S^+ is a (s x 1) vector of output slacks.

The DEA model was conducted using the data collected only for those Romanian public universities providing degree programs in more than 3 major groups of fields of study out of the total 5 groups of studies , i.e. engineering sciences; social sciences; biological and biomedical sciences; humanities and arts and mathematics, informatics and natural sciences. The data set includes 18 universities public universities, as out of the 49 public universities within the Romanian higher education system only these higher education institutions fulfil the above description.

The quantitative data was provided by the Ministry of Education and Scientific Research, namely the Executive Agency for Higher Education, Research, Development and Innovation Funding (2015). The study was conducted based on the most recent data available, for the years of 2006, 2007, 2009 and 2010, data reported by universities for the academic years of 2005/2006, 2006/2007, 2008/2009 and 2009/2010.

In order to determine the relative efficiency scores for each university we selected the appropriate input and output variables. Thus, the conducted DEA model determines the efficiency scores, based on two input measures and three output measures.

Concerning the input measures, we selected the institutional level of funding allocated under the contract concluded with the ministry, i.e. the amount of budget allocations (I1) and the share of qualitative indicators in total budget allocations - showing the influence quality/performance indicators have on the level of core funding (I2). The second input measure was defined as a controllable variable, as the percentage of public core funding allocated to universities is established by the policy makers within the higher education area, through the annual funding methodologies.

With respect to the output measures we defined three output measures, i.e. the total number of graduates (O1), the level of funds obtained for research projects, through competition, from international research funding institutions (O2) and the amount of revenues obtained from services and products supply (O3).

The descriptive statistics for the input and output measures used for assessing the efficiency scores obtained by the 18 universities, for the first and the last year under analysis, are listed in tables 1a and 1b.

Table 1a: Descriptive statistics of input and output variables, 2006

Variable	Mean	Standard deviation	Minimum	Maximum
I1	37.004.935,72	27.199.937,21	2.780.672	101.167.944
I2	20,85	3,02	16,49	28,98
O1	4.067,33	2.292,14	1.157	9.360
O2	1.356.009,27	1.256.020,31	55.333	4.872.637
O3	6.481.256,88	20.945.030,46	0	89.977.642

Source: Author's computations using the available data

Table 1b: Descriptive statistics of input and output variables, 2010

Variable	Mean	Standard deviation	Minimum	Maximum
I1	54.440.752,28	38.432.895,41	11.197.296	130.156.899
I2	26,41	3,72	19,5	30,92
O1	5.473,61	3.221,85	1.378	12.819
O2	2.381.278,55	2.498.099,46	4.453	9.917.816
O3	9.698.216,72	29.637.299,97	0	127.721.811

Source: Author's computations using the available data

As shown in the tables above, in 2010, compared to 2006, significant improvements took place within the average level of all considered variables.
Finally, the results obtained within each of the year of 2006, 2007, 2009 and 2010 were compared in order to identify the impact the changes occurred within the funding mechanisms had on the efficiency scores registered for each of the 18 Romanian public universities.

3. Findings

The results obtained after conducting both the study on the changes occurred within the Romanian public funding methodology of higher education institutions improved the relative efficiency scores of public funded universities, before and after the economic crisis of 2008, as well as the study on the relative efficiency of each selected public funded university, for the same period are presented in the following lines.

3.1. Stage one

The allocation process of public funds to public universities significantly changed in the year of 2002, when the policy makers decided to incorporate, into the funding formula qualitative indicators. At that moment, the decision to introduce qualitative indicators such as: the share of occupied academic jobs in total academic jobs; the percentage of professor and associate professor positions in total occupied academic positions; the share of academic staff aged under 35 in total academic staff and the percentage of academic staff with a PhD degree in total academic staff, was adopted in order to diminish the adverse effects the existing funding had in terms of academic staff salaries and other expenditures for developing the material base of the universities. Thus, the introduction of qualitative indicators into the funding formula had direct implications on costs and on the efficiency of spending public resources (CNFIS, 2002).
As a result of the Bologna process, between 2003 and 2006, significant changes occurred within the types and number of qualitative indicators included in the funding formula for core funding of universities. But, changes continued to take place in the following years. If at the beginning of introducing qualitative indicators into the funding formula the percentage of funds allocated base on these was representing only 9.7 percent of the total core funding, the importance of these indicators raised significantly until the last year of our analysis, i.e. 2010. The main characteristics of the universities core funding based on qualitative/performance criteria, within the years of 2006, 2007, 2009 and 2010 are listed in table 2.

Table 2: Changes into the core funding of universities, related to qualitative indicators

Core funding	2006	2007	2009 and 2010
Percentage of funds	20%	25%	30%

allocated based on qualitative indicators			
Number of qualitative indicators	13	13	16
Qualitative indicators: • teaching	Quality of academic staff – QAS (3,5% of total core funding); Staff development potential – SDP (2,5% of total core funding)	QAS (**4%**); SDP (**3,5**%)	QAS (4%); SDP (**4,5**%)
• scientific research	Level of performance in scientific research - LPSR (3% of the total core funding); The ratio between the amount of research and design revenues and the total revenue of the university-RARRTR (0,5% of the total core funding);	LPSR (**5%**); RARRTR (0,5%);	LPSR (**7%**); RARRTR (**2%**);
• material base	Quality of equipment –QE (2% of total core funding);	QE (2,5%); **Quality of the documentation means –QDM (0,5%)**	QE (2,5%); QDM (**1%**)
• university management	Quality of academic, administrative and financial management – QAAFM (5,5% of Total core funding); Quality of social and administrative services for students - QSASS (2% of total core funding).	QAAFM (7%); QSASS (2%).	QAAFM (7%); QSASS (2%).

Source: Author's representation based on available data collected from the annual funding methodologies of public universities

3.2 Stage two

With respect to the second stage of the research, the results are summarized in Table 3. As mentioned before, four different DEA models were performed in order to evaluate the relative efficiency of 18 Romanian universities, randomly coded from U01 to U18, two years before the emergence of the economic crisis of 2008 and the following two years after the onset of the crisis.

Out of the four considered years, the lowest average efficiency score was registered in 2009, while the highest average efficiency score was obtained in the year of 2007. Though, the percentage of universities operating on the efficiency frontier is the lowest in 2006 and the highest in 2007 and 2010.

Thus, the findings suggest that two out of the 18 universities efficiently use the inputs in obtaining the same level of results in terms of graduates, international research funds and revenues from services and products supply, in each of the considered years. Moreover, other two universities manage to obtain the maximum efficiency score in 2007, 2009 and 2010, but starting from initial efficiency scores that differ significantly (0,395 versus 0,944).

Table 3: Efficiency scores of Romanian public universities

University	Efficiency score			
	2006	**2007**	**2009**	**2010**
U01	0,676	0,733	0,702	0,834
U02	0,307	0,612	0,213	0,267
U03	0,395	1	1	1
U04	0,216	0,188	0,201	0,175
U05	0,479	0,787	0,421	0,398
U06	1	1	1	1
U07	0,880	0,383	0,347	0,471
U08	0,853	1	0,757	0,858
U09	0,394	0,376	0,587	1
U10	1	0,802	0,690	0,768
U11	0,627	0,646	0,503	0,532
U12	0,140	0,279	0,175	0,338
U13	0,560	0,614	0,572	0,737
U14	0,279	0,671	0,390	0,483
U15	1	1	1	1
U16	0,252	0,279	0,297	0,327
U17	0,374	0,330	0,311	0,220
U18	0,944	1	1	1
Minimum values	0,140	0,188	0,175	0,175
Maximum values	1	1	1	1
Mean	0,576	0,650	0,565	0,634
Standard deviation	0,302	0,287	0,294	0,307
Number of efficient universities	3	5	4	5

Source: Author's computations using DEA Frontier Software for benchmarking (Free version), available online at http://www.deafrontier.net/frontierfree.htm, based on the available data

As the efficiency scores below 1 show the inefficiency of universities in using the inputs, with respect to the rest of the universities considered within the analysis, in the last two years under analysis 50% of these registered reductions in the level of the relative efficiency scores, at least compared to the year of 2006. Furthermore, if we evaluate the minimum values of the efficiency scores we find out that among the inefficient higher education institutions there are some very inefficient units, compared with the average efficiency.
Also, to improve the efficiency of less efficient universities, these should adjust the level of one, two or all output indicators, while using fewer resources.

5. Concluding Remarks

The results of the two studies conducted within this paper confirm the hypotesis that a more performance oriented funding mechanism leads to the improvement of the efficiency scores of public universities. Thus, for the year of 2007 the percentage of public funds allocated to public universities, based on qualitative indicators, grew with 5 pp, compared to the year of 2006. The result of the DEA for the year of 2007 show us that the average relative efficiency score registered by the Romanian selected universities grew from 0,576 in 2006 to 0,650 in 2007. The number of efficient universities grew up with 8,33 %. Theoretically, the average growth in 2007 was quite high since the average share of qualitative indicators in total budget allocations was 27,09%, compared to share of 25% of the total core funding that was allocated, on qualitative criteria, to all 49 public universities.
In both 2009 and 2010 the percentage of public funds allocated to public universities, based on qualitative indicators, grew with 5 pp, compared to the year of 2007 and with 10pp, compared to the year of 2006. Though the funding policy moved in the same way as in 2007, the efficiency scores registered by the selected Romanian public universities decreased compared to the year of 2007. This result obtained for the years of 2009 and 2010 is the consequence of the fact that even if the whole percentage of public funds allocated to universities on efficiency criteria grew up to 30%, the average share of qualitative indicators in total budget allocations was only 24,77% in 2009 and 26,41% in 2010.
Considering all the above facts and results, the more quality/performance oriented is the funding method of public higher education institutions, the more operational efficient become public universities.
The results of the research undertaken could be used either by the policy makers within the area of higher education or by the administrative management of public universities in order to correlate the funding with the results obtained and/or the objectives assumed by both the government and the higher education institution as well as to optimize the public funding policy designed according to the degree of efficiency each university accomplishes in using the allocated funds.

6. Acknowledgements
This work was cofinanced from the European Social Fund through Sectoral Operational Programme Human Resources Development 2007-2013, project number POSDRU/159/1.5/S/134197 „Performance and excellence in doctoral and postdoctoral research in Romanian economics science domain".

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