EVALUATING THE EFFICIENCY OF HIGHER EDUCATION

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Introduction

The reform of higher education in Ukraine does not give a positive result due to the lack of justification of most actions. This country has about 300 universities and still nobody conducted a deep analysis of efficiency of their work. The Ministry of Education and Science is trying at all costs to reduce the number of universities, but whether this will give any results - nobody knows.

Existing ratings of Ukrainian universities show only the quantitative outputs of their scientific work and visibility in the Internet relaying on the data from Scopus and Webometrics (e.g. see Osvita, 2016 or Euroosvita, 2016). But they do not try to compare the outputs with inputs, and answer the question of what is a price of their getting.

Thus, the efficiency of the universities in Ukraine is still undiscovered. Without knowing the efficiency, we cannot hold a successful reform and achieve the high goals.

So the purpose of this study is to find an appropriate way to evaluate the efficiency of higher education in Ukraine.

Literature Review

There are a lot of publications concerning efficiency of educational institutions. While looking for appropriate method to evaluate the efficiency of higher education in Ukraine, we tried to consider the recent publications from the reputable publishers, institutions and authors. All of them were grouped into developed and developing countries to find possible specifics of evaluating.

Studies for Developed Countries

Wolszczak-Derlacz, J. (2014) uses data envelopment analysis (DEA) to evaluate the relative efficiency of 500 higher education institutions (HEIs) in ten European countries and the U.S. for the period between 2000 and 2010. Efficiency scores are determined using different input-output sets (inputs: total revenue, academic staff, administration staff, total number of students; outputs: total number of publications, number of scientific articles, graduates) and considering different frontiers: global frontiers (all HEIs pooled together) and a regional frontier (Europe and the U.S. having their own frontiers). Changes in total factor productivity are assessed by the means of the Malmquist index and are decomposed into pure efficiency changes and frontier shifts. Also the external factors affecting the degree of HEI inefficiency, e.g. institutional settings (size and department composition), location, funding structure are investigated (using two-stage DEA analysis following the bootstrap procedure proposed by Simar and Wilson, 2007). Specifically, it is found that the role of the university funding structure in HEI technical efficiency is different in Europe and in the U.S. Increased government funding is associated with an increase in inefficiency only in the case of European units, while the share of funds from tuition fees decreases the efficiency of American public institutions, but relates to the efficiency improvements in European universities.

Veiderpass and McKelvey (2016) note the lack of comparable data when comparing the performance of higher education institutions. These authors' remedy for the shortcomings of earlier studies is the use of a unique database that allows studying a broad diversity of organizations as well as organizations located in a number of different European countries. Veiderpass and McKelvey (2016) suggest evaluating a performance of HEIs in a production theory context, applying the well-known data envelopment analysis (DEA) method to cross-section of 944 HEIs in 17 European countries. The DEA approach is particularly suitable in this context, where little is known about production technologies and economic behaviour of the HEIs. These authors found that, on average, provision of education is found to be most efficient in the Slovak Republic followed by Belgium and Latvia, while Denmark and Norway display the lowest efficiency. This study also indicated a positive relation between efficiency and HEI size and efficiency and research intensity. Furthermore, the study pointed to the importance of continued data collection.

Cunha and Rocha (2012) applied DEA techniques to evaluate the comparative efficiency of public higher education institutions in Portugal. The analysis is performed on three separate groups: public universities, public polytechnics and the several faculties of University of Porto. Using several inputs and outputs at the institutional-level, these authors were able to identify the most technically efficient institutions that may work as a benchmark in the sector. The results suggested that a great portion of institutions may be working inefficiently, contributing to a significant waste of resources.

Johnes and Johnes (2013) used various stochastic frontier models to evaluate efficiency in English higher education institutions over the period 2003/04 to 2010/11, and over three sub-periods within that time frame. The stochastic frontier approach involves fitting a curve through data on costs and a variety of explanatory variables. This is not, however, a line of best fit; rather it is an envelope that defines an efficiency frontier – a curve that shows the lowest possible costs at which a given set of outputs can be produced. The position of this curve can then be used as a benchmark against which the efficiency with which each institution produces its output can be determined.

A key finding of the Johnes and Johnes (2013) study is that, once differences between institutions are accounted for 1, the variation in efficiency scores across institutions is greatly reduced, with a concentration of scores above 0.9 (where a score of one represents efficiency). Indeed, the relatively small number of institutions with low scores is exclusively made up of small and specialist institutions. The results do not, therefore, support the notion that substantial sector-wide gains could be made by using efficiency scores as a criterion for resource allocation.

Anderssona et al. (2016) investigated technical efficiency and productivity for Swedish HEIs. One identified problem in previous research concerns adjusting efficiency scores for input quality. This problem is avoided using grades from upper-secondary schools. A second problem concerns heterogeneity with respect to subjects and institutions between HEIs. Using the Swedish national resource allocation system, students are weighted according to subject. For research production, a bibliometric index that allows for differences in publication tradition is used. A third problem when using the DEA approach is the lack of statistical inference. These authors used bootstrapping to approach this problem. The results indicate an average inefficiency of 12% and a productivity increase of around 1.7% per year.

Studies for Developing Countries

Ramírez-Correa et al. (2012) estimated the efficiency for a group of Chilean universities, based on data envelopment analysis (DEA) technique, taking into account the reality of the Chilean university system. A DEA model with two input variables [operating expenses and academics full time equivalent (FTE)] and three output variables (operating income, Institute for Scientific Information (ISI) publications and student enrolments) was developed to evaluate the performance of 34 Chilean universities. The empirical results indicate that 9 of each 34 institutions are efficient to financial performance level, and at the research and teaching levels. In addition, these do not reveal significant statistical differences, between the efficiency of public and private institutions.

Kulshreshtha and Nayak (2015) examined the technical efficiency (TE) of eight important higher technical educational institutions (HTEIs) in India, namely, seven Indian Institutes of Technology (IITs) and Indian Institute of Science (IISc), by applying Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) to balanced panel data during 2001-2005. The study uses the input-oriented and output-oriented stochastic distance function models, as well as constant returns to scale DEA approach to measure the TE of the above institutions. This paper demonstrates that TE varies across the above HTEIs and highlights the need for strengthening the know-how (concerning higher technical education) of the Indian HTEIs, so that they can exploit the full potential of the existing educational inputs.

Srairi (2014) examines the relative efficiency of eleven public universities in Tunisia during the period 2009-2013 using a nonparametric approach. A two-stage analysis was utilized to evaluate three efficiency scores in examining trends over time and comparative efficiency analysis was performed on university size. This author attempts to determine the sources of university efficiency regressing the efficiency scores against a set of environmental variables. Empirical results indicate that after 2011 efficiency scores for all universities decreased and most technical inefficiencies are related to scale inefficiency rather than managerial inefficiency. Findings also reveal that medium and small universities are more efficient than large universities. Using the Tobit regression analysis this author found that the location of the university in developed region, a higher share of professors and associate professors, a higher number of women in academic staff and a better quality of student in secondary education improve the efficiency of the university. It was found that the size of the university and the load per teacher have a negative impact on the university's technical efficiency.

To conclude this review we should note the results of the study by De Witte and López-Torres (2015), which made an extensive overview of the literature on efficiency in education. These authors have summarized the earlier applied inputs, outputs and contextual variables, as well as the used data sources of papers in the field of efficiency in education. Moreover, they reviewed the papers on education that applied methodologies as DEA, Malmquist index, bootstrapping, robust frontiers, stochastic frontier analysis (SFA).

Therefore, as we can see above, DEA and SFA are the most widespread methods to evaluate relative efficiency of the higher education institutions both in developed and developing countries. Each of them has its advantages and disadvantages.

What Evaluating Method Is Better?

In 1977 several scholars contemporaneously have proposed stochastic models of production frontier, which take into account the technical inefficiency and recognize the fact that the production can be influenced by the random shocks that are not controlled by the producers (Goncharuk, 2011). The method of constructing the production frontier and calculating the efficiency scores by the means of these stochastic models was named stochastic frontier analysis (SFA). Coelli et al. (2005) defined the SFA as a method for frontier estimation that assumes a given functional form for the relationship between inputs and an output.

Using SFA in higher education needs a cross-section or a panel sample of HEIs. For the panel sample it does not require the condition of balance. For the production function it requires the quantitative data about inputs and output, for the cost function – a quantitative data about inputs and output, and the data about prices of products.

The main advantages of SFA use in higher education can be formulated as the following:

(a) It enables to take into account a certain kind of random error and, simultaneously, to estimate the element of inefficiency.

(b) It is suitable for modelling the influence of other factors on performance (quality, environment, etc.).

(c) It relies on a strong theory of significance tests (sensitivity, resampling, bootstrapping, asymptotic theory).

(d) Change in efficiency can be decomposed into components: the change of technical efficiency, technological change, scale change.

At once SFA usage has serious disadvantages:

(a) It requires an assumption about the functional form of the model and determination of the production technology.

(b) It requires assumption about the functional form of placement of the error term and inefficiency.

(c) In the analysis of the production function it can considers only one output indicator.

(d) In the analysis of the distance function it is difficult to explain obtained coefficients.

(e) In the analysis of the cost function it may be difficult to get exact prices for inputs.

(f) It is difficult to calculate.

DEA as well as the SFA is a frontier method. However, the DEA uses linear programming methods to construct non-parametric piecewise surface (frontier) for a sample of HEIs, and the calculation of the efficiency with respect to this surface. DEA methodology is based on the approach of piecewise-linear convex envelope to calculate the frontier proposed by M. Farrell (1957). For more than two decades this approach has remained in the shadow and only some authors attempted to solve the problem with mathematical programming methods. And only after the publication of an article by A. Charnes et al. (1978), where was first used the term "Data Envelopment Analysis" and the model of linear programming to solve the problem of frontier constructing and efficiency estimation, this method has received recognition and development.

Usually (see Goncharuk, 2007a; Goncharuk, 2007b) the choice of the DEA is predetermined by the following advantages:

(a) it gives an opportunity to include in a model few inputs and outputs that allows estimating efficiency without calculation of a sole parameter of input or output;

(b) absence of necessity to choose the functional form of production function;

(c) it allows to analyse the efficiency in cases when it is difficult enough formally to explain relation between numerous resources and outputs of industrial system;

(d) it enables to estimate the contribution of each of inputs to overall efficiency (or inefficiency) of the companies and to estimate a level of inefficiency of each input;

(e) and besides an estimation of technical efficiency, it enables to estimate other kinds of efficiency, for example, economic efficiency.

Besides, DEA method supposes simultaneous use both cost and physical units that enables to generalize heterogeneous inputs and outputs.

The main disadvantages of the DEA usage in higher education are the following:

(a) It does not provide a test for errors, i.e. DEA assumes that the errors in the original data are not available.

(b) The sensitivity of results to the number of variables in the model and number of observations, i.e. when the number of factors in the model increases and the number of observations decreases, then the number of HEIs that lie at the efficiency frontier increases.

Hence, we can conclude that SFA can be better efficiency evaluating method for higher education in the following cases:

(1) If we have only one output,

(2) If we need to decompose efficiency into main components,

(3) If we need to model the influence of various factors on HEIs' efficiency.

In other cases the DEA is better for evaluating efficiency. However, in order to use DEA for HEIs efficiency analysis we must be sure that our sample has enough data and this data doesn't have errors. This conditions cause us to discuss the problems with the data selection for efficiency evaluation.

What Data Should Be Collected and Evaluated?

To use DEA we need to have large and a valid database (without errors) like EUMIDA European University Data Collection, where a large number of HEIs' indicators can be found.

Berbegal Mirabent and Solé Parellada (2013) notes that globalization and the knowledge-based society have driven universities to an intense competition for the best professors, researchers and students. Yet, rankings and reports measuring how universities perform are available in abundance. Among these assessment tools it is worth highlighting those based on Data Envelopment Analysis (DEA), which since the 1980s have risen considerably. However, there is a lack of consensus when selecting the indicators that represent the inputs and outputs of such institutions in a best way. Aiming to clarify how these proxies are chosen, these authors do an exhaustive review of the indicators used in DEA empirical studies in the last decade, classifying them according to their nature and use.

We tried to systematize the main approaches to the data selection for DEA separately for inputs and outputs.

Inputs

As Cheslock et al. (2016) noted the researchers face multiple challenges when studying the cost of producing higher education, which has led many to avoid this topic altogether. As a result, higher education scholarship provides little guidance to institutional leaders aiming to reduce costs in response to financial difficulties. These authors use five major determinants of costs: size, scope, level of instruction, discipline, and revenues, and examine how costs can be decreased through reducing scope, increasing economies of scale, eliminating the cost disease, and altering incentives.

This and other approaches to choose the inputs we systematized in the Table 1.

Table 1. Variables and Approaches to Inputs Choice

Authors	Inputs (Variables)	Approach
Srairi (2014)	Number of academic staff Number of non-academic staff Non-labour expenditures Number of students	Mixed (quantitative and cost)
Cunha and Rocha (2012)	Total Funding per student Total Expenditure per student Academic Staff per Student	Mixed (cost and qualitative)
Ramírez-Correa et al. (2012)	Number of full-time academic staff Operating Expenditures	Mixed (quantitative and cost)
Agasisti and Pohl (2012)	Total number of students Number of academic staff Expenditure	Mixed (quantitative and cost)
Bonaccorsi et al. (2014)	Number of non-academic staff Number of academic staff Personnel expenditure Non-personnel expenditure	Mixed (quantitative and cost)
Parteka and Wolszczak-Derlacz (2013)	Academic staff Total revenue Number of students	Mixed (quantitative and cost)
Selim and Bursalıoğlu (2015)	Central government budget appropriations Own revenue Number of scientific research projects Number of academic staff	Mixed (cost and quantitative)
Ramzi and Ayadi (2016)	Number of students enrolled in Letter Number of students enrolled in Computer Sciences Media and Telecom	Quantitative

Source: Own Compilation and Grouping

It appears that practically all sets of inputs are mixed and have quantitative and cost nature. Such mixes are possible in DEA, and researchers actively used this advantage.

We found very poor usage of quality indicators in inputs sets. It can be explained by quantitative and cost nature of the HEIs' resources.

Outputs

Outputs should reflect the results of the HEIs. We systematized output variables and approaches in the Table 2.

Unlike inputs sets, we found many outputs sets with mixed as well as quantitative nature. Overall, in all outputs sets, the quantitative variables dominate.

Table 2. Variables and Approaches to Outputs Choice

Authors	Outputs (Variables)	Approach
Srairi (2014)	Number of graduates Total amount of research grant Rate of success (Ratio of number of students who passed the exam to number of students who sat for the exam)	Mixed (quantitative, cost and qualitative)
Cunha and Rocha (2012)	Total graduate students Total PhD degrees awarded Total number of courses	Quantitative
Ramírez-Correa et al. (2012)	Number of students Number of ISI publications Operating income	Mixed (quantitative and cost)
Agasisti and Pohl (2012)	Number of graduates Total amount of external grants and contracts for research	Mixed (quantitative and cost)
Bonaccorsi et al. (2014)	Total degrees ISCED 5 Total degrees ISCED 6 PUB Number of published papers International collaboration Normalized impact High quality publications Excellence rate	Mixed (quantitative and qualitative)
Parteka and Wolszczak-Derlacz (2013)	Number of graduates Number of publications indexed in Web of Science	Quantitative
Selim and Bursalıoğlu (2015)	Number of graduates per academic Number of post-graduates per academic Number of doctorates per academic Number of publications Number of students graduating who are employed	Quantitative
Ramzi and Ayadi (2016)	Number of research units and laboratories Number of graduates from fundamental and applied license	Quantitative

Source: Own Compilation and Grouping

Summarizing the input and output sets, we note that none of them consists exclusively of quality indicators.

Besides, some variables are considered as inputs and outputs, e.g. Number of students. This paradox reflects the dual nature of some total indicators of HEIs' work. Some researchers consider students as the consumers (clients) of HEIs' services and as output variable for DEA, but the other think them as HEIs' resource for development and include the number of students in inputs set.

This paradox (contradiction) explains the lack of a unified approach to the selection of indicators to evaluate the efficiency of HEIs.

Discussion and Conclusions

The study allowed identifying new issues that need to be addressed in the future.

On the one hand, to understand the nature of the efficiency of higher education in different countries, we need a common approach and a unified set of data for both inputs and outputs. As the study shows, the variables in different researches sometimes coincide, but not always.

On the other hand, we found a contradiction, which makes it impossible to create a unified performance evaluation system for higher education. This contradiction reflects the dual nature of some total indicators of HEIs' work, where the same indicator can be considered as an input and as an output.

Therefore, this dualism explains the lack of a unified approach to the selection of indicators to evaluate the efficiency of HEIs.

Each country adopted its own database of higher education indicators, and it is unlikely we will find in Ukraine the same set of available indicators like in the EU or in other countries. Hence, evaluation of higher education in Ukraine can be performed on the basis of the available indicators, which can have both quantitative and qualitative nature.

We found the most appropriate methods for performance evaluation of higher education – SFA and DEA. Moreover, SFA is more appropriate if we have only one output, need to decompose efficiency into main components and need to model the influence of various factors on HEIs' efficiency. In other cases the DEA is better for evaluating efficiency. However, in order to use DEA for HEIs efficiency analysis we must be sure that our sample has enough data and this data doesn't have errors.

The results of this study may be useful for scholars, government officials and education practitioners, who wish to evaluate an efficiency of HEIs and looking for an appropriate method and indicators.

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Abstract

In searching for an appropriate way of evaluating performance of higher education the author found a contradiction, which makes it impossible to create a unified performance evaluation system for higher education. This contradiction reflects the dual nature of some total indicators of higher education institutions’ work, where the same indicator can be considered as an input and as an output. This dualism explains the lack of a unified approach to the selection of indicators to evaluate the efficiency of higher education. The study found the Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) to be the most appropriate methods for performance evaluation of higher education under specific conditions.

Keywords: efficiency, evaluation, higher education institutions, DEA, SFA